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Final Environmental Impact Statement
Exxon Coal and Minerals Co. Zinc-Copper Mine
Crandon, Wisconsin

November 1986



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Cover graphics (top to bottom)

Oblique aerial photograph looking northeastward across the area where the proposed mine/mill complex and mine waste disposal areas would be developed. Lakes from left to right are Little Sand, Duck, and Deep Hole.

Artist's rendition of landscaped mine/mill complex.

Artist's rendition of mine/mill complex, mine waste disposal facility (MWDF), and nearby facilities superimposed on oblique aerial photograph. The four cells of the mine waste disposal facility are illustrated as they might appear in mid-project: pond T1 reclaimed and vegetated (green), pond T2 partly reclaimed (green and brown), pond T3 in use (blue), and pond T4 under construction. North of the MWDF are the reclaim ponds (blue), refuse landfill, and construction support area.

Artist's rendition of major aboveground project developments superimposed on a vertical aerial photograph to show the relationship between the proposed facilities and surrounding landscape features. The lakes from far left to far right are Mole, Oak, Little Sand, Duck, and Ground Hemlock.

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ENVIRONMENTAL IMPACT STATEMENT PROCESS

The Wisconsin Environmental Policy Act (WEPA), Section 1.11, Wisconsin Statutes, requires state agencies to prepare an environmental impact statement (EIS) for environmentally significant actions. Exxon Coal and Minerals Company has proposed to construct and operate an underground zinc-copper mine near Crandon, Wisconsin. This proposal is considered a major and significant action requiring an EIS. Exxon has applied to the Department of Natural Resources (DNR) for permits and approvals necessary to construct the mine. In addition, the Wisconsin Public Service Corporation, the utility serving the Crandon area, has applied to the Public Service Commission (PSC) for permission to build electric transmission and natural gas lines to the mine site. The EIS must be completed before either agency can act on these requests.

The draft EIS (DEIS) was circulated to state, federal and local agencies, as well as the public, following its release on May 12, 1986. An informational meeting to receive public comments on the DEIS was held in the Nashville Town Hall near Crandon on June 20 and 21, 1986. Both written and oral comments received at the informational meeting and additional comments received during the comment period, which ended July 7, 1986, were used to develop this final EIS (FEIS). A summary of the public comments received, agency comments, and DNR and PSC responses to those comments are contained in Chapter Five.

This FEIS is being circulated to commenting agencies and the public for final review. Following a 120 day mandatory review period, there will be a hearing on the FEIS and permit applications. The DNR and PSC will provide notice of the hearing procedures, location, and other details.

Specific questions relating to the FEIS for the proposed Exxon Mine, or to EIS procedures should be directed to the Bureau of Environmental Analysis and Review at 1-800-232-7367.

Comments or questions should be sent to:

Mr. Howard S. Druckenmiller, Director
Bureau of Environmental Analysis and Review
Department of Natural Resources
P.O. Box 7921
Madison, WI 53707

EXXON COAL AND MINERALS COMPANY ZINC-COPPER MINE

EIS SUMMARY

DESCRIPTION OF THE PROPOSED PROJECT

Exxon Coal and Minerals Company has proposed to construct and operate a zinc and copper mine/mill near Crandon, Wisconsin. The orebody proposed for development has recoverable ore reserves estimated at 67.4 million tons. The mine/mill would employ approximately 620 persons during operation. The timetable for the proposed project calls for a construction period of 3 years, operations for 29 years, and 4 years for closure and final site reclamation. Actual construction and operation of the proposed project would depend on market factors, permit issuance, conditions of the permits, and Exxon Coal and Minerals Company objectives.

The underground mine would be a highly mechanized operation which would first remove the zinc-rich massive ore over a 16 year period. If copper prices warrant, the copper-rich stringer ore would be mined over a 13 year period following massive ore removal. The metals in each ore would be concentrated on the surface in the mill and shipped by rail out of Wisconsin for smelting and refining. Approximately 7.2 million tons of metal concentrates would be produced during massive ore processing compared to 2.1 million tons during stringer ore processing.

The major surface facilities include mine support and mill facilities, the mine waste disposal facility (MWDF), reclaim ponds, mine refuse disposal facility (MRDF), and service corridors. The service corridors would include an access road from State Highway 55, a railroad spur from the Soo Line, and electric and natural gas utilities. The mill facilities include ore storage and processing buildings, offices, warehouses, shops, fuel and explosives storage, and wastewater and sewage treatment systems.

Intercepted groundwater and contaminated mine water pumped from the mine would be treated in separate systems and discharged to Swamp Creek, used as augmentation water for mitigating surface water impacts, or used as mill process water. Process water would be recycled within the mine operation. The two reclaim ponds, an integral part of the water treatment process, would receive water from the MWDF, MRDF, the mill, and other minor sources. There would be two synthetic geomembrane liners beneath the reclaim ponds. Wastewater from the treatment plant would be discharged via a buried pipeline to Swamp Creek downstream from the Mole Lake Indian Reservation.

Mining and ore processing would generate significant quantities of waste materials. The MWDF (four sequentially constructed, lined, earthen tailings ponds) and MRDF (three lined cells), located about one mile southeast of the mine/mill, would provide aboveground disposal of tailings/water treatment sludges and refuse, respectively. About 28.3 million tons of fine tailings would be disposed in the tailings pond while 30.3 million tons of coarse tailings would be used underground as mine backfill. About 102,000 cubic yards (51,000 tons) of general refuse would be disposed in the on-site landfill over the life of the mine. Each tailings pond and landfill cell would have a low permeability, bentonite-amended soil liner and leachate collection systems on the bottom and sides. After filling, each tailings pond and landfill cell would be capped with a bentonite-amended soil liner, a very low permeability synthetic membrane, glacial till, and then revegetated. Only one tailings pond and one landfill cell would be filled at a time.

Total project costs, in 1985 dollars, are estimated at $540 million. Construction costs for the mine/mill are anticipated to be nearly $340 million. Construction of the tailings ponds and water treatment facilities would cost an additional $50 million. Operation costs of project facilities over the 29 year life of the project would be about $109 million. Reclamation of the mine/mill facilities would cost about $35 million. The estimated total cost to the utilities (Wisconsin Public Service Corporation and ANR Pipeline Co.) for the construction of the natural gas pipeline and electric transmission line ranges between $5-6 million.

Monitoring would be used to detect environmental changes and determine compliance with environmental standards. The Department must approve the program to address air quality (e.g., suspended particulates, asbestiform fibers, heavy metals), surface water quality and quantity, groundwater quality and quantity (including private water wells), fish and other aquatic organisms, and wetlands monitoring. Monitoring would begin prior to project construction (to estabish baseline conditions) and continue until closure. Groundwater levels and quality would be monitored for at least 30 years following approved project closure.

Petroleum products (diesel oil and gasoline) would be used to power all mobile mine/mill/MWDF surface equipment and emergency electrical generators. Natural gas, supplied by pipeline, would be used for mine air heating, building heating, and to power the evaporation equipment in the reverse osmosis water treatment unit. Electrical energy, supplied by 115 kV powerline, would be used for lighting and to power the ore drilling, transporting, and processing equipment.

During closure, all equipment, buildings, and bridges without an approved alternative use would be removed or demolished and buried at the site. Closure wastes left at the site would either be disposed in the MRDF or covered with at least 18 inches of soil and revegetated. The main shaft and ventilation shafts would be capped with reinforced concrete at the bedrock-glacial overburden interface and filled to the surface with glacial till. Recyclable material from the access corridors would be removed and the corridors graded and revegetated. Permanent access to the MWDF and monitoring wells would be provided by a town road.

DESCRIPTION OF THE AFFECTED ENVIRONMENT

The project is located in rural northeastern Wisconsin, about five miles south of Crandon (population 4,000 including surrounding townships), 28 miles east of Rhinelander (population 16,000 in area) and 29 miles northeast of Antigo (population 10,000 in area). The region is known for its outdoor recreation activities, tourism, and commercial logging. The project site is primarily northern hardwood forest interspersed with numerous wetlands. The orebody is near Swamp Creek, a tributary to the Wolf River, and is surrounded by lakes and trout streams. Groundwater in the area is primarily contained in sandy glacial deposits ranging from 50 to 350 feet thick. Groundwater from the proposed mine site ultimately discharges into nearby lakes and streams.

The Mole Lake Chippewa Indian Reservation is located about 2 miles west of the mine site. Swamp Creek flows through Rice Lake on the reservation. The Forest County Potawatomi Indians have scattered tribal lands northeast of the project.

ENVIRONMENTAL IMPACTS OF THE PROPOSED PROJECT

Project facilities would directly affect about 866 acres of land, including 738 acres of forest, 82 acres of wetlands and 46 acres of open land. Of these totals, the MWDF would permanently cover about 365 acres of land including about 49 acres of wetlands. The tailings would constitute a potential source of groundwater contamination and would require long-term isolation. The MWDF cap, comprised of a bentonite/soil layer and a synthetic membrane, should essentially eliminate infiltration of water into the tailings. For impact modeling, however, an infiltration rate of 0.067 inches per year (through the membrane) was assumed. This approximates a 10% failure of the synthetic membrane. Computer projections at this infiltration rate indicate maximum (steady state) concentrations of sulfate, the predominant and most mobile leachate constituent, could range from 45 to 800 mg/l at the compliance boundary 1200 feet from the facility. Approximately 1,500-9,000 years would be required before steady state concentrations would be reached. The modeling further indicates that after 500 to 2,000 years, the 250 mg/l groundwater quality standard could be exceeded. Manganese concentrations also may be elevated above the 0.05 mg/l drinking water standard, but since background manganese concentrations in the glacial aquifer average eight times the drinking water standard the additional impact may not be noticeable.

Pumping water from the underground mine would cause the groundwater table to decline over a large area. Twenty-seven private wells would be affected by the groundwater drawdown. Exxon would deepen or replace effected wells prior to project construction.

Impacts of the groundwater drawdown on surface waters were analyzed both with and without Exxon's mitigation proposal. Without mitigation, the drawdown would lower the average levels of several lakes and decrease flows in area streams and springs. Computer modeling shows that the level of Little Sand Lake would drop about 7 feet. Skunk and Deep Hole Lakes also would be significantly affected. However, regional lakes including Ground Hemlock, Rolling Stone, St. Johns, and Walsh Lakes would not be significantly impacted. Hemlock, Hoffman, and Upper Pickerel Creeks along with two unnamed creeks (12-9 and 11-4) would experience reduced flows. Swamp Creek (above Rice Lake) also would be adversely affected during periods of low flow. Available habitat for fish and other aquatic organisms and trout spawning habitat would be substantially decreased.

Exxon proposes to mitigate surface water impacts by pumping water from a system of interception wells near the mine in the glacial aquifer, from the uncontaminated groundwater collection system within the mine and from dedicated wells near streams. Exxon's plan, however, may not provide sufficient water to mitigate all impacts to surface waters. Pumping groundwater from around the mine and from dedicated wells near streams for mitigation would further reduce groundwater contributions to surface waters, potentially resulting in a shortfall of mitigation water. Any shortfall could cause detrimental impacts to public rights in these waters. The specific rights and/or surface waters which would be affected by a shortfall would depend on how the available mitigation water was allocated.

The approximately 1300 gpm of wastewater discharged to Swamp Creek would contain sulfate and very low levels of various metals. A moderate increase in sulfate and very small increases in metals levels would result in Swamp Creek. A slight increase in sulfate and little or no change in metals concentrations would occur in the Wolf River below the confluence of Swamp Creek. No long-term impacts to aquatic life or other uses of these or downstream waters are expected.

Leachate seeping from the MWDF would enter the groundwater and eventually discharge into area streams. The contaminant plume would primarily flow eastward toward Hemlock Creek with a smaller plume flowing to the southwest. The computer predicted maximum (steady state) sulfate concentration would be 6.9 mg/l in Hemlock Creek and 0.35 mg/l in Creek 12-9. These concentrations would not represent appreciable changes in water quality. Other leachate contaminants would not be expected to move far from the MWDF. Formation of an acidic solution from pyrite oxidation in the tailings is not expected to be significant due to the nearly anaerobic conditions and long-term reduction of most infiltration.

Air pollutant emissions during construction and operation would not cause any exceedance of air quality standards and would not be noticeable more than a few miles from the project site. Concentrations of toxic metals for which standards have not been established would be substantially below existing guidelines. Total suspended particulates (TSP) would be the pollutant with the highest emission rate. Dispersion modeling projects an increase in TSP levels, but not beyond those found in other rural areas. Deposition of toxic metals on the mining site and on area lakes would be insignificant.

Noise from construction and operation phases would be audible at several sensitive receptor locations. Project noise could reach levels which people might find disturbing at Little Sand and Ground Hemlock Lakes and at other areas within a 2 to 3 mile radius of the mine.

Approximately 25% of the construction jobs and 50% of the 620 direct operation jobs at the mine/mill could be filled by area residents. The remaining jobs would be filled by inmigrants. An additional 310 jobs would result indirectly from the project. About 1600 new residents, including 700 school age children, are projected to locate primarily in the Crandon, Antigo, and Rhinelander areas. Approximately 480 new housing units would be required during the operations period. Due to the projected increase in school-aged children, the Crandon, Elcho, Rhinelander and Antigo School Districts would have increased costs. Local municipalities would need to provide services for the inmigrant population and related development. Forest County, the Crandon School District, and the Township of Lincoln would experience significant reductions in property tax rates.

Some jurisdictional or cost/revenue timing mismatches would occur, resulting in isolated fiscal shortfalls. The local native American communities would likely experience some adverse sociocultural impacts. Production of wild rice on Rice Lake would not be affected by the project. The project could result in net proceeds taxes of up to $118 million and corporate income taxes of up to $101 million depending on metals prices. The project would not likely result in a net substantial adverse economic impact to the area.

No significant impacts are anticipated for the local or regional tourist industry or outdoor recreation activities associated with the Wolf River. Impacts from increased rail and highway transportation are predicted to be negligible due to the small increases in traffic.

ALTERNATIVES TO THE PROPOSED PROJECT AND THEIR IMPACTS

Alternative sites were evaluated for all of the major project facilities. About 35 different sites were considered for the MWDF. Most of these sites are natural valleys and are undesirable because of adverse impacts to streams and wetlands. Several other sites were eliminated from further consideration due to highly permeable soils and shallow depth to groundwater. The two most favored locations are upland sites close to the mine with only minor environmental differences. Of the two, Exxon's selected site would provide greater groundwater protection and reduced soil borrow requirements.

Alternative routes also were considered for facilities located within corridors. Six corridors were evaluated for the railroad spur. The proposed route would result in the least environmental, construction and operational problems. Twelve alternative access road routes were considered. Several routes would result in less environmental damage but would either cause safety problems or are on lands unavailable to Exxon.

Eight alternative routes were evaluated for the electrical transmission line from Monico to the mine. Although the proposed route is one of the longest, a high percentage of the route is shared with existing transmission lines or highway rights-of-way. As a result, the proposed corridor would have the least overall environmental impact and would have minimal impacts on area residents.

A number of design and operational alternatives exist for the MWDF. Different materials could be used for the liner and cap. Natural clay, the customary liner material in landfill design, is not locally available and would require a large borrow area. Alternate materials for synthetic membranes are available but have less desirable longevity and chemical resistance characteristics than the proposed material. Leachate seepage could be reduced by alternate drain pipe spacing. Thickened or dried tailings disposal could be employed, but would offer no environmental advantages. Pyrite could be extracted from the tailings and disposed separately, but no environmental or cost advantages would be achieved. Pyrite could be processed and marketed. However, no sufficiently profitable process/marketing alternatives exist. The most profitable option would result in substantial additional environmental impacts.

An alternative surface water mitigation plan would provide for maximum reduction of mine inflow and maximum utilization of mine inflow for surface water mitigation. Several of the dedicated wells would not be installed. A pipe distribution system from the mine/mill area would provide required mitigation water. If an adequate amount of mitigation water were not available, the discharge to Swamp Creek would be significantly reduced. The discharge reduction would likely require installation of additional wastewater treatment capability in order to provide water suitable for mitigation.

Final use alternatives for the mill facilities include a range of industrial uses. Use of the underground mine as a radioactive waste disposal facility would not be feasible because the bedrock is too highly fractured and the mined out areas would be backfilled.

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CHAPTER ONE
DESCRIPTION OF THE PROPOSED PROJECT

INTRODUCTION

LOCATION

Exxon Coal and Minerals Company proposes to mine a zinc-copper orebody in northeastern Wisconsin. Crandon, the county seat of Forest County, is five miles north of the orebody. Other regional communities include Rhinelander, 28 miles west; Antigo, 29 miles southwest; Iron River, Michigan, 44 miles north; and Iron Mountain, Michigan, 75 miles east of Crandon (Figure 1-1). The orebody is two miles east of the Mole Lake Indian Reservation and State Highway 55, 1/4 mile north of Little Sand Lake and one mile south of Swamp Creek. The orebody is in Section 25, Township 35N, Range 12E, Town of Nashville, and in Section 30, Township 35N, Range 13E, Town of Lincoln.

The following facilities would be located on Exxon property: mine/mill surface facilities; mine waste disposal facility (MWDF); reclaim ponds; landfill; access road; and railroad spur. The wastewater discharge pipeline would be on lands with Exxon easements while the electric transmission line and natural gas pipeline would be on rights-of-way obtained by Wisconsin Public Service Corporation or ANR Pipeline Company. The layout of the proposed Exxon facilities is shown in Figure 1-2.

The ownership of specific parcels of land within the project site is shown in Figure 1-3. Exxon controls 7,960 acres within the project site: 3,228 are under corporate ownership, 4,711 acres are under land purchase options and/or mining leases, and 21 acres are under easement.

HISTORY

Exxon began mineral exploration in northern Wisconsin in 1969 and favorable areas were selected for drilling surveys. An airborne electromagnetic survey during the summer of 1974 identified a geologic anomaly near Skunk Lake and Little Sand Lake in Forest County. Exploratory drilling started in June, 1975, and ore was discovered on July 4, 1975. The discovery was formally announced in May, 1976. Exxon opened a project office in Crandon in May, 1977 to conduct onsite evaluations and feasibility studies.

In July, 1978, Exxon submitted a Notice of Intent to collect data to support a mining permit application. Early in 1980, Exxon submitted preliminary project plans to the DNR. In March, 1980, the DNR told Exxon the project was a major and significant action requiring an EIS. Since December, 1982, Exxon has submitted the following major documents or applications: Environmental Impact Report (EIR), Mine Waste Disposal Facility Feasibility Report, Mining Permit Application, Air Permit Application, Wisconsin Pollutant Discharge Elimination System Permit Application, High Capacity Well Approval Applications, Mine Refuse Disposal Facility Feasibility Report, Chapter 30 and 31 permit applications, and supporting documents to the DNR. Additional permit applications and plan approvals have been submitted to the Department of Transportation (DOT) and local units of government by Exxon, and to the Public Service Commission (PSC) by the Wisconsin Public Service Corporation.

In May 1985, Exxon decided to redesign the proposed mine to extract the zinc-bearing ore first, followed by the copper-bearing ore. As a result, Exxon had to revise its permit applications and EIR. This EIS is based on the information contained in Exxon's revised permit applications and EIR submitted to the DNR in late 1985 and early 1986 and on information contained in the utility applications submitted to the PSC.

PROJECT PERSPECTIVE

The metal concentrates to be produced at the proposed mine/mill in order of economic return, are zinc, copper, silver, gold, and lead (Table 1-1).

Table 1-1
Annual Metal Recovery and
Relative Economic Importance of Metals in the Crandon Concentrates
(Typical Year of Operation)

Metal	1985 Price Ranges[1,2,3]	Massive Ore Phase[4]	Stringer Ore Phase[4]
Zinc	0.330 - 0.453 $/lb	420,000,000 lbs. (72%)	23,000,000 lbs. (15%)
Copper	0.617 - 0.694 $/lb	31,000,000 lbs. (9%)	68,000,000 lbs. (75%)
Lead	0.171 - 0.205 $/lb	19,000,000 lbs. (1%)	-
Silver	5.82 - 6.67 $/tr oz	3,600,000 Troy Oz. (10%)	415,000 Troy Oz. (4%)
Gold	284.25 - 340.90 $/tr oz	60,000 Troy Oz. (8%)	11,000 Troy Oz. (6%)

1 These estimates reflect the market price for the purified metal, not the price Exxon would receive for their concentrate. Exxon's return would depend on the metal content of the concentrate less transportation charges, smelter loss and smelter charges.
2 Average weekly metal prices for 1985 as published by "Metals Week."
3 Silver and gold are contained in the zinc, copper and lead concentrates and would be recovered during the smelting and refining process.
4 (%) = market value of refined metal based on average 1985 metal price.

Domestic use and production estimates were calculated using 1979 through 1983 statistics. A five year reference period was used to reduce the effects of cyclic fluctuations in metal production and consumption. The information sources were the U.S. Bureau of Mines: Minerals and Materials (1982-83), the Minerals Yearbook (1981), Mineral Commodity Summaries (1984), and Mineral Commodity Profiles (1983). The following subsections discuss the recovery, uses, and future demand for each metal.

Zinc ranks third in domestic use behind aluminum and copper among non-iron metals. Zinc is an important industrial metal because of its corrosion resistance, machineability, relatively low melting point, and ability to alloy with copper. The major uses are galvanization, brass hardware, die-cast components for autos and appliances, batteries, and tire manufacture. The U.S. Bureau of Mines estimates U.S. demand for zinc may grow at a rate of 2.2% annually through the year 2000.

U.S. demand for zinc was met by domestic mine production (25%), recycling zinc materials and alloys (13%) and imports (62%). The proposed mine would yield about 210,000 tons of zinc metal annually during the massive ore phase and 11,500 tons annually during stringer ore removal. The zinc produced would increase world production by three percent and U.S. production by 40% during the massive ore phase.

Copper has valuable properties such as high electric and thermal-conductivity, malleability, corrosion resistance, and appearance. The uses for copper include electric wiring, telecommunications, plumbing and heating tubes, automotive radiators, valves and fittings, and household appliances.

U.S. demand was met by domestic mine production (60%), recycled copper products (29%), and imports (11%). The U.S. Bureau of Mines estimates U.S. demand for copper may grow at 1.1% annually through the year 2000. The proposed project would generate about 15,500 tons of copper metal annually during the massive ore phase and 34,000 tons during stringer ore mining. The mine would increase U.S. copper production less than one percent during massive ore removal.

Silver use has changed dramatically since World War II. Silver use in coins has declined but industrial use has increased. Silver is used in jewelry, silverware, photographic film, electrical conductors, and as a brazing constituent.

Between 1979 to 1983, U.S demand was met by domestic mine production (26%), imports (44%), and recycling (30%). Historically, most of the U.S. silver supply has been produced as a by-product of copper, lead, and zinc mining. The mine would have an annual yield of approximately 3.6 million troy ounces during the massive ore phase and 415,000 troy ounces during the stringer ore phase. According to the U.S. Bureau of Mines, U.S. demand for silver may increase 2.2% annually through the year 2000.

Gold is principally used in jewelry, dental services, and electrical devices. U.S. demand was met by domestic mine production (32%), recycling (41%), and imports (27%) between 1979 and 1983. Based on a 1960 to 1981 reference period, U.S. demand may grow two percent annually through the year 2000. The proposed mine would yield 60,000 troy ounces of gold annually during the massive ore phase. This represents about 2.5% of present U.S. gold production. During the stringer ore phase about 11,000 troy ounces of gold would be produced annually.

Lead is used in storage batteries, pigments and chemicals, cable sheathing, and materials for the construction and metal working industries. U.S. demand between 1979 and 1983 was met by domestic mine production (46%), recycling (50%), and imports (four percent). The mine would yield about 9,500 tons of lead annually during massive ore mining. This represents a two percent increase in U.S. mine production. No lead would be recovered during the stringer ore phase. Lead demand may increase by 1.8% through 1990 in the U.S.

REGULATORY AUTHORITY

Exxon must satisfy numerous federal, state, and local regulations before construction is allowed. These regulations include various permit, plan approval, and zoning requirements. The major permits and approvals Exxon must obtain are outlined in Table 1-2.

Table 1-2
Major Permits and Approvals Required for the Proposed Project

Statutory Authority	Administering Agency	Activity	Action
FEDERAL			
33 U.S.C. 1344	U.S. Army Corps of Engineers	Dredge or fill permits for activities in or affecting navigable streams and wetlands; wetlands at the MWDF	Permit issuance
33 U.S.C. 1321	Environmental Protection Agency (EPA)	Spill prevention control and counter measure plan (40 CFR 112.7)	Have plan on file before operations begin
STATE			
Wis. Stat. 28.11(11)	DNR, Forest County	Withdrawal of land within project site boundary from County Forest status	Approve withdrawal
Wis. Stat. 144.025(2)(e)	DNR (NR 112)	High capacity wells	Plan approval
Wis. Stat. 144.04	DNR	Wastewater treatment system water reclaim pond and sewage treatment plant	Plan approval

Table 1-2 (continued)
Major Permits and Approvals Required for the Proposed Project

Statutory Authority	Administering Agency	Activity	Action
Wis. Stat. 144.391 and 392	DNR	Air emission	Permit issuance
Wis. Stat. 144.44 and 46	DNR (NR 182)	Mine Waste Feasibility Report, Plan of Operation	Plan approval
Wis. Stat. 144.43	DNR (NR 180)	Landfill	Plan approval
Wis. Stat. 144.85 and 86(3)	DNR	Mining	Permit issuance and mining authorization
Wis. Stat. Chap. 147	DNR	Wastewater discharge	Permit issuance
Wis. Stat. Chap. 162 and Chap. 144	DNR	Potable Water Supply	Plan approval

The Wisconsin Public Service Corporation (WPS) must receive approval from the Public Service Commission (PSC) before it can construct and operate the proposed electric transmission line and natural gas pipeline to the mine site (Chap. 196.491 and 196.49, Wis. Stat.). WPS also requests authority to provide the Township of Nashville with natural gas service. The ANR Pipeline Company would require authority from the Federal Energy Regulatory Commission to construct the northern 3.5 miles of the proposed natural gas pipeline.

Depending upon the route(s) approved, the electric transmission line and natural gas pipeline would need one or more of the following permits:

Wisconsin DOT permits to cross Federal or State highways;
Chapter 30 permits from the DNR to cross rivers or streams;
U.S. Army Corps of Engineers (Section 404(b)) permits for river or stream crossings; and
county/township zoning permits at stream and road crossings.

The Department of Agriculture, Trade, and Consumer Protection also developed an Agricultural Impact Statement (AIS) on the proposed electric transmission corridor (section 32.035, Wis. Stat.). The findings contained in the AIS have been incorporated into this EIS.

In addition, the Department of Industry, Labor and Human Relations (DILHR) has the authority under Wisconsin Statutes, Chapters 101 and 145, to regulate health aspects of mine construction and enforce building and plumbing codes. The Department of Transportation (DOT) regulates the access road connection with State Highway 55 and placement of the wastewater pipeline under State Highway 55.

The following local zoning ordinances are in effect at the project site.

Forest County Board of Supervisors approved and adopted the revised zoning ordinance prepared by the North Central Wisconsin Regional Planning Commission (1980). There are no sections or requirements in the ordinance prohibiting or restricting the construction and operation of the proposed mine. The county also has authority for wetland and shoreland zoning permits.

Township of Lincoln (Forest County) Board of Supervisors adopted a zoning ordinance (Township of Lincoln Zoning Ordinance, 1982). The township zoning ordinance is based on the Forest County ordinance with the pertinent mining section found in Chapter 15 - Planned Development. Exxon must apply to the township for the necessary permits.

Township of Nashville (Forest County) comprehensive zoning ordinance became effective January 31, 1985. This ordinance has sections pertinent to mining activities. Exxon must apply to the township for the necessary permits.

Langlade County Board of Supervisors has authority for wetland and shoreland zoning permits.

REVIEW/VERIFICATION ACTIVITIES

The DNR determined the validity of the Exxon submittals through a process of review and/or data verification. In disciplines where DNR expertise was limited, outside consultants assisted in the review/verification. Several approaches were used to review/verify the Exxon data gathering and analysis techniques. Professional judgment of DNR staff and consultants was a major element in this process. Verification also included making joint observations in the field and taking samples along with Exxon consultants. This approach provided a check on sampling techniques and accuracy of lab results. The DNR also examined laboratory quality control procedures to assess data validity. In certain disciplines, the DNR independently evaluated background conditions in the environmental study area, e.g., fisheries and groundwater modeling. These methods plus comments from other agencies and interested parties were used throughout the review process.

The information regarding the electric transmission and natural gas lines was provided by the Wisconsin Public Service Corporation. This information was reviewed and checked by PSC and DNR staff, including on-site inspections of the proposed utility corridors.

DESCRIPTION OF PROPOSED FACILITIES

To the Reader: The following description includes many technical terms related to mining. If these terms are unfamiliar please refer to the Glossary. All time periods are stated in terms of project years or, less commonly, as project months. This relative time scale is used because the outcome of the permitting process and Exxon's decision to start construction, if permits are granted, are not certain. All project years or project months refer to a time period occurring after project construction begins.

MINE

The proposed underground mine would be highly mechanized and would operate 20 shifts per week. Massive ore would be mined for 16 years (project years 4 through 19) while the stringer ore would be mined for 13 years (project years 20-32). Ore would be crushed underground and hoisted to the surface for processing. Various cross sectional views of the mine are shown in Figure 1-4. Mine surface facilities include a headframe with collar house, mine air heater, exhaust fans, backfill handling facilities, a change house for personnel, ore transport systems, and fuel storage.

Main Shaft and Headframe - The main shaft and headframe would be the entrance and exit point for personnel, materials, ore, waste rock, and services. These services include communications, electric power, potable water, intercepted and/or contaminated mine water, and compressed air. For safety reasons and operating efficiency, the liquid fuels and backfill would enter the mine through separate cased boreholes.

The main shaft, about 1,800 feet deep and 24 feet in diameter, would contain two ore skips and one personnel/material cage. The headframe would be an enclosed, rectangular concrete and steel structure, over the main shaft. This structure would be about 155 feet high, 32 feet long and 36 feet wide. The collar house attached to the headframe would provide a protected working and staging area for personnel, mine equipment, and materials.

Mining Drifts - There would be three types of drifts in the proposed mine: main level, sublevel, and crosscut (Figure 1-4). Main level drifts would be horizontal passages excavated in the bedrock surrounding the orebody. These drifts would be constructed at about 400-foot intervals between the 450 foot level and the 1,950 foot level. The main level drifts, 11 to 16 feet wide by 10 feet high, would connect with the main shaft. Between the main level drifts, smaller sublevel drifts would be developed to provide greater access to the orebody. Crosscut drifts would provide direct access to the orebody for drilling, blasting and ore removal purposes. A ramp decline, similar in size to the main level drifts, would connect all main level and sublevel drifts. This ramp would aid the movement of ore, equipment, supplies, and personnel within the mine.

Underground Services and Facilities - The main level drifts would contain services, storage areas for explosives, and maintenance shops. The services include personnel facilities and a distribution network for communications, electric power, fresh and utility water, and compressed air. Personnel facilities would consist of lunch rooms, locker rooms, and training facilities with first aid supplies and emergency rescue equipment. Sanitation facilities would consist of chemical toilets installed in rock wall cutouts. Sanitary wastes would be disposed in the on-site sanitary wastewater treatment plant. Communications in the mine and between the mine and surface would consist of a cable network, telephone system and/or radio system.

Electrical power would be distributed to permanently installed load centers, e.g., fans and pumps, and periodically relocated load centers at active mine workings, e.g., electric drills. For safety reasons, a separate electrical system would be used to initiate all production blasts in the mine. If outside power was not available, diesel generators on the surface would provide emergency electrical power for hoisting, ventilation, and pumping.

During full operation of the mine, about 5,000 pounds of explosives would be used daily. Blasting frequency and intensity would depend on the type of blasting, the amount of explosives used, mining method, and the number of delays per blast. Each main level drift would have two explosives storage magazines with a total of 25,000 pounds to 40,000 pounds of blasting material stored underground. Stored explosives would include water gels, ammonium nitrate/fuel oil, detonating cord, and electric and nonelectric blasting caps. For safety purposes, explosives and detonators would be stored in separate magazines with nonsparking interiors and controlled access.

The maintenance shop, on the 1,150-foot level would look like a truck garage and would be used to inspect and repair mining equipment. Fuel for mine vehicles would be stored near the maintenance shop. Valves controlling the filling and emptying of the surface tank and the underground tanks would be interconnected to prevent fuel oil spills. The fuel delivery borehole from the surface to the underground tanks would be steel cased in the glacial deposits.

Mine Ventilation and Mine Air Heating - Fresh air would flow down the main shaft to the main and sublevel drifts. Air flow to the mine workings would be controlled by ventilation doors, regulators, and booster fans. Small fans and air ducts would provide fresh air to mine areas not on completed ventilation circuits. The mine warning system would use an odor agent which would permeate the mine workings through the fresh air ventilation system and the compressed air lines.

Exhaust air would be discharged to the atmosphere through exhaust shafts, called raises, (18 feet diameter) at the east and west ends of the orebody. A system of smaller raises would channel exhaust air from all mine levels toward the primary east and west exhaust raises. The main exhaust fans, installed at the top of the exhaust raises on the surface, would provide the driving force for the mine ventilation system. These fans would draw about 850,000 cubic feet per minute of air through the mine workings.

Air temperature in the underground mine workings would average 55°F year round. During the winter months fresh air entering the mine would require heating to about 40°F to prevent icing problems. Natural gas heaters at the air intake opening of the main shaft would heat incoming air to the desired temperature.

Mine Air Pollution Controls - The primary ore crusher and ore handling operations would be hooded, with exhaust passed through fabric filters before release. Captured dust would be returned to the operation being controlled. The ore hauling vehicles would utilize a ceramic filter with exhaust return to reduce nitrogen oxide and suspended particulate emissions. Catalytic scrubbers also would be used on each vehicle to reduce carbon monoxide and hydrocarbon emissions.

The majority of the dust generated by production blasting, rock handling, and mine vehicles would settle in the mine. Airborne dust not settling would be vented to the atmosphere through the east and west exhaust raises. Gaseous pollutants (sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons) due to blasting, fuel combustion, and fuel storage also would be vented to the atmosphere through the exhaust raises.

Mining Methods - Three techniques would be used to mine the ore: 1) sublevel blasthole open stoping with delayed backfilling; 2) vertical crater retreat stoping with delayed backfilling; and 3) cut-and-fill mining. Most of the ore, for both the massive and stringer phases, would be removed using the sublevel blasthole open stoping technique. All ore beneath the 750 foot level drift would be removed with this technique. Between the 750 feet level drift and the 450 foot level drift, vertical crater retreat would be used where rock weathering is more developed. Cut-and-fill mining would be used to remove less than 10% of the ore and would be confined to drifts above the 450 foot level where weathering has substantially reduced rock strength. Vertical crater retreat and cut-and-fill mining techniques would have greater use during the massive ore phase because rock weathering is more pronounced in this ore type.

The sublevel blasthole open stoping technique is highly mechanized and can be used to remove large quantities of ore on a daily basis (Figure 1-5). Ore would be removed from large vertical excavations, called stopes, that are 300-400 feet high, 150 feet long and as wide as the ore zone. Stope development would begin by boring a vertical opening, called a stope slot, through the entire height of the block. Next, blastholes would be drilled adjacent to the stope slot and charged with explosives. The explosives would be detonated and the shattered ore would be blasted into the stope slot. The stope slot would be thus enlarged by a series of weekly blasts. This process of blasting ore into the expanding slot would continue until all ore in the stope block had been shattered.

The shattered ore would drop to the bottom of the stope and would be removed through access tunnels called drawpoints. After all the ore was removed from the stope, the drawpoints would be plugged and the empty stope backfilled. Following backfilling, the adjacent stope blocks would be mined. At expected capacity, 4 to 6 stopes would be mined simultaneously to produce 7,800 tons of ore daily during the massive ore phase. During the stringer ore phase, 3 to 5 stopes would be mined simultaneously to produce 5,700 tons of ore per day.

By comparison, the cut-and-fill mining method is more labor intensive, expensive, and slower. Ore removal is only one-third to one-half of the rate achieved by the sublevel blast hole open stoping technique. Horizontal sections of ore 13 feet to 16 feet high and as wide as the orebody would be removed in this mining method. The void created by ore removal would be backfilled before mining the next section.

Approximately 10% of the 67,400,000 ton orebody would be left in place. The unmined portions of the orebody would consist of thin seams, pockets too deep to mine economically, rock pillars used to stabilize backfilled stopes, and the ore crown pillar. The crown pillar would be needed primarily to improve rock stability but also would minimize groundwater inflow. Between 20 and 100 feet of competent bedrock would be left beneath highly weathered zones to form the ore crown pillar. The thickness of the ore crown pillar would vary depending upon the following factors: depth of weathering; type(s) of weathering processes affecting the orebody at a given location; and the geometry of the orebody. A discussion of bedrock weathering and its importance to mine inflows is contained in Chapter 2 (Geology).

Ore Transport and Primary Crushing - Broken ore removed from the stope drawpoints by ore-hauling vehicles would be dropped into steeply sloping ore passes or brought up the ramp decline from the 1,950 foot level by diesel trucks. Ore and waste rock in the passes would be funneled into trucks waiting on the 1,550-foot level. The trucks would dump the ore and waste rock into two coarse rock storage compartments. The ore and waste rock would drop from the storage compartments into the primary crusher. This crusher would reduce the rock to eight inches or less in diameter. After primary crushing, the ore or waste rock would be conveyed to a set of storage bins. A belt conveyor below these bins would feed the crushed material to a loading pocket next to the main shaft. This loading pocket would discharge to the skips and the ore or waste rock would be raised to the surface and dropped into the headframe hopper. From the hopper, a conveyor belt would transport the ore to the coarse ore storage building or the waste rock to the waste rock handling system.

Mine Drainage - The primary source of water entering the mine would be groundwater inflow. Normally, groundwater flow between the bedrock and the overlying glacial aquifer is minor. Development of the mine, however, would induce flow from the glacial aquifer through pores and fissures in the weathered bedrock and orebody. Estimates of bedrock permeabilities, glacial deposit permeabilities, water pressure, and other factors indicate a maximum inflow rate of 2,000 gallons per minute may occur. The anticipated mine inflow, however, should be closer to 1,200-1,300 gallons per minute. An inflow rate of 2,000 gallons per minute was assumed for designing the water collection system.
Groundwater inflows would be handled in either of two separate systems: the groundwater interception system or the contaminated mine water collection system. Each water control system has a backup of equivalent capacity in case inflows are higher than expected or equipment breakdown occurs.

Water collected in the groundwater interception system would be piped to a sump/pump station on the 750 foot mine level (Figure 1-6). Some of the intercepted water would be used as mine utility water. The remainder would be pumped to the surface, treated if necessary, and used for mill process make-up water, mitigation purposes, or discharged to Swamp Creek. At the 1,200-1,300 gpm mine inflow rate, the interceptor system is anticipated to collect 40% of the inflow. Interception success would vary with the rate of mine inflow and could be impractical at low inflow rates. If mine inflow rates are low when mining operations are active in the unweathered portions of the orebody, the groundwater interceptor system may not be used. To minimize inflow, initial mine production is proposed between the 1,150 and 1,550 foot level drifts. In addition, bentonite and/or cement grouting may be used to reduce inflow where feasible. Grouting would throttle water courses in active mining areas and redirect inflow toward the interceptor system.

Contaminated water from the mine workings and backfilled stopes would be collected in the drainage ditches and sumps of the contaminated mine water system. Rock particles suspended in the water would settle in the ditches and sumps allowing the clear, but contaminated, water to be pumped to the main sump. The main sump would be near the main shaft on the 1,550-foot level drift. The contaminated mine water would be pumped to the surface for treatment and reuse or discharge. Particles settling in the contaminated mine water sumps would be removed with front end loaders and added to the mined-out stopes as backfill.

Mine Backfilling - During backfilling, the ore drawpoints at the bottom of the empty stopes would be plugged with timbers or concrete and glacial sand. Waste rock from development drifts and backfill slurry then would be added. The backfill slurry would consist of sand-sized tailings (waste minerals), crushed waste rock, cement (if needed), and process water. The slurry would flow into and fill crevices between the waste rock with the excess water draining out the bottom of the backfilled stope over a period of months.

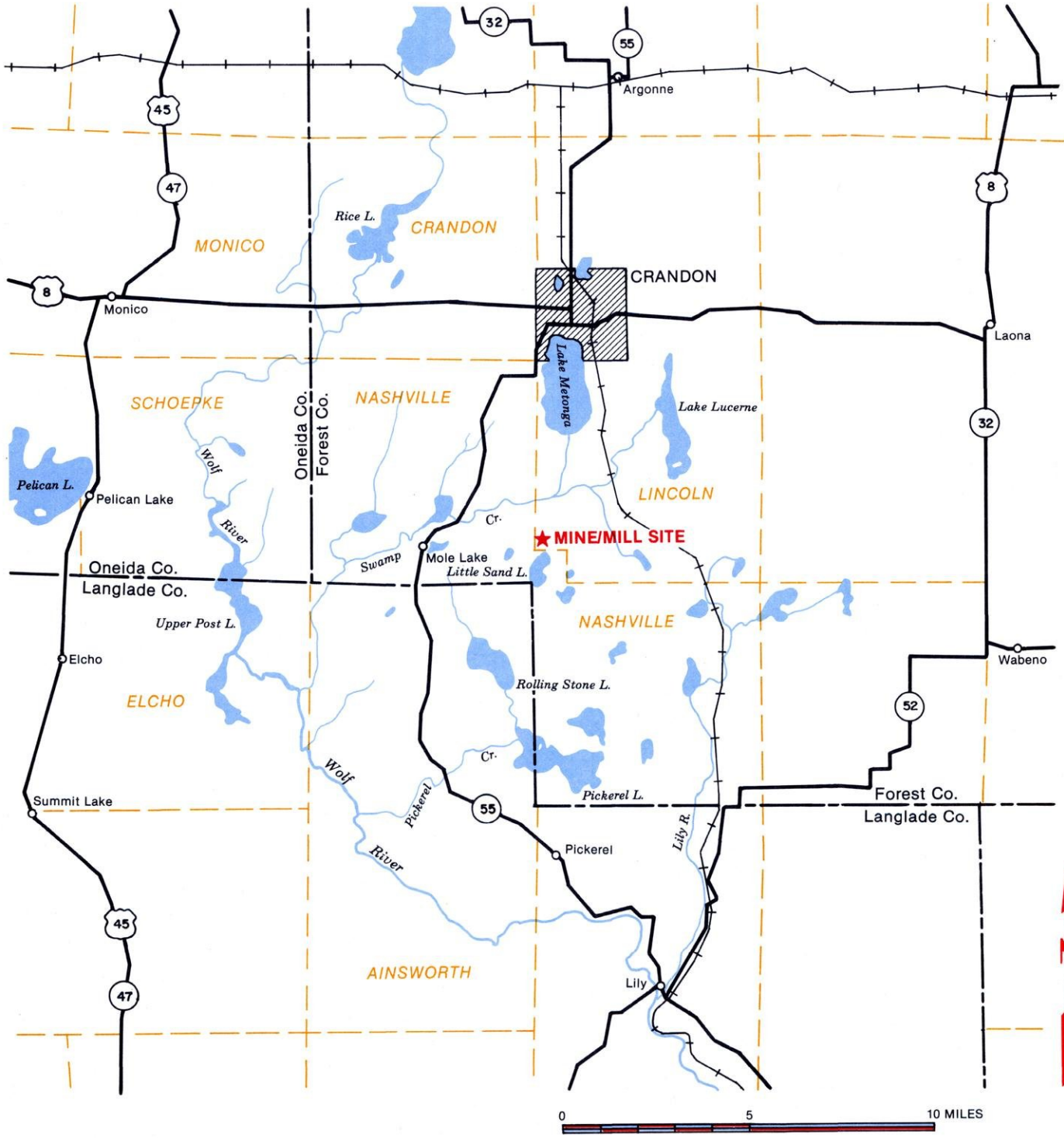
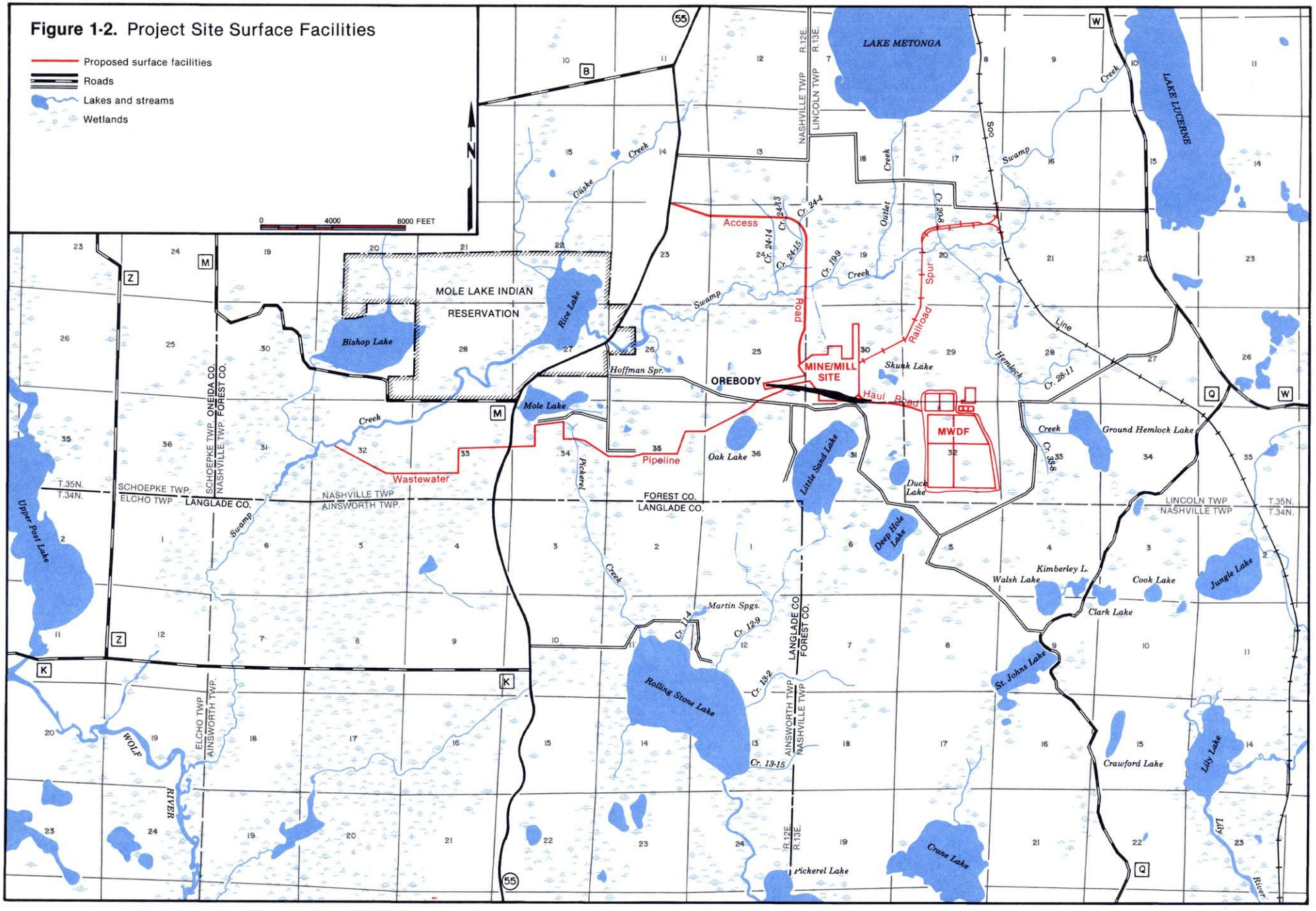
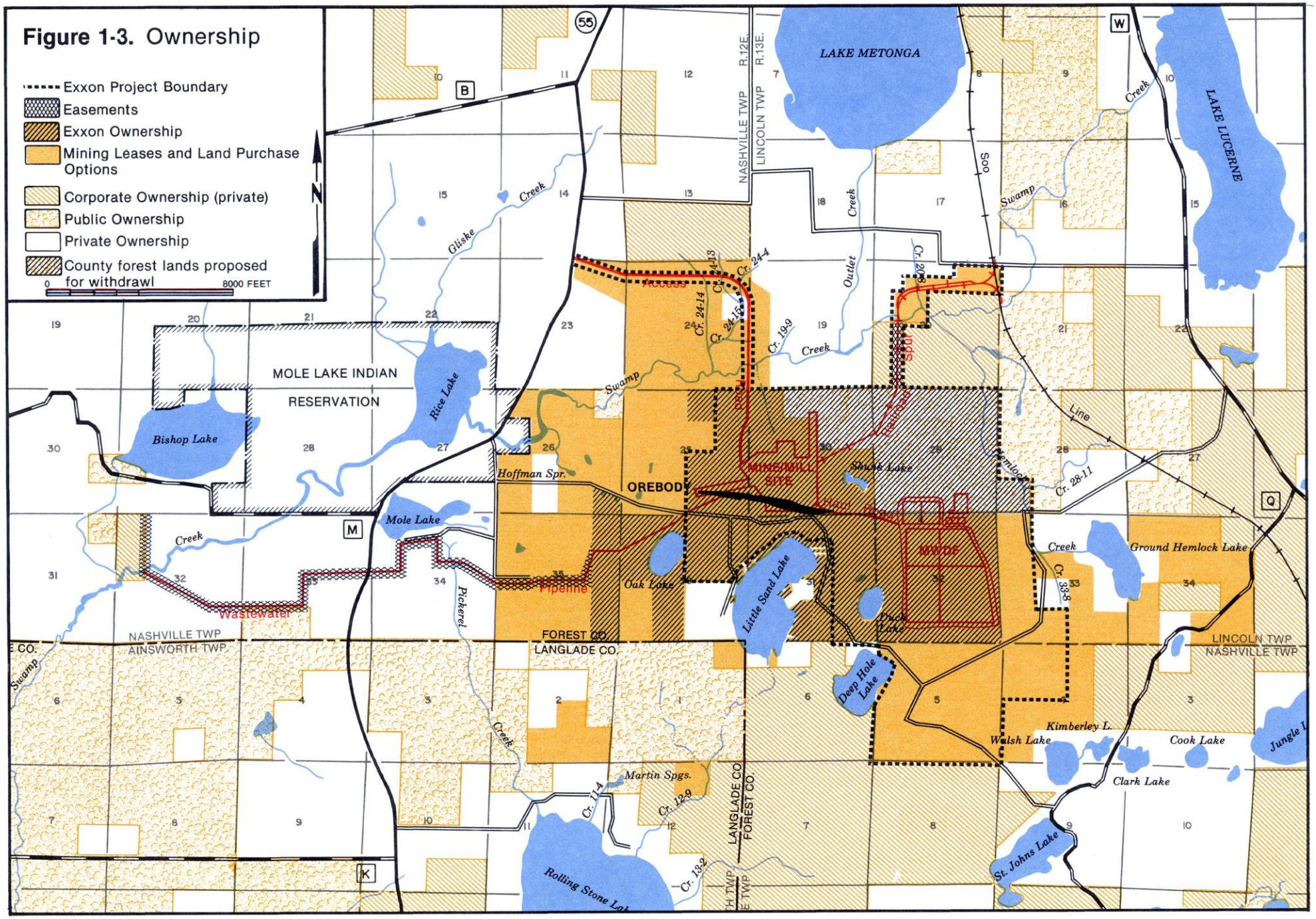




Figure 1-1. Project Location


Figure 1-2. Project Site Surface Facilities
Proposed surface facilities
Roads
Lakes and streams
Wetlands
N
0 4000 8000 FEET
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Upper Post Lake
Rolling Stone Lake
LAKE METONGA
LAKE LUCERNE
Skunk Lake
Oak Lake
Little Sand Lake
Deep Hole Lake
Duck Lake
Ground Hemlock Lake
Walsh Lake
Kimberley L.
Cook Lake
Jungle Lake
Clark Lake
St. Johns Lake
Crawford Lake
Lily Lake
Crane Lake
Pickerel Lake
Martin Spgs.
Hoffman Spr.
Access
Road
Railroad Spur
Haul Road
Pipeline
Wastewater
MINE/MILL SITE
OREBODY
MWDF
Creek
Swamp
Outlet
Line
Pickerel
Lily River
WOLF RIVER
SCHOEPKE TWP.
ELCHO TWP
NASHVILLE TWP
AINSWORTH TWP.
LINCOLN TWP
ONEIDA CO.
FOREST CO.
LANGLADE CO.
T.35N.
T.34N.
R.12E.
R.13E.
Cr. 24-13
Cr. 24-14
Cr. 24-15
Cr. 24-4
Cr. 19-9
Cr. 28-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
Cr. 13-15


Figure 1-3. Ownership
Exxon Project Boundary
Easements
Exxon Ownership
Mining Leases and Land Purchase Options
Corporate Ownership (private)
Public Ownership
Private Ownership
County forest lands proposed for withdrawl
0
8000 FEET
N
LAKE METONGA
LAKE LUCERNE
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Hoffman Spr.
OREBODY
MINE/MILL SITE
MWDF
Shark Lake
Oak Lake
Little Sand Lake
Duck Lake
Deep Hole Lake
Ground Hemlock Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Rolling Stone Lake
Martin Spgs.
Gliske Creek
Swamp
Outlet
Soo Line
Pickerel Creek
Wastewater Pipeline
Haulroad
Access
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 199
Cr. 208
Cr. 28-11
Cr. 33-8
Cr. 114
Cr. 129
Cr. 132
FOREST CO.
LANGLADE CO.
AINSWORTH TWP
LINCOLN TWP
NASHVILLE TWP

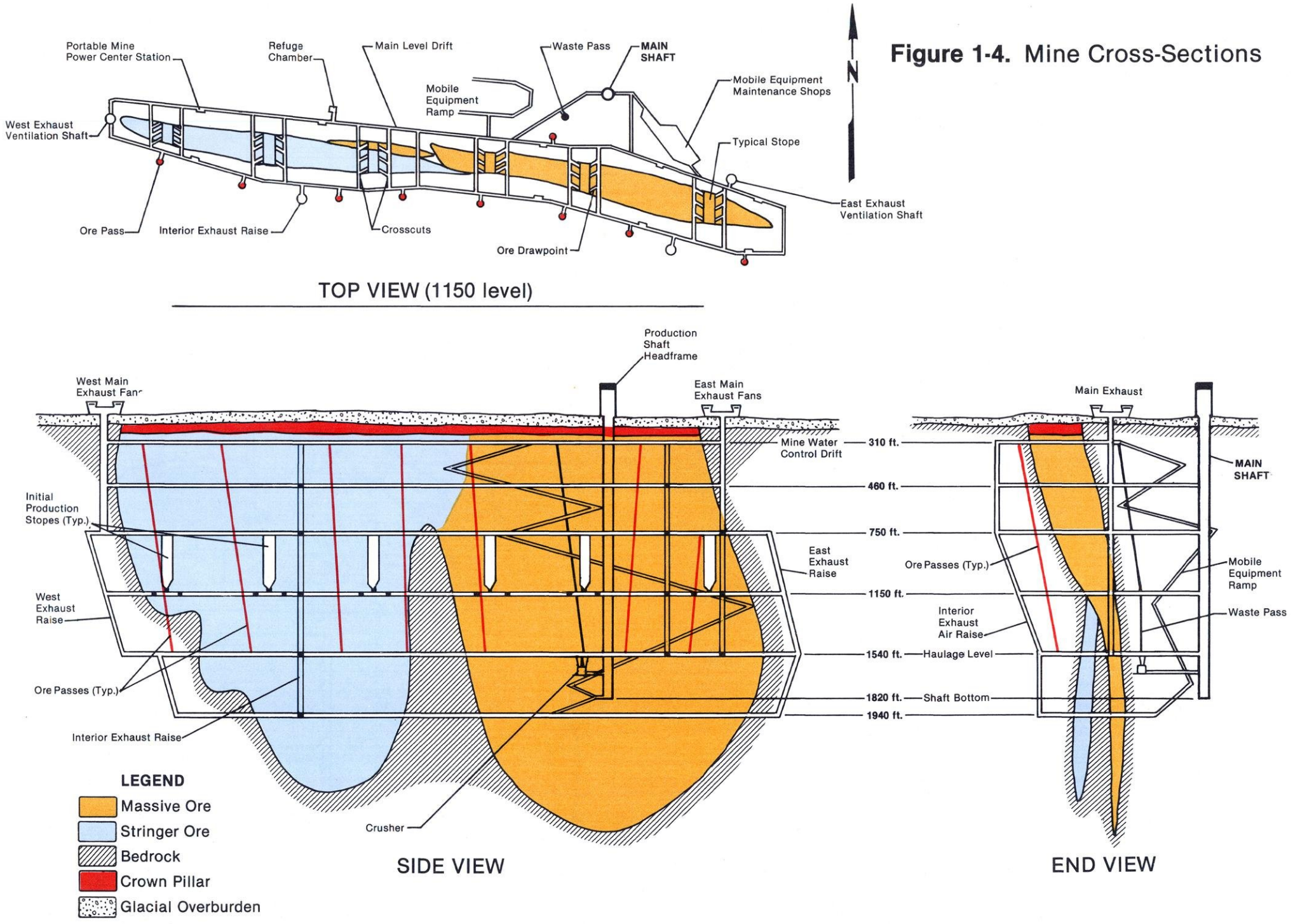


Figure 1-4. Mine Cross-Sections

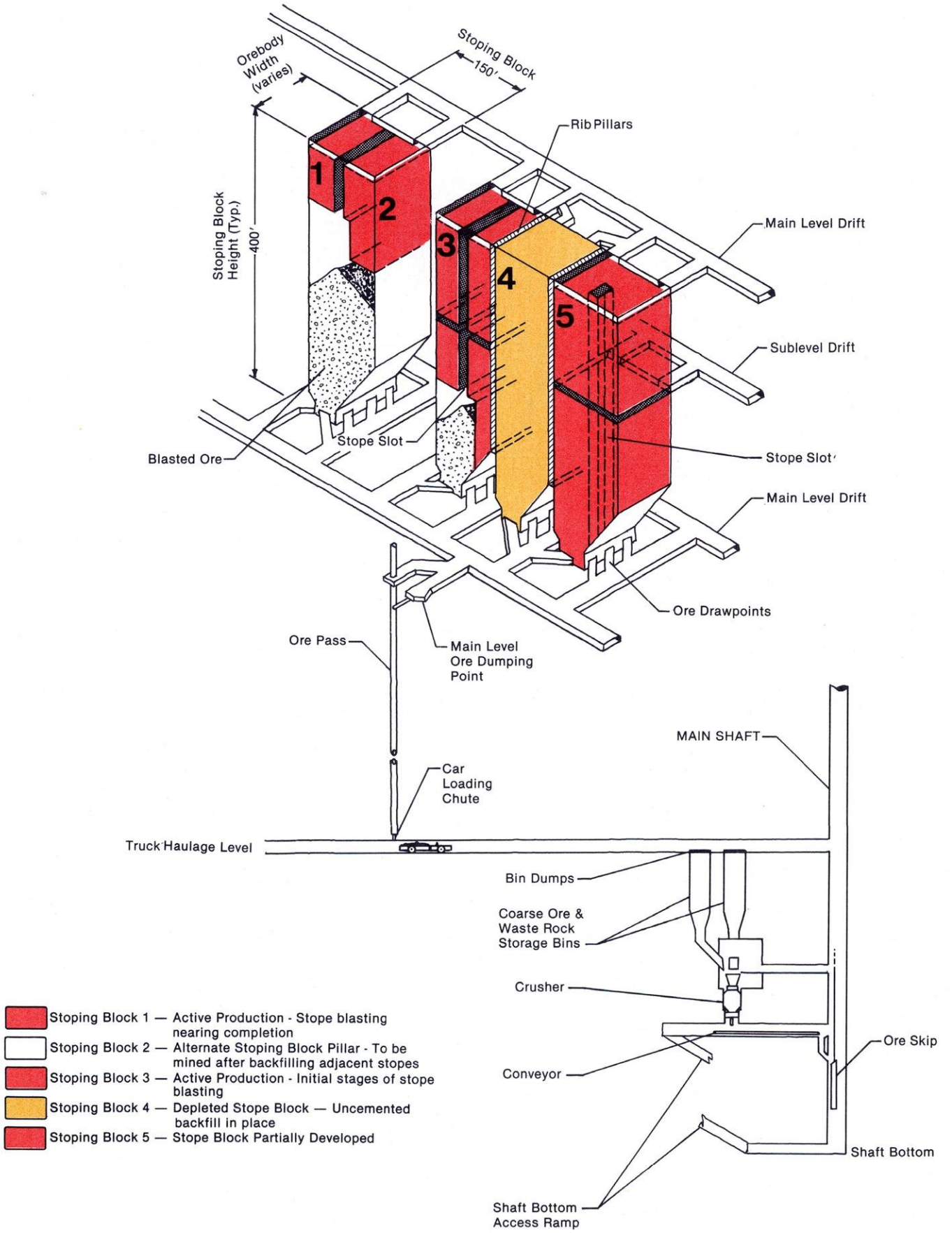


Figure 1-5. Conceptual Mining Sequence

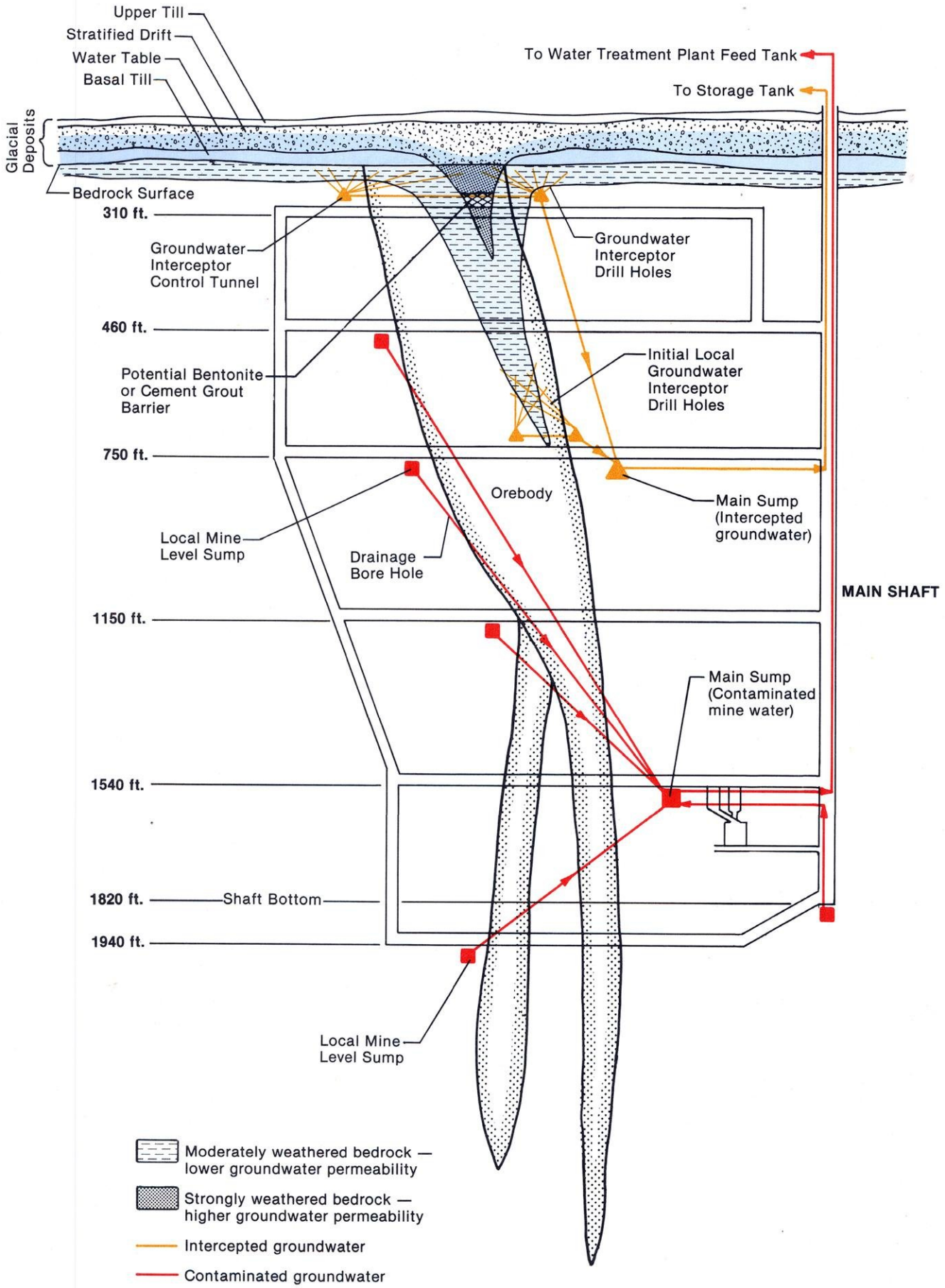


Figure 1-6. Mine Drainage Schematic

Depending on the stoping sequence and bedrock stability, cement would be added to improve backfill stability as needed. Backfill with cement should have sufficient stability to stand unsupported, thus ore could be removed from adjacent stopes without the need for a rib pillar. Without cement, a rib pillar of ore must be left between the backfilled stope and adjacent stopes. The addition of cement is particularly needed in the upper portions of the orebody where weathering has reduced rock strength and cut-and-fill mining is to take place.

MILL

The proposed mill facilities would operate seven days a week, 24 hours a day, except during maintenance shutdowns. The concentrator building and coarse ore storage building would contain equipment for storing, grinding, and concentrating the ores hoisted to the surface. Figure 1-7 illustrates the relative size and configuration of the mill buildings. The anticipated production rates are given in Table 1.3.

Table 1-3
Proposed Mill Production Rate

	Massive Ore	Stringer Ore
Project Years	4-19	20-32
Tons/Day	7,400	5,700
Tons/Year	2,655,000	2,060,000
Zinc Concentrate (Tons/Year)	381,200	19,700
Copper Concentrate (Tons/Year)	51,300	139,400
Lead Concentrate (Tons/Year)	20,200	--
Tailings (Tons/Year)	1,066,000	864,000
Backfill (Tons/Year)	1,136,000	1,037,000

Storage - After hoisting to the surface, the ore would be conveyed to the coarse ore storage building. The building, an unheated, enclosed steel structure with a cement foundation, would have belt feeders below the stockpiles for conveying ore to the concentrator building. This facility would hold two days of mine production during the massive ore phase and almost three days during stringer ore mining.

Before completion of the concentrator building, uncrushed ore would be trucked to the eight acre preproduction ore storage pad north of the mill. About 350,000 tons of preproduction ore and 525,000 tons of waste rock would be stored on the pad. Preproduction ore would be crushed on the north side of the coarse ore storage building and returned to the coarse ore storage building once the mill becomes operational. The temporary crusher would operate two shifts per day during project years 2 and 3.

Flotation - Following storage, the ore would be ground, classified, and sent to the flotation circuits. During flotation, air and reagents would be added at various steps to aid in the sequential separation of the zinc, copper, and lead minerals. The reagents create conditions in which specific metallic minerals become strongly attached to the air bubbles rising from the bottom of the flotation tanks. The finely ground minerals then float to the surface forming a metal-rich froth. The enriched zinc, copper, and lead froths would be skimmed off, dewatered, and filtered while the noneconomic waste minerals (tailings) would be pumped as a slurry to the backfill preparation facility.

Concentrate Dewatering - The froths, approximately 25 to 35 percent solids by weight, would be dewatered in a two-step process. First, each froth would be pumped to a thickener where the metal-rich solids would settle. Clarified water overflowing the copper, lead, and zinc thickeners would be pumped to the reclaim pond, fine tailings thickener, and mill process stream, respectively. The metal-rich solids on the bottom of the thickeners would be mechanically raked toward the center and pumped to pressure filters for final dewatering. The dewatered concentrates would be black or brassy in color, have a moisture content of 8-10%, and a metal content ranging from 55% to 60% for the lead and zinc concentrates to 25%-30% for the copper concentrates. Table 1-4 provides estimates of concentrate storage capacity during each phase.

Table 1-4
Estimated Daily Concentrate Production and Storage Capacity

	Production Rate (tons)	Storage Capacity (tons)	Storage Capacity (days)
Massive Ore Phase			
Zinc	1,060	2,500	2.4
Copper	145	1,050	7.2
Lead	56	1,000	18
Stringer Ore Phase[1]			
Zinc	55	2,500	45
Copper	390	1,050	2.7

[1]Since lead concentrate would not be produced during this phase, an additional 1,000 tons of storage capacity would be available if needed.

Concentrate Storage and Shipping - The dewatered concentrates would be transported by conveyor belts to the enclosed concentrate loadout facility. Conveyor belts would transport the concentrates to the north end of the concentrator building into 70 to 100 ton capacity, open top gondola railcars. After loading, each railcar would be covered with a plastic sheet or sprayed with a polymer to reduce dusting. Exxon's locomotive would deliver 16 to 18 loaded rail cars to the siding daily during daylight hours. Approximately every three days the Soo Line would pick up 50 to 55 loaded rail cars and return 50 to 55 empty rail cars. Truck haulage of concentrates is not anticipated but 20 ton capacity trucks would be used if necessary. None of the the concentrates would be smelted or otherwise processed in Wisconsin. They would be shipped to smelting and refining facilities in other places in the United States, Europe or Asia. The potential destinations for the concentrates are discussed in Chapter Four of the DEIS.

Rail Deliveries - Rail deliveries of mine/mill supplies would consist of about 10 railcars per week. Delivery requirements, railcar availability, and weather, however, may cause variances in the proposed shipping frequency and railcar numbers.

Backfill Preparation - At the backfill preparation facility, the coarse fraction of the tailings, about half the total, would be recovered, mixed with crushed waste rock and cement (as needed), and pumped as a slurry to the mine. Coarse tailings would be stored in two steel tanks with a combined capacity of 18,000 tons (about six days of coarse tailings output). Backfilling would begin with the start of milling operations. Demand would be continuous and would roughly equal daily coarse tailings production. About 3,150 and 2,750 tons of coarse tailings would be produced daily during the massive and stringer ore processing phases, respectively.

Fine Tailings Thickening and Transport - Fine tailings cannot be used as backfill because of their poor drainage characteristics. The fine tailings would require disposal in the tailings ponds. After separation from the coarse tailings at the backfill preparation facility, the fine tailings slurry would be pumped to thickeners. In the thickeners, lime added to the slurry would cause the tailings to sink. The tailings then could be mechanically raked to the center of the thickener and pumped as a slurry, 55% solids by weight, by pipeline to the tailings ponds. Overflow water from the thickeners would be recycled to the backfill preparation facility or pumped to the reclaim pond.

Reagents - Many chemicals would be used in the milling and water treatment processes. Reagents in bags or drums would be stored in the concentrator building next to the flotation circuits. Bulk liquid reagents would be pumped from storage tanks to the mixing tanks in the flotation area. After mixing, the reagent blends would be pumped to day tanks for storage and use. Durable reagent containers, such as drums, would be returned to the suppliers for refilling. The reagent storage areas would be serviced by rail and truck. A summary of the reagent types and uses is contained in Table 1-5.

Table 1-5
Reagent Use, Consumption Rate, and Storage

Chemical	Primary Use	Receive By	Estimated Monthly Consumption (pounds)	Form	Storage Capacity (pounds)	Shipment Size (pounds)
Ore Flotation						
Sulfur Dioxide (SO_2)	Depressant	Truck	100,000	Liquid	150,000	60,000 or 100,000
Copper Sulfate ($CuSO_4 \cdot 5H_2O$)	Activator (Resurfacing Agent)	Rail	160,000	Granular	300,000	100,000 minimum (100 lb bag)
Sodium Cyanide (NaCN)	Depressant	Truck	14,400	Briquette	36,000	36,000
Polypropylene Glycol Methyl Ether (Dowfroth 250)	Frother	Truck	4,000	Liquid	50,000	36,000
Sodium Sulfide ($Na_2S \cdot 9H_2O$)	Activator and Precipitant	Rail	5,000	60% Flake	80,000	80,000 minimum (400 lb bag)
Xanthates	Collectors	Truck	36,000	Granular	63,000	40,000
Zinc Sulfate ($ZnSO_4 \cdot 7H_2O$)	Depressant	Truck	48,000	Granular	54,000	24,000 minimum
Starch (CMC-7LT)	Depressant	Truck	22,000	Powder	30,000	25,000 minimum (50 lb bag)
Sodium Dichromate ($Na_2Cr_2O_7$)	Depressant	Truck	32,000	Liquid	117,000 (12,000 gals.)	78,000 minimum (8,000 gallons)
Sodium Silicate (Na_2SiO_3)	Dispersant	Rail	92,000	Liquid	175,500 (15,000 gals.)	117,000 (10,000 gallons)
Activated Carbon	Absorbent	Rail	50,000	Powder	75,000	24,000 minimum (50 lb bag)
Methyl Isobutyl Carbinol (MIBC)	Frother	Rail	16,000	Liquid	82,000 (12,000 gals.)	40,000 minimum (6,000 gallons)
Lime (CaO)	pH Modifier	Rail	882,000	Pebble	1,320,000	190,000 minimum

Table 1-5 (continued)
Reagent Use, Consumption Rate, and Storage

Chemical	Primary Use	Receive By	Estimated Monthly Consumption (pounds)	Form	Storage Capacity (pounds)	Shipment Size (pounds)
Ore Flotation (continued)						
Caustic Soda (NaOH)	Sodium Cyanide Preparation	Truck	240	Pellet	600	-
Water Treatment						
Lime	pH Modifier	Rail	40,000	Pebble	------	------
Soda Ash (Na_2CO_3)	pH Modifier	Rail	530,000	Granular	750,000	200,000 minimum
Sulfuric Acid (H_2SO_4)	pH Modifier	Truck	78,000	Liquid	67,500	45,000
Ferric Sulfate ($Fe_2(SO_4)_3$)	Coagulant	Truck	15,000	Granular	75,000	------
Sodium Hexa-metaphosphate	Anti-scalant	Truck	3,900	Granular	7,000	no minimum (100 lb bag)
Flocculant (Type not chosen yet)	Flocculant	Truck		Liquid or Powder	45,000	

The following reagents require special storage and handling:

1. Liquid sulfur dioxide (SO_2) would be received by trucks and stored in tanks outside the mill building for safety reasons. The sulfur dioxide would be used to produce sulfurous acid in the flotation process. Vented vapors would be recompressed to a liquid and returned to the storage tanks.

2. Burnt lime (CaO) would be delivered by rail and stored in covered bins outside the mill building. The burnt lime would be mixed with water to prepare milk-of-lime ($Ca(OH)_2$) for use in the flotation, tailings thickening processes and water treatment plant processes.

3. Sodium dichromate, received in solution form, would be stored outside the mill building. The sodium dichromate would be diluted with water and mixed with sodium silicate for use in the flotation process. Sodium dichromate also could be received as solid.

4. Sodium cyanide and sodium sulfide would be stored indoors in a controlled access storage area.

5. Sulfuric acid would be used and stored at the water treatment plant.

The noncompatible reagents, e.g., sulfur dioxide, sodium cyanide, and sodium sulfide, would not be unloaded or stored near acids or strong caustics. Reagents with similar properties, such as xanthates, would be stored together. For safety reasons, the reagent storage and mixing areas would have first aid equipment, explosion-proof electrical equipment, and would be constructed with corrosion resistant materials.

Spill and Odor Control - Berms would surround all reagent storage, mixing, and day tank areas to isolate noncompatible reagents and contain spills. Blind sumps, within the bermed areas, would be used to return spilled reagents to their respective mixing or day tanks. If recovered spills could not be reused, the materials would be discarded. To avoid circuit contamination, spills in the grinding and flotation areas would be collected in floor sumps and pumped back to the original circuit. Spills from process piping, e.g., tailings and backfill pipes, would be channeled into drainage trenches, collected in sumps, and returned to the appropriate process stream. The concentrator building would have an overflow system if a major spill could not be contained by floor sumps and containment berms. Spills reaching the overflow system would drain into drainage basin #2. All water from basin #2 would be pumped to the reclaim pond for treatment.

The major source of odors would be the reagent mixing and storage areas in the concentrator building. The reagent preparation area and the day tank area would have monitors and/or exhaust systems for hydrogen sulfide, carbon disulfide, and hydrogen cyanide. Where necessary, tanks in this area would be equipped with vapor-collecting equipment to exhaust the vapors to the atmosphere without treatment.

Mill Air Pollution Controls - Dust from roads, ore handling, and liner processing operations would be the major potential air pollutant. The access road and parking areas would be paved to reduce dust emissions. Dust from ore grinding, screening, and transport operations would be contained within the covered conveyors and captured by insertable collectors. Stack tests would be conducted during mill start-up and would be periodically rechecked to verify proper operation. The lime, soda ash, and cement storage bins would have fabric filters to control dust. Additional insertable dust collectors would be used in the concentrator and coarse ore storage buildings where necessary.

Waste Rock - Most of the waste rock (90-95%) brought to the surface during the construction and operation phases would be crushed and returned to the mine as backfill. During mine development, however, about 525,000 tons of waste rock would require temporary surface storage. To accommodate this surge of waste rock, as well as preproduction ore, storage would be provided on the lined, eight acre preproduction ore storage pad. After the stored ore and waste rock had been processed, the pad would be used for equipment storage or surge storage of concentrates, waste rock or ore. An estimated 400,000 tons of waste rock would remain aboveground as rock slope protection in the tailings pond and reclaim pond. By project years 31 and 32, waste rock production would be minimal.

MINE WASTE DISPOSAL FACILITY (MWDF)

The proposed MWDF (tailings ponds) would be about one mile southeast of the mine/mill (Figure 1-2). Other facilities located near the MWDF would be the water reclaim pond, mine refuse disposal facility (MRDF or landfill), construction support area, and a soils borrow area (Figure 1-8). The tailings ponds would provide surface disposal for fine tailings, excess waste rock, and reclaim pond and water treatment plant sludges. Most of the waste would consist of tailings. Each tailings pond would be constructed mainly from on-site glacial soils. The four large earthen ponds and surrounding perimeter road would cover a total of 365 acres. The 20 foot wide perimeter road would provide access for construction, monitoring, and reclamation activities.

MWDF Design - A major element of the MWDF design is the layered structure of both the bottom liner and final reclamation cover (see Figure 1-17). This design uses layers of high permeability material to filter and conduct water to leachate collection systems or peripheral discharge zones. These high permeability layers are underlain by low permeability liners which impede the downward movement of leachate through the bottom of the ponds or precipitation through the reclamation cover.

The underdrain is designed to allow the leachate (slurry water) to percolate rapidly downward through the filter and drain layers, but travel laterally once it reaches the bottom liner. Leachate could then be captured in the collection system and pumped to the reclaim ponds for treatment. The leachate collection system is designed to limit seepage into the groundwater system during the operations phase. Liquids collected in monitoring lysimeters placed beneath the bottom liner would be analyzed to provide an estimate of seepage quality and quantity.

By comparison, the final cover is designed to limit water movement into the tailings thereby reducing long-term seepage from the MWDF. Runoff from the final cover would flow toward the outer slopes and the adjoining landscape. Infiltrating water would be intercepted by the overdrain and would flow toward the recharge enhancement zones between the ponds and in the crest of the banks.

MWDF Volume - The anticipated volume of tailings requiring disposal from the 67.4 million ton orebody would be 28.3 million tons (18.8 million cubic yards). In addition, about 320,000 cubic yards of water treatment wastes would require disposal. This results in a total waste volume of slightly over 19.1 million cubic yards. Since the slope of the tailings beaches would add about 13% to the required storage volume, the resulting design total is 21.6 million cubic yards. The capacity, operational life, and size of the four tailings ponds are listed in Table 1-6.

Table 1-6
Tailings Ponds Information

Pond	Area to toe of Embankment (acres)	Separation Distance (Height Above Groundwater) (feet)	Storage Volume (cubic yards)	Approximate Operational Life (project years)
T1	60	38	3,100,000	4-7
T2	95	38	5,740,000	7-14
T3	70	38	3,660,000	14-21
T4	140	38	9,100,000	21-32

MWDF Operation - At full production, about 3,000 tons (massive phase) and 2,400 tons (stringer phase) of fine tailings would require surface disposal daily. A buried tailings pipeline would transport the slurried tailings from the mill to the MWDF. In the event of a pipeline shutdown, the tailings characteristics are such that they should be capable of being resuspended and flushed out during startup. At the MWDF, the pipeline would be routed aboveground along the north-south axis of the inner banks. The tailings would gently slope away from the discharge points with a water clarification pool created at the low end of the beach. The clarification pool would cover roughly 20% of the pond area. Each tailings pond would be lined with waste rock where the clarification pool forms to prevent wave erosion of the banks and liners. As a pond was filled, the tailings slurry discharge points would be moved to develop the desired final slope. Figure 1-9 is a conceptual cross section of an operating tailings pond.

Water would enter the tailings ponds in the tailings slurry or as precipitation, and would leave as evaporation, seepage or would be cycled to the reclaim pond. At the pond crest, water from the underdrain would be combined with water from the clarification pool (decant water) for transfer to reclaim pond B. To limit seepage from the tailings ponds, water would be pumped from the underdrain even during project shutdowns to maintain low water pressure on the bottom liner. A small portion of the water would be retained permanently in the pores between the tailings particles.

Dust from the ponds would be reduced by keeping the tailings surface moist or by spraying with a chemical stabilizer. The haul road and MWDF roads also would be sprayed with water or chemical stabilizers to minimize dust.

WATER BALANCE AND WATER TREATMENT

Water Balance - The overall water balance for the proposed facilities is shown in Figure 1-10. This figure shows the major and minor flows for estimated average conditions during the massive ore phase. These flows would remain the same or decrease slightly during the stringer ore phase. The predicted flow to Swamp Creek, however, would remain the same throughout the project, except for potential diversions for mitigation purposes. If the flows within the project water circuit were greater than expected, the excess water could be discharged to Swamp Creek. The greater than anticipated flows could be caused by factors such as high mine inflows or an accumulation of precipitation in the reclaim ponds/MWDF. An important function of the reclaim ponds in the overall water balance for the project would be to provide excess water storage capacity. For example, this storage capacity would be used if operating problems at the water treatment plant prevent the discharge of water to Swamp Creek or if mine inflows were greater than expected.

Water Treatment - The water treatment plant would have three separate systems as shown in Figure 1-11. Each treatment system would adjust the pH of incoming water, precipitate dissolved metals, and remove suspended solids. These treatment systems should be operational 16 months after construction begins. There will be interconnections between the three systems to increase the flexibility of the treatment options and provide backup in case one of the systems were shut down. A computer system would control treatment plant operations such as monitoring reagent feed rates and the recycling of low quality effluent. Full time operators would be responsible for monitoring the computer system, collecting water samples, and performing preventive maintenance.

Two systems would be used to treat mine water. One system would treat intercepted groundwater if the WPDES permit standards were not met. Otherwise, intercepted groundwater would be pumped to a surge tank, monitored, and released to the water discharge lagoons or used for mitigation purposes. The second mine water treatment system would treat about 80% of the contaminated mine water for discharge to Swamp Creek. Table 1-7 presents the predicted chemical composition of the intercepted groundwater and contaminated mine water.

Table 1-7
Projected Water Quality of Intercepted Groundwater and Contaminated Mine Water

Constituent[1]	Intercepted Groundwater[2]		Contaminated Mine Water[3]
Cations			
Silver (Ag)	<0.001		0.01
Aluminum (Al)	<0.53		0.75
Barium (Ba)	<0.02		0.019
Calcium (Ca)	29.8		120.0
Cadmium (Cd)	<0.002		0.061
Chromium (Cr (Total))	<0.002		0.56
Copper (Cu)	<0.007		0.25
Iron (Fe) (Total)	<1.74	Fe 2+	1.5
		Fe 3+	0.03
Mercury (Hg)	<0.0001		0.0004
Potassium (K)			3.7
Magnesium (Mg)	12.0		17.0
Manganese (Mn)	<0.423		0.37
Sodium (Na)			48.0
Lead (Pb)	<0.01		0.30
Selenium (Se)	<0.001		0.11
Zinc (Zn)	<0.052		18.0

Table 1-7 (continued)
Projected Water Quality of Intercepted Groundwater and Contaminated Mine Water

Constituent[1]	Intercepted Groundwater[2]	Contaminated Mine Water[3]
Anions		
Arsenic (As)	<0.001	0.047
Carbonate (CO_3)		1.6
Chloride (Cl)	<4.0	4.1
Cyanide (CN) (Total)	<0.001	0.01
Fluoride (F)	<0.20	0.9
Bicarbonate (HCO_3)		27.0
Nitrate (nitrogen)	<0.37	5.6
Phosphate (PO_4)	<0.06	0.12
Sulfate (SO_4)	<9.0	390.0
Sulfide		0.006
Thiosulfate (S_2O_3)		85.0
Carbon dioxide (CO_2)		2.1
Miscellaneous		
Silica (SiO_2)		9.9
Hardness	125.0	390.0
pH	7.6	5.8
Total Dissolved Solids (TDS)	166.0	660.0
Total Suspended Solids (TSS)	50.0	1200.0

1 All values except pH are in parts per million (< means less than).
2 After the initial flushing of bedrock fissures and pores, intercepted groundwater quality should be similar to the glacial aquifer water quality. Data for intercepted groundwater quality was compiled from information sources on glacial aquifer water quality.
3 Values based on normal winter conditions (CH_2M Hill Water Use Model, Jan. 1986)

Both mine water treatment systems would use the following unit operations (listed in order of their occurrence in the system);

1. Neutralization Reactor - In this reactor, recycled sludge from the lime softener, fresh lime (to enhance metal precipitation), ferric sulfate (for coagulation), activated carbon (for organics removal if necessary), and air would be mixed with the mine water to raise the pH and initiate the formation of metal precipitates.

2. Lime Softener - In this tank, the formation of metal precipitates would be completed by adding sodium sulfide. Settling of the metal precipitates as a sludge on the bottom of the tank would be enhanced by addition of a polymer. Clarified water would flow to the pH adjustment tank while the sludge is either recycled to the neutralization reactor or pumped to the fine tailings thickener for disposal in the tailings ponds.

3. Dual Media Filter - This filter would remove suspended solids and precipitates from water leaving the lime softener unit and pH adjustment tank. Each filter would consist of two layers: an 18 inch pulverized anthracite coal layer and a 21 inch silica sand layer.

4. Neutralization Tank - Sulfuric acid would be added in this tank to adjust the pH of the treated mine water to limits specified in the WPDES permit.

The third system would treat about 20% of the water being recycled from the reclaim pond and about 20% of the contaminated mine water. This system would reduce dissolved solids in the mill process water, especially calcium and sulfate, to prevent scaling in mill piping and equipment. This system

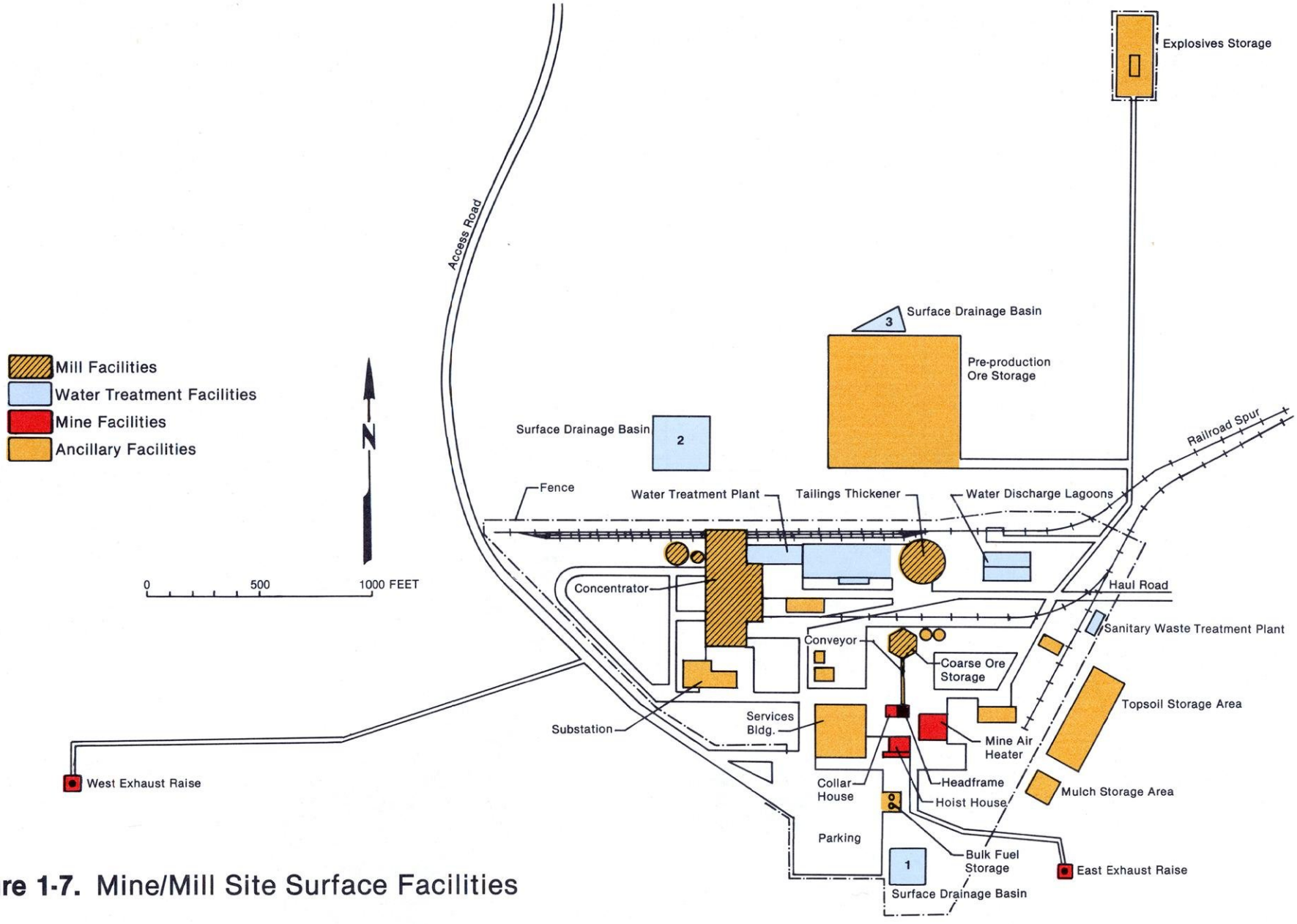


Figure 1-7. Mine/Mill Site Surface Facilities

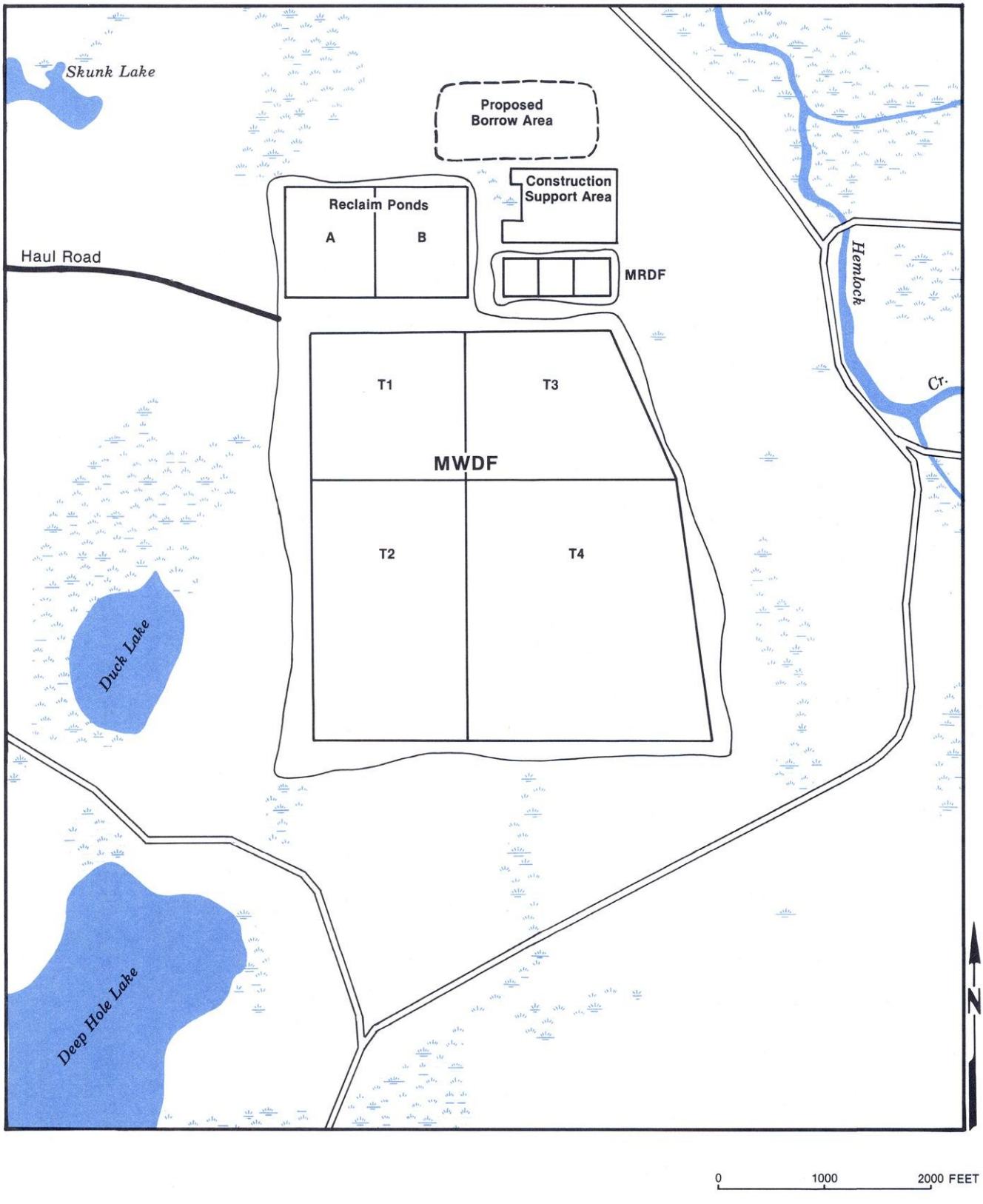


Figure 1-8. MWDF and Adjacent Facilities

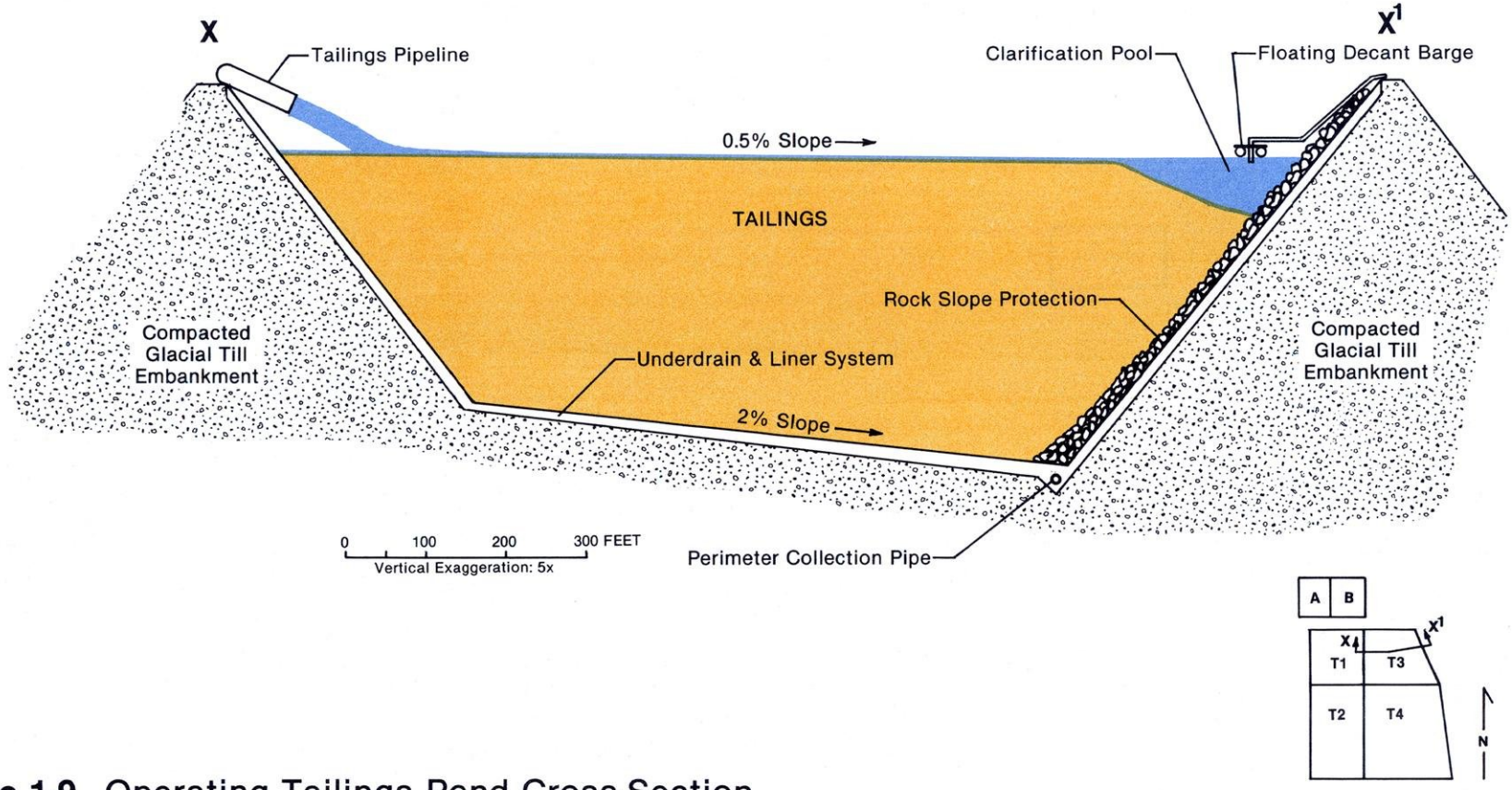


Figure 1-9. Operating Tailings Pond Cross-Section

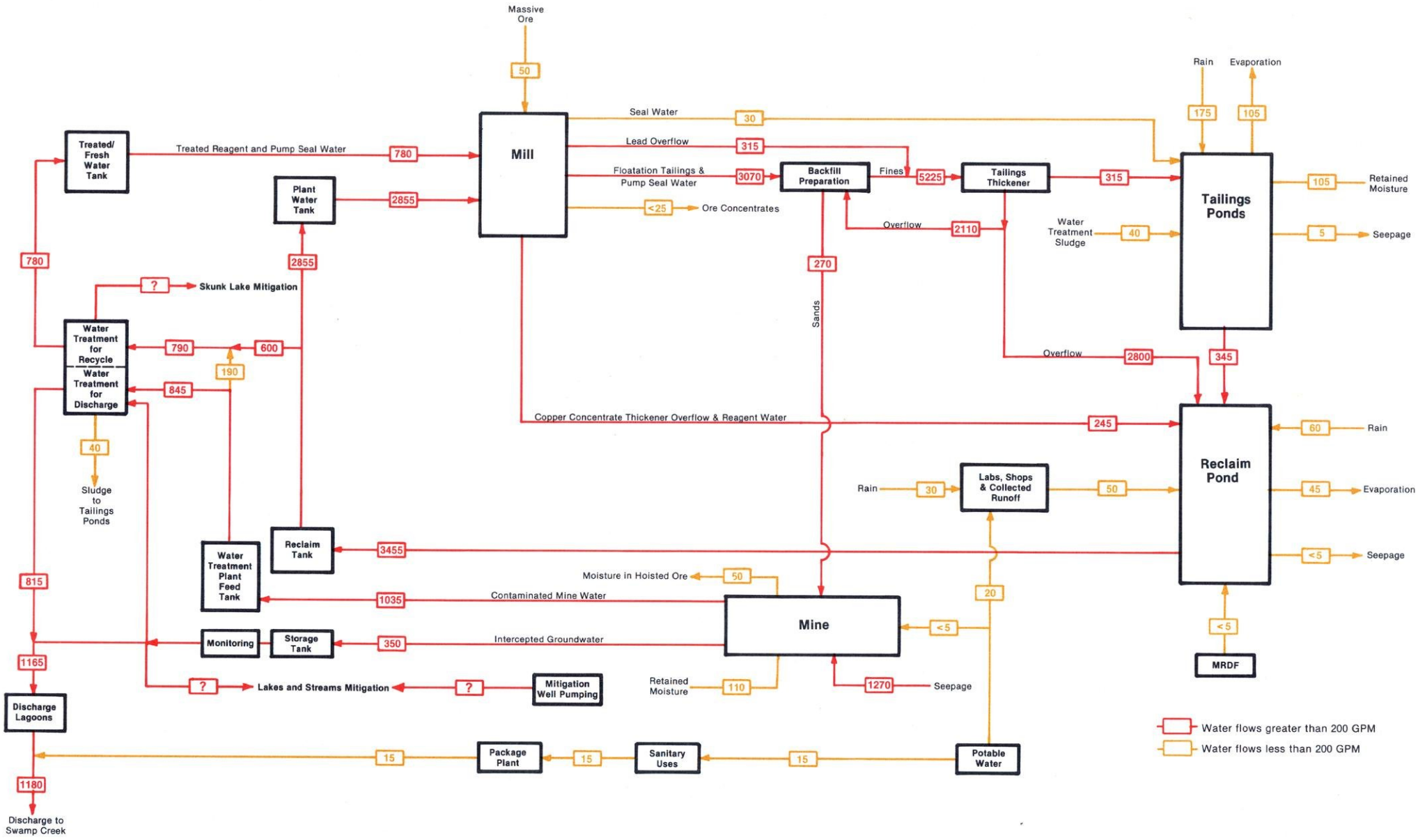


Figure 1-10. Water Balance

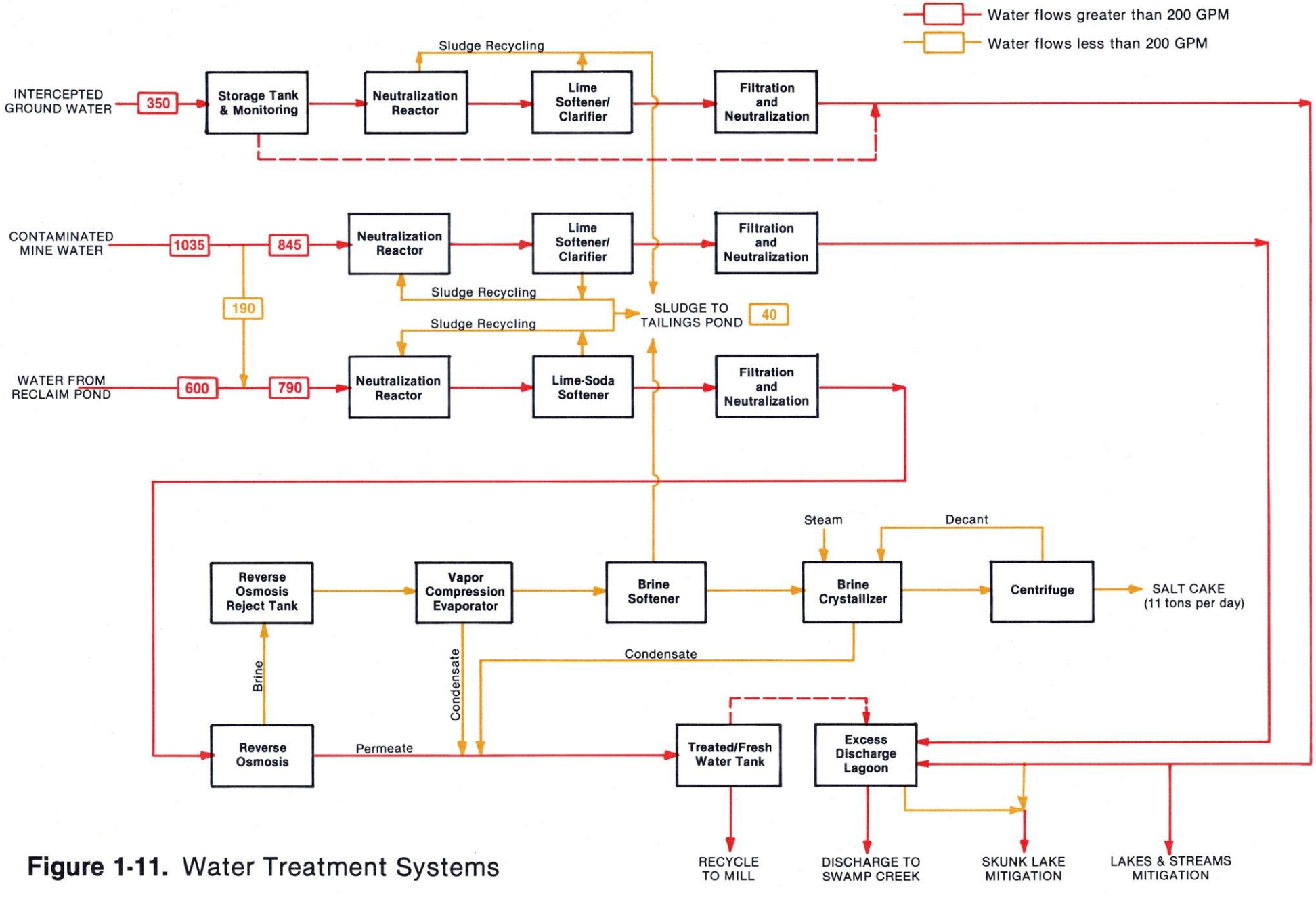


Figure 1-11. Water Treatment Systems

would be similar to the intercepted groundwater and mine water treatment systems except for the reverse osmosis equipment. If the maximum water storage capacity in the system was reached and the mill was not operating, the water treatment plant could treat and discharge excess water to Swamp Creek. The following unit operations would be included in the mill process water treatment system (listed in order of occurrence):

1. Neutralization Reactor - Same as described earlier.

2. Lime Softener - Same as described earlier except soda ash (sodium carbonate) would be added in place of the sodium sulfide resulting in the precipitation of calcium carbonate.

3. Dual Media Filters - Same as described earlier. Any necessary pH adjustment would occur just upstream of the filters by the addition of sulfuric acid.

4. Neutralization Tank - The pH of the water would be adjusted to a level compatible with the reverse osmosis process.

5. Reverse Osmosis - The water would be pumped at high pressure through semi-permeable membranes. Water passing through the membranes would be low in dissolved solids and suitable for use in the mill process water circuit. Dissolved solids unable to pass through the small pores of the membranes would be concentrated into a brine stream, and pumped to the vapor compression evaporator. The membranes would be kept clean of mineral scale and bacterial growth by using a mixture of sodium hexametaphosphate and detergents, acid, and by periodic chlorination. The cleaning solution would be flushed to the tailings ponds.

6. Vapor Compression Evaporator - This unit would concentrate the dissolved solids in the reverse osmosis brine stream by evaporation. The evaporated water would be condensed and recycled to the mill water circuit.

7. Brine Softener - This unit would be similar to the lime softener. Lime, soda ash, and polymers added to the brine would result in a sludge containing calcium sulfate, calcium carbonate, and metal hydroxides, and a solution of sodium sulfate.

8. Brine Crystallizer - This step would concentrate and crystallize the sodium sulfate solution in an evaporator and centrifuge. Clean condensate water from this evaporator also would be recycled to the mill water circuit. The solid sodium sulfate would either be sold or isolated in the tailings ponds.

The chemical reagents stored at the wastewater treatment plant would be kept in isolated areas with berms around each tank. Blind sumps would collect spills for reuse.

To a great degree, effluent restrictions from U.S. Environmental Protection Agency (EPA) effluent guidelines and Wisconsin DNR Water Quality Standards define the types of wastewater treatment which would be feasible. For newly constructed mine/mill facilities, EPA requires complete recycle of milling wastewater except for an allowable discharge equal to 1) the annual gain due to excess precipitation over evaporation from open areas of the wastewater circuit, i.e., the operating tailings disposal area and any water treatment ponds, 2) the total volume of water seeping into an underground mine and 3) any drainage from tailings placed into the mine as backfill. The level of treatment required by EPA is expressed as allowable average and maximum pollutant concentrations based on best demonstrated pollution control technology at new facilities. State limitations are imposed when the application of EPA requirements would result in water quality degradation. Water quality based limitations are dependent on stream flow, chemistry, plant and animal life, and designated uses. Thus, limits are site-specific and would be different at different discharge points. The EPA effluent restrictions and DNR water quality based effluent limitations for the proposed Swamp Creek discharge location are indicated in Table 1-8.

The monthly average water quality based limits for some parameters are dependent on effluent flow (Table 1-8). Monthly limits are presented for the average predicted flow (less than 1300 gpm) as well as for the projected maximum mine inflow (2000 gpm). Limits for short-term discharges (as high as 3000 gpm) are listed for flows caused by excess precipitation accumulation in the reclaim ponds and tailings ponds.

Table 1-8
Proposed Effluent Limitations and Projected Effluent Quality
for Surface Water Discharge to Swamp Creek (from WPDES permit)

Parameter	Daily Maximum[2]	Monthly average limits[1] based on effluent flows of <1300 gpm[3]	1301-2000 gpm[3]	2001-3000 gpm[3]	Projected[4] Effluent Quality (Daily Ave.)
Arsenic	1.48	0.626/0.663[5]	0.508/0.533[5]	0.436/0.452[5]	0.05
Cadmium	0.073	0.0045/0.0048	0.0037/0.0039	0.0032/0.0033	0.0006
Chromium^{+6}	0.058	0.051/0.053	0.042/0.043	0.036/0.037	0.012
Chromium^{+3}	11.0	0.27/0.28	0.22/0.23	0.19/0.19	0.06
Copper	0.025	0.025/0.025	0.021/0.022	0.019/0.019	0.01
Cyanide[6]	0.093	0.010/0.011	0.010/0.011	0.010/0.011	0.006
Lead	0.6[7]	0.118/0.125	0.096/0.10	0.082/0.085	0.04
Mercury	0.002[8]	0.0002[8]	0.0002[8]	0.0002[8]	0.00017
Nickel	2.58	0.096/0.102	0.079/0.082	0.072/0.070	<0.02
Selenium	1.0	0.165/0.174	0.134/0.140	0.115/0.119	0.06
Silver	0.007	NRV[9]	NRV[9]	NRV[9]	0.003
Zinc	0.44	0.14/0.14	0.11/0.12	0.10/0.10	0.06
BOD_5[10]		20 (summer)[10]	20 (summer)[10]	15 (summer)[10]	<15 [11]
		40 (winter)[10]	40 (winter)[10]	30 (winter)[10]	<15 [11]
TSS[12]	30 [7]	20 [7]	20 [7]	20 [7]	10
pH (S.U.)	6-9				6-9
Barium		10.8/11.4	8.8/9.2	7.5/7.8	0.03
Fluoride		14.6/15.5	11.9/12.4	10.2/10.6	2.0
Iron		1.8/1.9	1.5/1.6	1.4/1.4	0.4
TDS[13]	- [14]				700

(1) The monthly average limits (based on chronic toxicity) were calculated using mass balance equations which will be included in the WPDES permit. During the construction phase of the project, the monthly average limits that would likely be applied are based on an effluent flow rate of 1300 gpm. During the operation phase the monthly average limits may be based on the higher effluent flows depending on the amount of wastewater to be discharged.

(2) For most of the toxic pollutants (except lead), the daily maximum limits were derived from the available acute toxicity information for resident Wisconsin aquatic species. All units are in parts per million (mg/l) unless otherwise specified.

(3) Two scenarios were assumed in determining the monthly average effluent limits. The first set of numbers (before the slash) were calculated based on an upstream $Q_{7,10}$ of 13.5 cfs (assuming no flow mitigation for Upper Swamp Creek). The second set of numbers were calculated based on an upstream $Q_{7,10}$ of 15 cfs (assuming that there will be flow mitigation to Upper Swamp Creek).

(4) WPDES Permit Application values (Dec. 1985, amended October, 1986). The projected daily average effluent concentrations were based on: the water treatment tests on synthetic mine water using the proposed water treatment methods; the results of water model projections of the water treatment system effluent concentrations; and conservative estimates of the differences that may occur between pilot plant/laboratory conditions and actual daily plant operations.

(5) The water quality criterion for arsenic is based on the acute and chronic toxicity effects to resident Wisconsin aquatic species.

(6) Limits for cyanide apply to results from the test method for cyanide amenable to chlorination.

(7) Categorical limits (New Source Performance Standards) apply because they are more stringent than the water quality numbers.

(8) The water quality criterion necessary to prevent exceedance of FDA action limits in fish and thus protect human health is 0.0002 mg/l. This criterion value is near the detection limit of most current analytical techniques.

(9) NRV = No Recommended Value

(10) BOD_5 (Biochemical Oxygen Demand) limits are applied as weekly rather than monthly averages.

(11) This value applies at all flows.

(12) TSS = Total Suspended Solids

(13) Limits for chlorides and sulfates are regulated as part of the TDS (TDS = Total Dissolved Solids) number.

(14) The maximum limit for TDS is 1275 mg/l when discharge is less than 1300 gpm, 1000 mg/l when discharge is between 1301 and 2000 gpm, and 910 mg/l when the discharge is between 2,001 and 3,000 gpm.

Note: Tin, bismuth, manganese, aluminum, and platinum monitoring would be required in the WPDES permit. Since information on the toxicity of these metals is currently not available in the literature, limits cannot be set at this time. Effluent limits may be established as information on these substances becomes available.

Wastewater Discharge Lagoons - Treated mine water, as well as intercepted groundwater not requiring treatment, would be pumped to the water discharge lagoons before release to Swamp Creek. The two lagoons would have a total operating capacity of 3,300,000 gallons providing 48 hours retention for the predicted average flow rate. Each lagoon would have concrete retaining walls and a geomembrane for a bottom liner. The water in the lagoons could be recycled for additional treatment if the WPDES effluent limits were not met. About 1,200 gallons per minute would be discharged by pipeline to Swamp Creek downstream of the County Highway M bridge.

Reclaim Ponds - The two reclaim ponds would be an integral part of the overall water management system. The base and sides of each pond would have four layers: the top layer would consist of a 1.5 foot protective sand cushion; the second layer would be a 36-mil or thicker geomembrane liner; the third would be a carbonate-free sand underdrain/vent layer of variable thickness (8 to 18 inches); and the bottom layer would consist of a 36-mil or thicker geomembrane liner. A subbase beneath the bottom geomembrane would be prepared from processed till. The processed till would have large rocks removed to minimize the potential for puncture of the geomembrane. The underdrain/vent layer would have pipes to collect seepage and prevent gas build-up. A layer of large rocks would be placed along the water line of each pond to prevent bank erosion by waves. The two ponds would be separated by an earthen dike. Cross sections of the reclaim ponds are shown in Figure 1-12. The reclaim ponds would have the following operational characteristics listed in Table 1-9.

Table 1-9
Reclaim Ponds Operating Characteristics

	Pond A	Pond B
Area inside crest (acres)	18.0	18.0
Area to toe of embankment (acres)	25.0	25.0
Maximum Pond Depth (ft)	33.0	33.0
Maximum Operating Depth (ft)	21.0	21.0
Separation Distance from Groundwater (ft)	45.0	45.0
Operational Life (years)	33.0	30.0
Storage Volume (gallons)	70,700,000	84,840,000
(cubic yards)	350,000	420,000

Biological, physical, and chemical processes occurring in both ponds would remove fine particles, cyanides, organic flotation reagents, and thiosulfates from process water. All water treated in the reclaim pond would first flow into pond B. Flows to pond B would come primarily from the fine tailings thickener and decant/underdrain water from the tailings ponds. Smaller amounts would come from the contaminated runoff collection system (drainage basins #2 and #3), concentrate thickener overflows, and the landfill.

At expected flows of 3,450 gallons per minute during the massive ore phase, retention time in the two ponds would be 35 days. The water flowing into pond B would probably have an initial pH of 10-11 and contain very fine tailings in suspension. Sulfur compounds (thiosulfates) in the process water would be oxidized in pond B thus increasing acidity (pH 4 might occur) during the summer. During the winter, however, the colder temperature would inhibit oxidation and the water would remain alkaline (pH = 7 to 10). To compensate for the increased acidity of the water during the summer months, lime would be added to water flowing from pond B to pond A to raise the pH from 4 to 7. Calcium carbonate sediments and fine tailings would accumulate in pond B, while the sediment in pond A would primarily consist of gypsum (calcium sulfate) and metal hydroxides. About 140,000 cubic yards of sediment would settle in the reclaim ponds over the life of the project. This sediment would be disposed periodically during operation and in tailings pond T4 during the reclamation phase.

Runoff Collection Basins - Runoff from the mine/mill area would flow to three sedimentation basins (see Figure 1-7). These basins would be used over the life of the project. Runoff from the mine/mill site during construction would flow to Basin #1 or Basin #2, both of which would be completed by the sixth month of construction. Basin #1 would discharge to wetlands near Little Sand Lake throughout the life of the project. Runoff to Basin #2 would discharge toward Swamp Creek until the operations phase when runoff would be pumped to the reclaim ponds for treatment. Basin #3 would collect runoff from the preproduction ore storage pad for treatment in the reclaim ponds. Both basins #2 and #3 would be lined with geomembranes. Each basin would be designed to hold the runoff from a 25-year, 24-hour storm event.

Runoff or utility water contaminated with oil from shaft sinking operations would go through an oil/water separator before being pumped to the reclaim ponds during the construction phase. Oily runoff water from fuel storage areas, the construction lay down area, and around the services building would pass through the oil/water separator. The oily contaminants would be stored in holding tanks or drums at the lubricant storage building until sold to an offsite processor. Clear water from the separator would be pumped to the reclaim ponds for further treatment.

Sedimentation basins also would be built at the MWDF to control runoff. Water from these basins would discharge to natural drainage channels adjacent to the MWDF. The runoff control basins would be constructed as the tailings ponds were sequentially constructed and closed (see Figure 1-16 for additional detail).

Sanitary Treatment Plant - This system would treat wastewater from toilets, showers, and washbasins in an enclosed, factory manufactured treatment plant utilizing an activated sludge extended aeration process. The plant would be located on the eastern edge of the mine/mill site and would cover 0.1 acres. The plant would treat 25,000 to 30,000 gallons per day based on an estimate of 650 people on-site per day. Sludge would be stored in a holding tank for one or two months until removed from the site by a private hauler. Treated water from the plant would be added to the discharge pipeline and pumped to Swamp Creek.

ANCILLARY FACILITIES

Wastewater Discharge Pipeline and Swamp Creek Outlet Structure - Treated wastewater from the proposed water treatment plant and sanitary treatment plant would be discharged to Swamp Creek, about one mile downstream of the County Trunk Highway (CTH) M bridge (Figure 1-2). The pipeline would be constructed of 14 inch diameter, high density polyethylene (HDPE) plastic pipe and buried at least five feet deep. The pipeline corridor would be 6.1 miles long with corridor easements 50 feet wide. The corridor would cross through forests and open farmland as well as 5600 feet of wetland. No permanent road or pump installations would be required along the pipeline corridor route. The concrete outlet for the pipeline would be located in a wetland and placed level with the ground surface to minimize erosion.

Potable Water System - Potable water for the facilities would be pumped from a new well constructed one half mile southwest of the mine/mill during the first year. The 18-inch diameter well, with a pumping capacity of 600 gallons per minute, would pump fresh water to a 50,000-gallon storage tank. The potable water system would supply water for reagent preparation and employees. Treatment of the potable water is not anticipated. A new well in the construction support area, northeast of the tailings ponds, would be used to supply water for soil processing. Existing wells at the MWDF would be abandoned or used for monitoring purposes.

Haul Road and Pipelines - The haul road and three pipelines would share a 100 foot wide by 3,800 foot long corridor between the mine/mill and the reclaim pond (Figure 1-2). The haul road would be 28 feet wide with a dividing berm confining traffic to the gravel surfaced portion of the corridor. The haul road would be used to transport waste rock and construction materials to the MWDF. The corridor would cross wooded uplands except for a 190 foot crossing of a wetland. The topography is fairly level but steep slopes occur near the reclaim pond.

The three pipelines would be used to transport; (1) the fine tailings slurry to the tailings ponds, (2) fine tailings thickener overflow water to reclaim pond B, and (3) return reclaim pond water to the ore processing circuits and water treatment plant. The pipelines would be buried within the boundaries of the mine/mill site and along the corridor but would be above ground at the tailings ponds. Piping needed to transfer clarification pool and underdrain water from the tailings ponds to the reclaim ponds and between the water treatment plant, concentrator building, water tanks, and tailings thickener also would be above ground. A strip about eight feet wide would be kept clear of trees and brush to permit inspection of the pipeline route along the haul road/pipeline corridor.

Borrow Area - The proposed borrow area is a 40 acre upland site north of the construction support area. This area would be disturbed only if soil were needed for reclamation purposes.

Mine Refuse Disposal Facility (MRDF) - The MRDF, an on-site landfill, would be used for the disposal of refuse (packaging, crates, paper, wood ash, wood, etc.) during mine construction, operation, and closure (Figure 1-8). The estimated refuse volume is about 102,000 cubic yards (51,000 tons) and would consist of the following waste types: paper and garbage (75%), plastic (5%), wood (5%), metal (10%), and miscellaneous (5%). The MRDF would cover 15 acres and would consist of three cells. Each cell would cover five acres, have a total capacity of 40,000 cubic yards, and an operating life of nine to fourteen years. This facility would not be open to the public.The separation distance between the bottom of each cell and groundwater would be about 85 feet. Each cell would have a bottom liner/leachate collection system and reclamation cover with the same design thicknesses and layer sequencing as the tailings ponds (see Figure 1-8 for location and Figure 1-17 for liner design). Leachate collected in the landfill would be pumped to the reclaim ponds for treatment.

Access Road - About a mile north of the Village of Mole Lake, the proposed access road would proceed eastward and southward from State Highway 55 for three miles to the mine/mill site (Figure 1-2). This roadway would have two 12 foot bituminous concrete lanes, eight foot gravel shoulders, and a 100 foot right-of-way.

Five streams and three drainageways would be crossed by the access road. The largest stream, Swamp Creek, would be crossed by a 125 foot long by 40 foot wide, single span, concrete bridge. This bridge would have about eight feet of clearance during normal water levels. Crossings for four nonnavigable unnamed creeks (#24-4, #24-13, #24-14, #24-15) and two drainageways would consist of 24 inch to 27 inch diameter culverts installed under the roadway.

The access road would be private except adjacent landowners would have contractual access rights. Other than State Highway 55, no public roads would intersect the access road. Normal highway maintenance practices would include mowing and cutting to control woody vegetation, and sanding and salting during winter.

Railroad Spur and Siding - The proposed railroad spur would be a single set of tracks running 2.7 miles to the northeast from the mine/mill to the existing Soo Line tracks (Figure 1-2). The spur right-of-way would be 100 feet wide except at some deep earthern cut areas (up to 150 feet wide). Where the siding would be adjacent to the spur, the right-of-way would be 150 feet wide. The siding would consist of three adjacent sets of tracks, each 3,280 feet long, north of Swamp Creek.

Two streams would be crossed by the rail corridor. Swamp Creek, would be crossed by a 66 foot long, single span concrete bridge. The underside of the bridge would have about 10 feet of clearance during normal water levels. An eight foot wide by four foot high box culvert would be built at a small unnamed creek (#20-8). In addition, six metal or concrete culverts ranging from 24 inches to 33 inches diameter would be constructed at drainageways along the corridor. Berry Lane, a gravel town road, would be relocated a short distance with railroad warning signs erected at the new crossing.

Maintenance would consist of vegetation and erosion control along the spur. The tracks would be kept free of vegetation by using herbicides or other means, such as cutting. Vegetation in the right-of-way would be controlled by mowing, herbicides or other means.

Services Building, Parking and Gatehouse - The services building would house administrative offices, a mill change room, maintenance shops for the mobile equipment, and two emergency vehicles (fire truck and ambulance).

The parking area, south of the services building, could accommodate 480 vehicles and would be paved with concrete curbing and gutter. A fence around the mine/mill facilities would limit access to the gatehouse between the services building and parking lot.

Lubricant Storage Building - The lubricant storage building would contain lubricants, paints, and cleaning materials. Waste oil and grease also would be stored here prior to removal. The building would have a concrete floor to contain any spills.

Explosives Storage Buildings - The explosives storage buildings and associated parking areas north of the mine/mill would be protected by a security fence.

Preproduction Ore Storage Pad - This eight acre facility would have a liner consisting of two, four-inch thick bentonite-amended soil layers. All runoff throughout the construction and operation phases would be directed into drainage basin #3. This water would be pumped to the reclaim pond for treatment. The pad would be used to store preproduction ore and waste rock during mine construction and early operations. After this period the pad would be used for surge storage of waste rock, ore, and concentrate or for equipment storage.

Mine/Mill Support Facilities - These facilities consist of the core storage building, covered storage, air compressors, cold storage, and topsoil and mulch storage piles.

Mitigation Facilities - These facilities would mitigate lake and/or stream impacts caused by groundwater drawdown. Water from the potable water well, dedicated mitigation wells and/or a groundwater interception system would be discharged to lakes and streams. Some treated mine water as well as groundwater would be discharged to Skunk Lake to supplement lake levels. Wells may be constructed adjacent to Swamp Creek, Hoffman Pond, Martin Springs/Creek 11-4, Creek 12-9, Hemlock Creek and Upper Pickerel Creek. Groundwater would be pumped from these wells to augment stream discharge during mine-induced low flow conditions. Concrete weirs may be built at the outlets of Duck Lake and Little Sand Lake to help maintain lake levels. The procedures for installing these facilities are discussed in the Mitigation Section (p. 45).

Electric Service - Electrical service for the mine/mill would be provided by the Wisconsin Public Service Corporation (WPS). The following has been proposed to provide the electrical service needed:

1. Construction of a new 18.3 mile long, 115 kV electric transmission line between the existing WPS Venus Substation near Monico, WI, and the Exxon project site;

2. Modification of the Venus Substation to connect the new line with the other transmission lines currently terminating at Venus; and

3. Construction of a new Exxon-owned substation at the mine/mill to lower the voltage from 115/kV to the 13.8 kV voltage used for distribution within the plant site.

A distribution line presently supplies power to the site. Additional electric power, however, would be needed at the site especially during the construction phase. To supply this supplementary power a 2,500 kW diesel generator would be used until the proposed transmission line was completed. After the transmission line was operating, Exxon would use this diesel generator and two additional diesel generators, rated at 2,500 kW and 1,500 kW respectively, only as emergency power sources. They would operate certain underground equipment and the hoist during interruption of electrical service. The diesel generators would be in the concrete block building housing the main electrical substation for the mine/mill.

The proposed transmission line route is shown on Figure 1-13. The route would be eastward out of Monico, WI, for about 9.5 miles along the northern edge of the Highway 8 right-of-way. The route then turns southward for about five miles with the last section following the proposed access road to the mine site.

The transmission line would be built on single-pole wood structures (Figure 1-14). The poles would be 75 feet tall and about 350 feet apart. Wood support poles with steel guy wires would be used where the line changes direction.

The poles would have three steel side-arms with each side-arm supporting a string of seven suspension insulators. Cables to carry the electrical power would be attached to the end of each insulator string. The minimum clearance between the cables and the ground would be about 25 feet. A grounded shield wire would be attached to the top of each pole to protect the circuits and poles from lightning. The distribution circuit currently occupying the proposed transmission line route along Highway 8 would be accommodated below the transmission circuit.

The width of a powerline right-of-way depends on line voltage, structure design, and adjacent land uses. A new right-of-way for the proposed line through forests or shrublands would be cleared to a width of 80 feet. Rights-of-way paralleling town or county roads would require clearing an additional width of 42 feet. Adequate right-of-way already exists along the proposed Highway 8 section. Along the access road, an extra 80 feet may be cleared to accommodate the transmission line.

The transmission line right-of-way would be kept clear of trees and tall shrubs to prevent short circuits, service loss, and minimize fire hazards as well as to facilitate maintenance and repair. During right-of-way maintenance, trees and shrubs would be sprayed and/or cleared from the right-of-way by herbicide application, manual clearing, or a combination of these methods. The specific clearing method would depend on a number of factors, including vegetation type, terrain, ease of access, easement restrictions, and other possible restrictions.

The existing WPS Venus substation, located one mile south of Monico, WI, would be expanded to accommodate the new 115 kV line. Substation expansion would require the clearing of 0.2 acre of land. The new line would be connected to the three 115 kV lines currently terminating at the substation. Circuit breakers, along with associated disconnection switches, metering, controls, capacitors and relaying equipment would be added as needed.

The primary substation, to be built at the termination of the transmission line in the mine/mill site, would change voltage levels from 115 kV to the 13.8 kV level used at the mine/mill facilities. Major equipment would include two 115/13.8 kV transformers, switching gear, circuit breakers, and a 10 MVAR capacitor bank.

The primary substation would be in a concrete block building while the secondary substations would consist of open, above ground equipment supported on concrete pads. Electrical power would be distributed through an underground network at the mine/mill site but would be above ground from the mine/mill to the MWDF. The above ground sections would be on wooden poles and would follow the haul road/pipeline corridor.

Natural Gas Service - Natural gas would be used to heat mine ventilation air, certain surface buildings, and the water treatment plant. Gas also would be used to power the reverse osmosis unit at the wastewater treatment plant. The proposed six-inch pipeline would be a joint project of the Wisconsin Public Service Corporation (WPS) and the ANR Pipeline Company (ANR). A metering and regulating facility would be constructed at the junction of the ANR and WPS pipeline segments.

The proposed underground pipeline would be about 8.5 miles long and would run southward from an existing ANR pipeline to the mine/mill. The existing ANR pipeline runs generally east-west and passes 0.5 mile north of Crandon. ANR would construct and operate the northern 2.5 miles while WPS would construct and operate the remaining six miles of the pipeline. The proposed route would follow town roads, State Highway 55, and the Exxon access road for almost the entire length. The natural gas pipeline would cross Drake Creek, Rocky Siding Creek, and Swamp Creek. The proposed pipeline route is shown in Figure 1-13.

The pipeline would consist of a six-inch diameter steel pipe wrapped in a polyethylene protective coating and equipped with magnesium anodes to minimize corrosion. The pipe would be buried at a minimum depth of 36 inches. Below streams and roads, the pipeline would be buried to a minimum depth of 48 inches.

The right-of-way for the buried pipeline would be cleared of trees and shrubs during construction and periodically recleared to allow access for maintenance and repair. Where the pipeline paralleled an existing road, a 30-foot right-of-way would would be needed during construction and a permanent 10-foot right-of-way would be maintained. For a cross-country stretch of pipeline, the construction right-of-way would be 50 feet wide and the permanent right-of-way would be 20 feet. The pipeline would have four foot tall markers, four inches in diameter, at about 0.5 mile intervals along the route. Road, stream, and fenceline crossings also would be marked.

A meter and regulator station would be built at the junction of the ANR and WPS portions of the gas line. The station would consist of a small building and some external equipment inside a 2,500 ft^2 fenced enclosure. Equipment at the station would record the amount of gas flowing from the ANR pipeline into the WPS pipeline, lower the natural gas pressure, and add an odorant to the natural gas to aid leak detection. The ANR portion of the pipeline would have normal operating pressures between 500 pounds and 800 pounds per square inch while the WPS portion would be operated between 60 pounds and 150 pounds per square inch. Another meter station would be located at the mine site to record the amount of natural gas delivered to the mine/mill.

Fuel Storage and Distribution - Two aboveground 15,000-gallon diesel storage tanks would be located east of the parking lot. The storage tanks would have truck access but would be surrounded by dikes to contain potential spills. The area within the containment dikes would be lined with a petroleum resistant material to prevent spills or contaminated runoff from reaching groundwater. Minor spills, tank wash down, and contaminated runoff contained within the dikes would be transported by truck to the oil-water separator. If a major spill occurred, the contaminated fuel would be sent to an offsite disposal facility or to a reprocessor.

The fuel distribution system for the mine would consist of two 3,000 gallon measuring tanks located on the surface at the mine fuel delivery borehole. Assuming no contamination, water contained in dikes surrounding the two tanks would be drained after each storm. Contaminated water would be pumped to the oil-water separator with the treated water added to the process water cycle.

The surface fueling station for vehicles would be south of the water discharge lagoons. One 4,000 gallon, buried storage tank would be used for diesel fuel and one 1,000-gallon buried storage tank would be used for gasoline. Diesel fuel at the MWDF would be stored and pumped from tank trucks. Three tanks, buried east of the switching station, would hold a total of 37,000 gallons of diesel fuel to power the emergency generators.

CONSTRUCTION OF PROPOSED FACILITIES

CONSTRUCTION SEQUENCE AND SCHEDULE

Initially, construction would focus on site preparation for the mine/mill surface facilities. The existing roads to the site would be used until the access road and railroad spur were completed. Construction at the mine/mill surface facilities would be sequenced to support shaft sinking and mine development. Mine construction would occur in the following order: 1) erect the headframes; 2) excavate the main and east exhaust air shafts; 3) develop the initial main level drifts, ore passes and the maintenance shop; and 4) install the underground equipment.

The following surface systems would be constructed or provided in the early phases of mine/mill development: 1) drainage basins for surface runoff and mine inflow control; 2) the water and sanitary treatment facilities; 3) the services building; 4) the access road and railroad spur to the mine/mill; 5) temporary power; 6) concrete batching facilities; and 7) a security fence around the mine/mill site. The construction of the other ancillary facilities would follow as needed (Figure 1-15).

SITE PREPARATION

Site preparation would be performed in several stages. Marketable trees would be removed from the mine/mill site followed by the sequential installation of stormwater drainage/retention systems, clearing, grubbing, and rough grading of the site. Tree stumps and brush from clearing and grubbing would be either burned or mulched (see Table 1-10). Excess subsoil from grading operations would be transferred to the MWDF construction support area soil stockpile. Areas not scheduled for immediate development following rough grading would be seeded to control erosion. Site preparation at the tailings ponds, reclaim ponds, landfill, and construction support area would be similar to the mine/mill sequence.

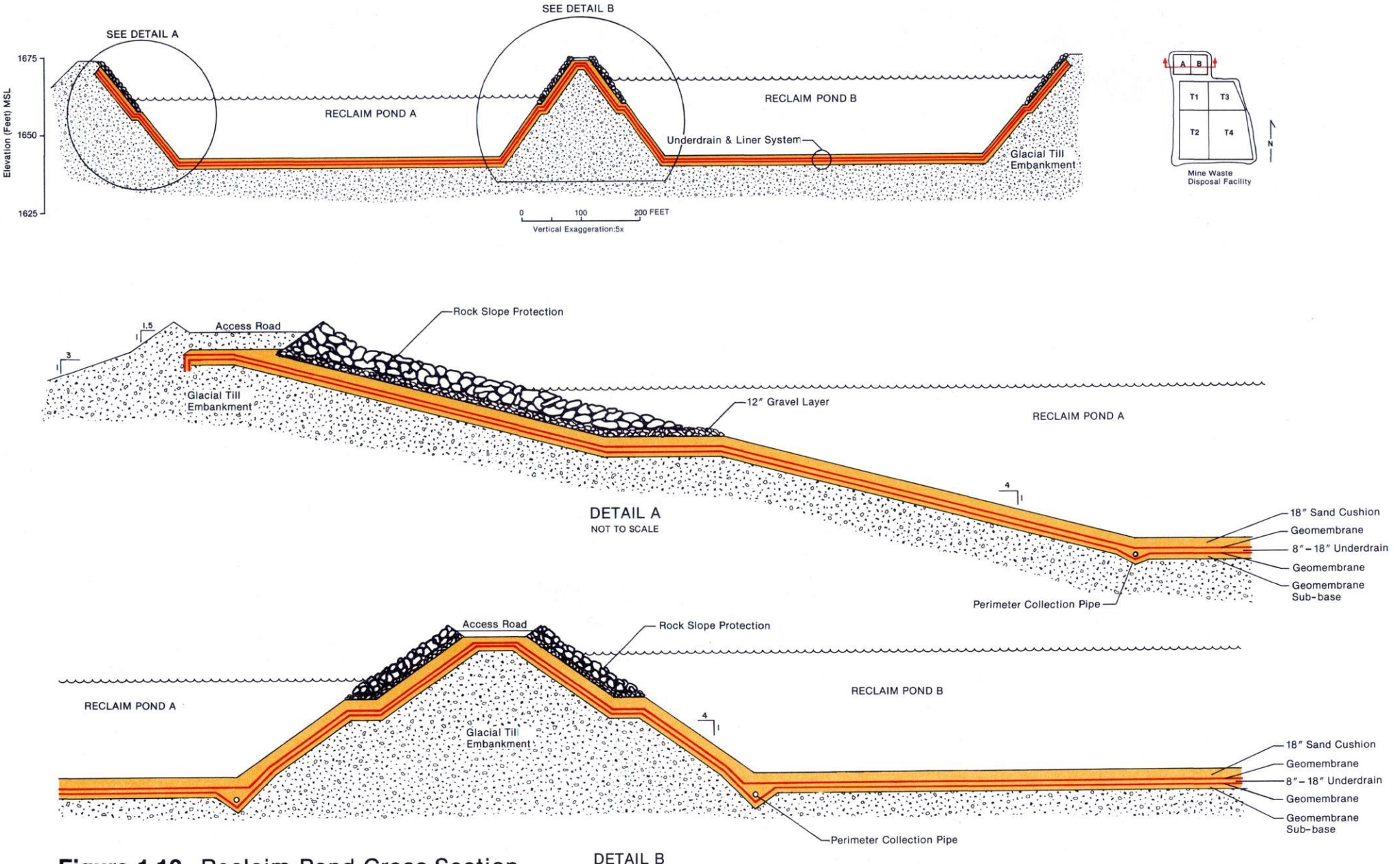
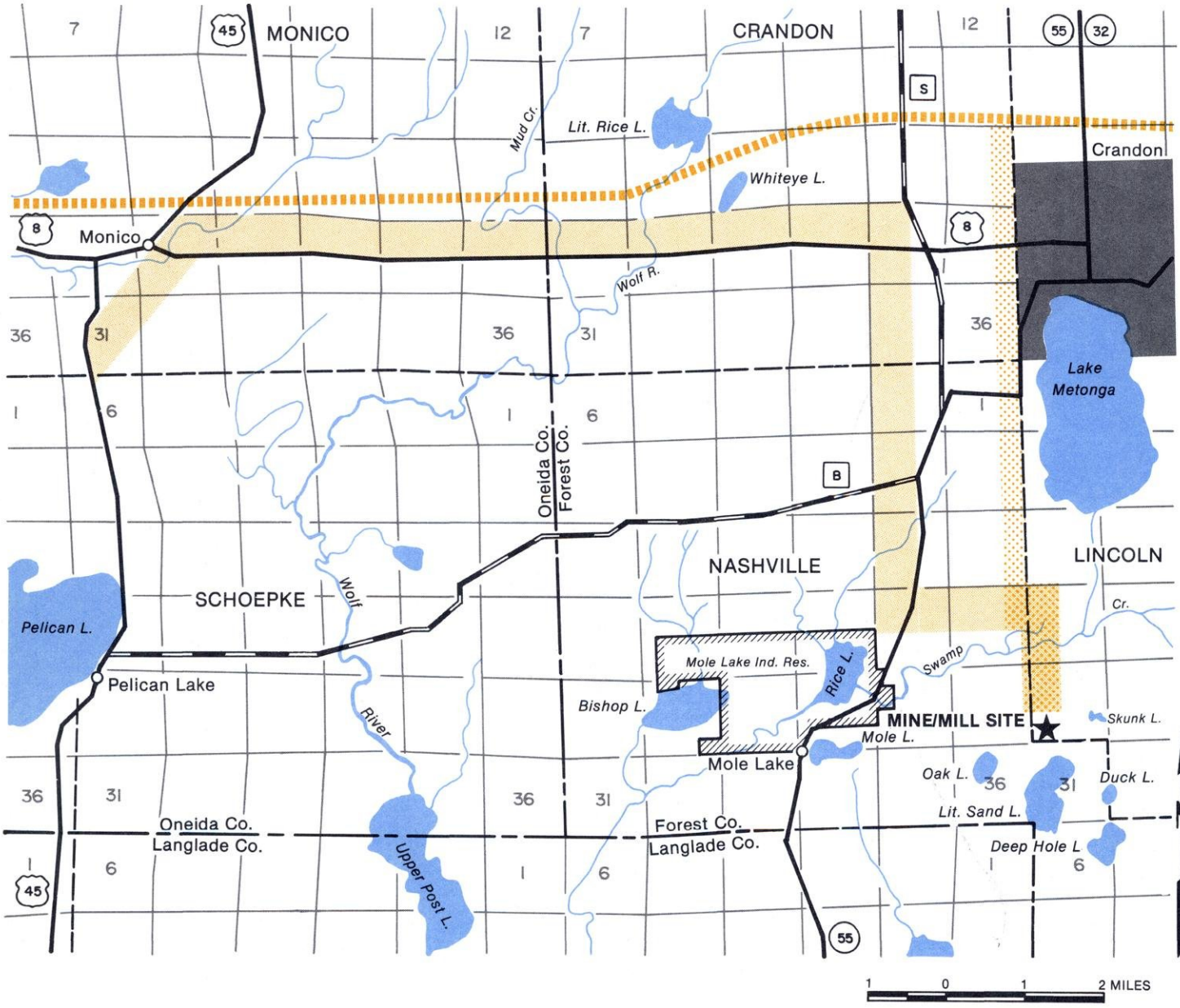


Figure 1-12. Reclaim Pond Cross-Section



Existing natural gas line

Proposed natural gas line route

Proposed electric line route

Figure 1-13. Proposed Electric Transmission and Natural Gas Line Corridors

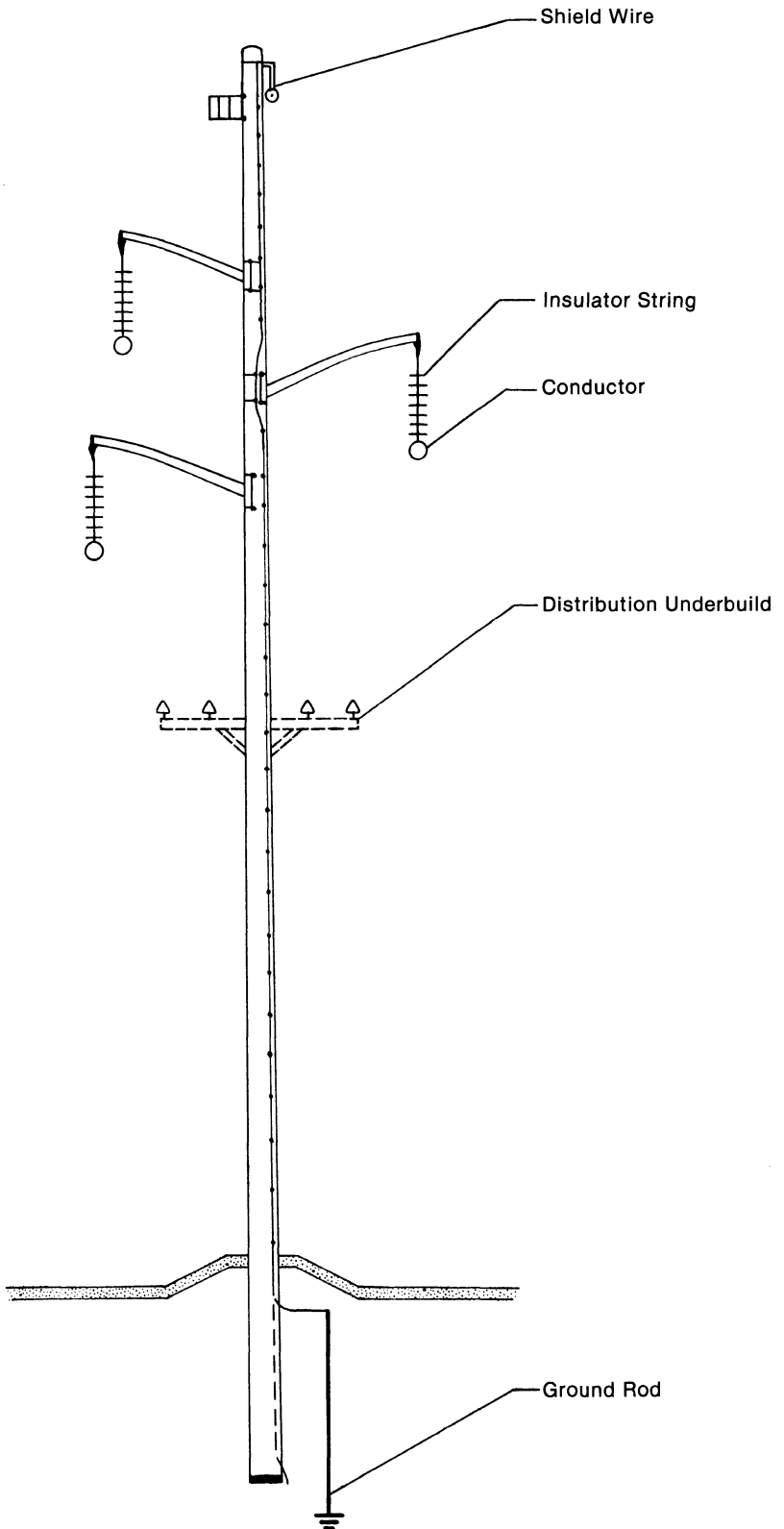
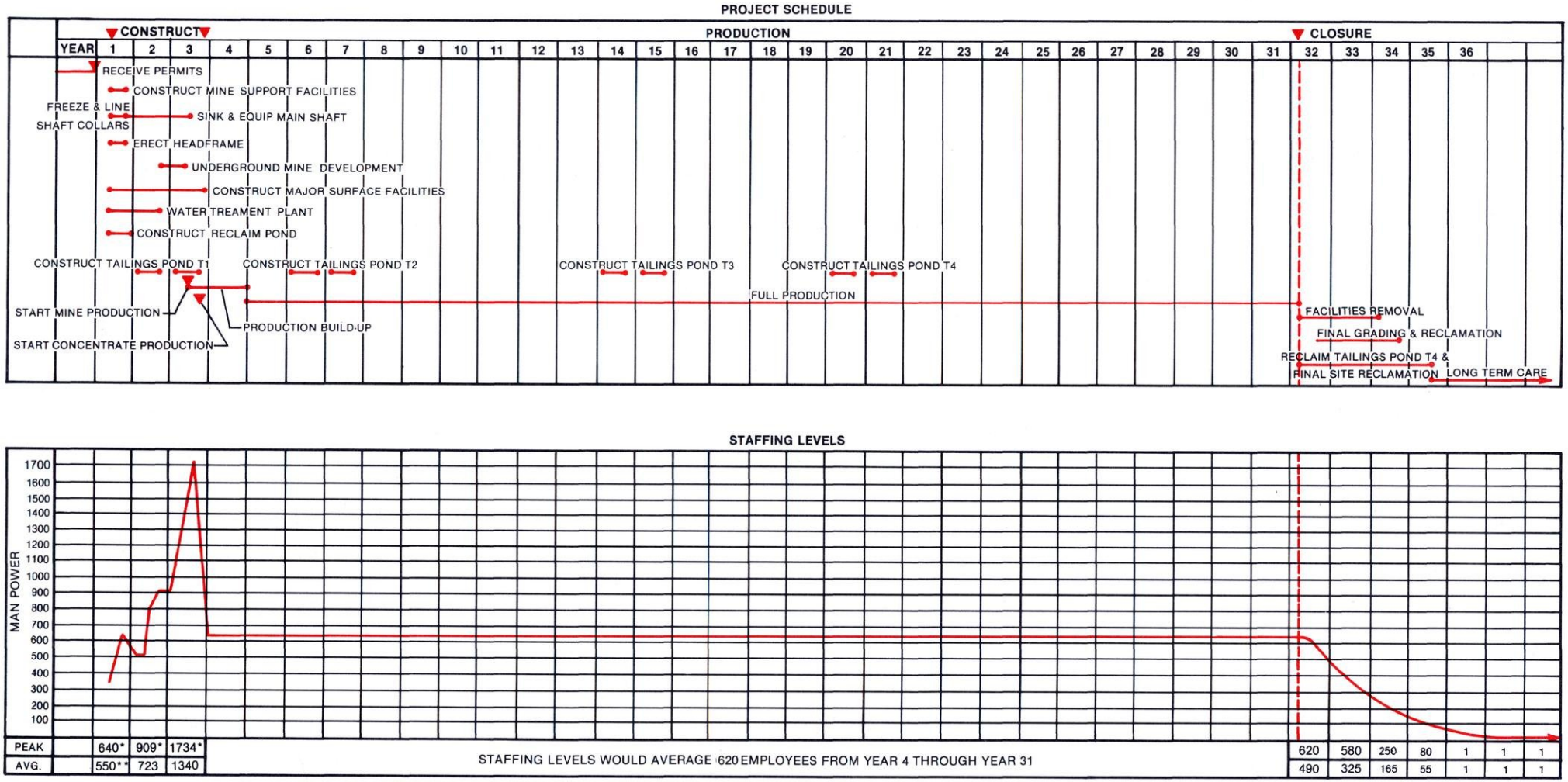


Figure 1-14. Proposed Transmission Pole Appearance



* CONSTRUCTION MANPOWER INCLUDES 20% CONTINGENCY.

** 7 MONTH AVERAGE

NOTES: 1) CONSTRUCTION OF TAILINGS POND 2, 3, & 4 WILL BE DONE AS REQUIRED DURING PRODUCTION. RECLAMATION OF TAILINGS POND 1, 2, & 3 WILL BE DONE DURING PRODUCTION.

2) ACTUAL CONSTRUCTION SCHEDULE MAY VARY DEPENDING ON PERMIT ISSUANCE & ECONOMIC CONDITIONS.

Figure 1-15. Project Schedule and Employment

Topsoil salvaged from the construction areas would be processed to remove large stones, stockpiled and stabilized. The main stockpile would be sited on the east side of the mine/mill site but additional temporary topsoil stockpiles would be located along the major corridors and at the MWDF. Stripping the topsoil to a depth of 9 to 12 inches should provide a sufficient volume for reclamation purposes.

During the first few months of construction, water needed for processing soil, making concrete and dust control would be drawn from existing wells. After the first few months, potable water would be supplied from a permanent high capacity well southwest of the mine/mill. The existing wells at the MWDF would be abandoned or used for monitoring purposes. A new well in the construction support area would supply water for soil processing.

CONSTRUCTION OF FACILITIES

Some temporary structures (trailers, construction headframes) would be required at the site, but permanent facilities would be used wherever possible. Temporary parking for staff would be provided at the working areas until the permanent parking lot was completed. Portable sanitary facilities would be located at all major work sites. An on-site fire truck would be used for fire protection of temporary facilities.

Mine - Initial mine development would consist of the excavation of two vertical shafts; the main shaft and the east exhaust raise. Shaft excavation through the glacial sediments would include temporary stabilization and groundwater inflow control by ground freezing, removal of the glacial overburden, and lining the excavation with concrete from the surface to competent bedrock. Grout pumped into the bedrock - overburden interface would reduce groundwater seepage into the shaft.

After the concrete collar section of each shaft was completed, headframes would be erected for shaft sinking in bedrock. Sinking of the main and east exhaust shafts would involve one to three blasts per day with the broken rock hoisted to the surface. Waste rock and ore hoisted to the surface would be transported to the preproduction ore storage pad. At specified intervals, level stations would be excavated to develop the main level drifts. Upon completion of the permanent headframe and the shafts, 18 to 22 months after construction begins, mine development would start. By project month 30 the underground crusher would be operational and mine/mill production could commence. Full production, however, would not be reached until the end of project year 4.

The west exhaust raise would be constructed in project year 5 and would be excavated by boring a six foot hole to the 750 foot level drift. This borehole would be enlarged to 18 feet in diameter by subsequent drilling and blasting. Permanent exhaust fans would be installed above each exhaust raise on the surface to complete the ventilation circuit. Before completion of the ventilation circuit, fresh air would be forced down the main shaft and into the various working places.

Contaminated water from the shaft construction sites and the preproduction ore storage pad would be stored in the wastewater storage lagoons or reclaim pond cell A. This water would be stored until the water treatment plant is operational or used as ore processing water during mill start-up.

Mill - The mill facilities would consist of buildings with concrete foundations, structural steel frames, and insulated structural walls and roof. Process structures such as thickeners, tanks, conveyors, and pipe racks also would be supported on concrete foundations. These structures and associated equipment would be installed over a 30-month period.

The sequence of surface facilities construction would be timed to support mine development activities and provide needed environmental protection systems. Major facilities started in project year 1 and completed by project year 2 include: the sanitary treatment plant, water treatment facilities, surface drainage basins, wastewater storage lagoons, services building, compressors, perimeter fence, and the fire protection and water storage system. Several of the miscellaneous storage buildings also would be built early on and would be available for use by the construction crews. During project year 1 foundations would be started for the concentrator building.

During project years 2 and 3, the coarse ore storage facility would be constructed. Machinery installation, electrical, and instrumentation work would increase late in project year 2 as the civil and structural work decreases. The principal aboveground structures would be constructed by the end of project year 3. Sufficient underground and aboveground development should have occurred by project year 3 to allow limited mine production to proceed. Clean-up and landscaping activities, which would be ongoing throughout the construction phase, would be completed at the mine/mill site.

Factors which may influence the construction schedule of the mill as well as the mine and MWDF include: inclement weather, labor problems, delays in equipment/material deliveries, design modifications and localized mine water inflows higher than anticipated.

Lined Facilities - The following facilities would have liners: the tailings ponds, reclaim ponds, landfill, preproduction ore storage pad and water discharge lagoons. Drainage basins #2 and #3, discussed on page 19, would be lined with synthetic geomembranes. These facilities must have liners because they would confine materials which could contaminate the environment. Due to the limited construction season, work on these facilities would be concentrated in the months of May through November during daylight hours. The development, as well as reclamation, sequence of the tailings ponds, reclaim pond, and landfill is shown in Figure 1-16.

During project year 1 the preproduction ore storage pad and drainage basin #3, the first cell of the landfill, and reclaim pond A would be constructed. In addition, the tailings discharge and return water pipelines from the mine/mill would be laid along the haul road corridor. Construction of tailings pond T1 would begin in project year 2 with completion scheduled for project year 3. Reclaim pond B would be constructed in project year 4.

All of the tailings ponds would have the following construction sequence. First, the banks would be built up and compacted. Next, the bottom of the pond would be prepared and monitoring devices to sample leachate would be installed. The successive placement of the two 4-inch thick bentonite-amended soil layers, the drain layer and leachate collection system, a geotextile, the filter layer, and finally the rock slope protection would follow. Installation of the bottom layers would take four to six months and is proposed to be completed in a single construction season. The bottom liner sequence, as well as the reclamation cover liner sequence, is shown graphically in Figure 1-17.

A berm to contain water treatment sludges (sodium sulfate) also would be constructed in an upper corner of each tailings pond, if needed. The liner system for the sodium sulfate disposal area would be part of the overall liner system of the pond.

The tailings ponds, reclaim ponds, landfill and preproduction ore storage pad would be constructed using standard earth-moving equipment. Glacial till found at the site would be used for embankments, soil grading layers, drain and filter layers, and final covers. The over and underdrain layers and filter layers of the tailings ponds and landfill as well as the underdrain/vent layer of the reclaim ponds would consist of washed and screened glacial till. Soil fines from the washing operation would settle in a two to four acre sedimentation pond located in the construction support area while screening would remove gravel and cobbles greater than 0.75 inches in diameter. Excess soil, gravel and stone from the excavating and processing activities would be stockpiled adjacent to the construction support area. This stockpile would cover about 25 acres and would be used during the construction and/or closure of the tailings ponds.

Liner Materials - Bentonite-amended soils would be used in the top and bottom liners in the tailings ponds and landfill cells, and bottom liner of the preproduction ore storage pad. Several thousand tons of bentonite clay from Wyoming would be required for the project. Bentonite clay would reduce the permeability of the sandy tills 10 to 1,000 fold by plugging the pores between the sand grains. The existing permeability of the till is 3.3×10^{-6} feet/second to 3.3×10^{-8} feet/second. The compacted bentonite-amended soil liners would be designed to have a permeability of about 1.6×10^{-9} feet/second.

Techniques and equipment common to highway pavement construction and dam building operations would be used to mix and lay the bentonite-amended soil liners. After screening and washing, the soil would be mixed with bentonite and water in a processing plant. Following mixing, all of the bentonite-amended soil liners would be laid with highway pavers and compacted. In corners inaccessible to the highway paver, the soil liner would be put in place by hand.

In addition to the soil liners, synthetic liners such as Hypalon, HDPE, or PVC are being considered for use:

Hypalon or HDPE - 36 to 40 mil - reclaim ponds A and B
HDPE - 40 mil - MWDF and landfill final cover
PVC - 40 mil - MWDF monitoring lysimeters

Drainage basines #2 and #3, and the water discharge lagoons at the mine/mill site would have geomembranes with minimum thicknesses of 30 mil. The geomembranes, received in large rolls, would be rolled out, overlapped with the adjacent sheet, and thermally or chemically bonded to create a water tight seal. In addition, petroleum resistant elastomeric membrane would be used at petroleum storage sites.

The drain, filter, and/or cover layers would be pushed out over the soil and synthetic liners to eliminate the direct contact of construction equipment on the liners. Quality control at the construction site during liner construction would consist of two parts: pre-operational quality control and operational/post-operation monitoring. Construction testing would consist of physical tests of the glacial till to determine if the materials meet design requirements. Other construction quality controls would consist of liner installation tests, liner and seam permeability tests, and inspections of lysimeters and leachate collection system installation. Operational/post-operation monitoring would consist of sampling the monitoring wells and lysimeters for a period of 30 years to determine if the liners are operating as expected.

Access Road, Railroad Spur, and Haul Road - Construction of the access road would be initiated during project year 1 with work being started simultaneously from both state highway 55 and the mine/mill site. Construction of the railroad spur also would be started during project year 1. Both of these facilities would be completed during project year 2. The proposed cut-and-fill construction balance minimizes the need for borrow or dump areas. Some sand, gravel, and stones from outside sources, however, would be needed. An estimated 23,000 cubic yards of organic soils would be excavated from wetlands in these corridors and stockpiled for use as a soil cover. Approximately 93,000 yd^3 of sand and gravel, 10,000 yd^3 of asphalt pavement and 42,000 tons of stone would be required for access road and railroad spur construction.

Pipelines - Pipelines for wastewater discharge to Swamp Creek and tailings/process water between the mill and MWDF would be constructed in the following manner: (1) the trench would be excavated; (2) the 38-foot lengths of HDPE plastic pipe would be fusion butt welded to form a continuous pipeline; and (3) the pipe would be laid on the supporting gravel/sand bed and leak tested. Instrument cable also would be buried with the pipe for pipeline locating purposes. The pipe would be covered with sand or gravel and the trench backfilled with material removed during excavation. All pipelines, except the natural gas pipeline, would be buried at least five feet deep. Spare plastic pipe and the needed construction and installation equipment would be stored on-site for repair purposes.

Mitigation Facilities - The construction corridors for the water supplementation pipelines and associated powerlines would be about 20 feet and 25 feet wide, respectively. Pipelines would extend to Little Sand Lake, Skunk Lake, Duck Lake, Deep Hole Lake, Hoffman Pond, Hemlock Creek, Swamp Creek, Martin Spring/Creek 11-4, Upper Pickerel Creek and Creek 12-9. The buried pipeline and powerline corridors would be seeded and allowed to revert to native vegetation. Aboveground pipeline and powerline corridors would be kept clear of trees and brush that might interfere with maintenance or operation. Discharge structures would be constructed at the outlet of each of these pipelines.

Electric Service - Trees and brush along the right-of-way easement would be cut and cleared with the slash pushed to one side. The slash usually remains the property of the landowner. Soil holes would be bored and the wooden transmission poles positioned with a crane. The sidearms, insulator strings, and other hardware would be attached before the poles were raised. Ropes threaded through pulleys attached to the insulator strings would be used to pull the one to three mile lengths of electric cable. A winch-type machine would pull the rope, threading the cable through the pulleys. The separate sections of cable then would be spliced, attached to the insulator strings, and the pulleys removed. Any surface disturbances on the right-of-way would be graded and seeded. Electric service should be available at the project site by project year 2.

Natural Gas Service Construction - The right-of-way would be cleared of trees and shrubs and a two foot wide by four foot deep trench dug using a backhoe or trencher. The trench would be deeper under roads and streams. The pipeline would cross three named creeks (Swamp, Rocky Siding, and Drake) and three unnamed streams. Pipe sections would be laid on the trench bottom, welded, and covered with sand or the original soil. Backfill at the Swamp Creek crossing would consist of excavated mineral soil, sand or gravel as needed. Excavated material not suitable for backfilling, e.g., organic soils, would be disposed in an upland location out of the floodplain. Finally, disturbed soil surfaces would be graded to the original contour and seeded. Natural gas service should be available at the mine/mill site late in project year 1.

EROSION CONTROL

Note: Seeding, sodding, mulching or other stabilization of exposed soil would be required as soon as is practicable. In addition, the amount of disturbance would be minimized to the extent possible. Stormwater collection basins would be installed first so that runoff could be contained on-site. Exposed areas not seeded immediately would be physically stabilized using mulch or emulsifiers.

Mine/Mill - Construction activities would be phased to reduce the area disturbed and the length of time bare soil would be exposed. Clearing, grubbing and rough grading operations would start at drainage basins #1 and #2, then expand outward to the rest of the 115 acre area. Rough grading would be used to bring the site to required elevations and direct runoff to drainage basins #1 and #2. Both drainage basins would be sized for a 25-year, 24-hour storm event while culverts, drainage ditches, swales and similar conducting structures would be sized for a 10-year, 24 hour event. Sizing requirements for the various structures conform to engineering standards and DNR code requirements. Permanent erosion control structures, such as sediment traps, berms, slope drains, and toe-slope ditches, would be left in place while filter fences would be removed once vegetation was established and erosion was no longer a threat. Topsoil would be stockpiled for revegetation and landscaping purposes. Mulched wood chips left from the clearing operations would be used for landscaping or stockpiled.

The DNR approved landscape plan (an element of the mining permit) would be implemented in phases as the mine/mill site and MWDF was brought to final grade. Quick germinating, rapid growing plant species selected for their ability to control erosion would be established on all exposed areas immediately following grading and topsoiling. Permanent plantings including groundcovers, shrubs and trees would be planted later with species such as those found in the existing floral communities. Seed and plant stock for landscaping would be contracted for and obtained from local suppliers and whenever possible from approved on-site sources. Natural invasion would be allowed to augment permanent plantings wherever practical.

Landscape maintenance at the mine/mill site would include standard horticultural and silvicultural management techniques such as soil and tissue analysis, corrective fertilizer application, remedial seeding, tree planting, weed and disease control, pruning, mowing, and brush removal to ensure lawn and plant vigor and a pleasing site appearance. Vigorous vegetation, minimum soil exposure and mulch would help control erosion. Continuous tree, shrub and ground cover propagation would help achieve long-term stability and return the site to natural conditions.

Tailings Ponds, Reclaim Ponds, and Landfill - Runoff from these facilities would be routed through a series of ditches and retention basins before release (Figure 1-16). All surface water drainage ditches, culverts and other drainage control structures at the MWDF would be designed for a 100-year, 24-hour rainfall event. Any excess glacial till or topsoil generated during construction of these facilities would be stockpiled and revegetated. Wetland soils removed during pond excavation would be used as a topdress for the tailings ponds embankments. Erosion control measures such as straw bales, check dams, and filter fences would be used as needed.

Access Road and Railroad Spur - A system of culverts, berms, riprap, filter fences, straw bales, and retention basins would control runoff along these corridors. Exposed soil would be fertilized, seeded, and mulched. The stream banks at bridge crossings would be protected by riprap and sheet piling to limit soil movement into Swamp Creek. Wetland soils removed during construction and sediment trapped by control structures would be used as a topdress during revegetation efforts. Unused topsoil would be transferred to the soil stockpile adjacent to the mine/mill.

Wastewater Discharge Pipeline - Trench excavation, pipe laying, and backfilling would be completed in segments to minimize the amount of open trench. In erosion-prone areas, filter fences would be used to contain sediment and revegetation would immediately follow trench backfilling. Construction in wetlands would either take place in the winter or lightweight equipment and swamp mats would be used during the growing season. The concrete discharge structure at Swamp Creek would be installed after the site was graded and riprap installed.

Haul Road and Tailings Transport/Water Return Pipelines - The dividing berm on the haul road would control runoff water as well as vehicular traffic. The haul road also would have a surface water discharge ditch on the north side of the road. Temporary erosion control features such as straw bales and filter fences would be used during construction as needed. The pipeline route would be revegetated but kept clear of woody growth to permit vehicular passage for routine inspections.

Dust Control - Airborne dust, the major air pollutant associated with the project, would be generated during construction of the mine/mill and ancillary facilities. Site clearing and grading, blasting, ore and waste rock handling, and traffic on unpaved roads would be sources of dust. A watering truck would spray water or chemical stabilizers such as calcium chloride, to suppress dust from unpaved roads and construction areas. Trucks carrying waste rock, preproduction ore or soil materials would be covered or water sprayed as necessary. The access road and frequently traveled mill roads would be paved during the construction phase to minimize dust generation. Cleared areas without buildings would be revegetated after final grading to reduce erosion and minimize dust emissions. The concrete batch plant at the mine/mill site during the construction phase would have hoods with fabric filters to collect dust.

Dust emissions during construction of the tailings ponds would be caused by till handling, vehicle travel on unpaved areas, and operation of the liner batch and soil processing plants. Exposed soil would be water sprayed, treated with chemical stabilizers, or revegetated as necessary to suppress windblown dust. The liner batch plant and soil processing plant would have dust controls similar to the concrete batch plant.

CLOSURE AND RECLAMATION

Mine/Mill - Mining activities are expected to end in project year 32. Reclamation and revegetation activities at the mine/mill would be aimed at erosion prevention, creating a pleasing visual effect, and establishing a self-sustaining, long term plant cover. The proposed final use for the mine/mill and tailings ponds is recreation and forestry. Only limited potential exists for agricultural uses.

Final reclamation of the mine/mill and ancillary facilities would occur in the following order: demolition of major surface structures and disposal of the demolition waste; site regrading and erosion control; removal and revegetation of the water treatment plant and reclaim pond sites; and long-term monitoring and site maintenance.

Underground Facilities - Upon completion of mining, salvageable materials would be removed from the underground workings. Materials prone to decay or containing chemical agents deleterious to groundwater quality are proposed to be removed from the mine. All boreholes for fuel delivery, backfill delivery, and groundwater interception would be plugged. The main shaft and both ventilation shafts would be permanently capped and sealed. Reinforced concrete plugs would be installed at the bottom of each shaft collar to reduce the mixing of mine water with the overlying glacial aquifer. The plugs would be secured to bedrock with steel reinforcing rods. Above the plugs, the shafts would be filled to the surface with glacial material, covered with topsoil, and revegetated. Once pumping ceases, the mine would fill with groundwater in about two to three years.

Surface Facilities - The closure phase would involve conversion of facilities to alternative uses if possible, otherwise the facilities would be removed and the site reclaimed. Salvageable buildings and equipment would be removed from the site. Concrete and bituminous pads and all foundations would be broken up and covered or used as fill during regrading. All wells, except those needed for monitoring purposes, would be plugged and abandoned. Water storage and fire protection systems would be maintained until late in the closure period.

Following building demolition and waste removal, about 80 acres at the mine/mill site would be regraded. The final reclamation grades would approximate the original drainage patterns to the extent possible. Any soil borrow material required to complete the final grading would be obtained from the borrow area near the tailings ponds. Demolition rubble would be covered with a minimum of 18 inches of soil.

Mine/mill roads, the access road, and railroad spur would be among the last items to be reclaimed to facilitate the removal of salvageable materials. The ultimate disposition of the access road and rail spur would depend on the final uses of the mine/mill complex after mining is completed. If the access road is reclaimed, the pavement, crushed stone base and the bridge over Swamp Creek would be removed. Reclamation of the railroad spur would consist of rail, tie, ballast and bridge removal. Culverts in each corridor may be removed to prevent future drainage problems. These corridors and roadways at the site would be rough graded to restore the area for recreational, forestry or agricultural use. Wetlands filled along the corridors would not be re-established.

MWDF - Since only one tailings pond would be receiving tailing, closure and reclamation would be an ongoing activity at the MWDF. The multi-layered final cover would be constructed after the tailings had suitably consolidated in a filled pond. First, a grading layer of glacial till would be pushed out over the surface of the tailings. This layer would be compacted primarily to provide a suitable base for the liners and secondarily to limit air and water entry into the tailings. The grading layer would be thickest near the center of each pond and would thin toward the banks, thus giving the final cover a slope of 2%. The grading layer would be allowed to settle for a year or two before two 4-inch thick bentonite-amended soil layers would be laid. In turn, a 40 mil thick geomembrane liner would be laid over the soil liner. The geomembrane would be covered with a drain layer (coarse gravel to medium sand) to aid the movement of percolating water to the seepage zones in the crest of the banks and between the ponds. The seepage zones were designed to increase groundwater recharge around the margins of the tailings ponds. Finally, a geotextile and a cover layer consisting of 5 feet of glacial till and topsoil would be placed over the drain layer to protect the liners and provide a medium for plant growth. Specific areas on the MWDF final cover (Figure 1-18) may require special erosion control management. Exxon has proposed to place rock riprap in these areas to minimize erosion.

At project termination, the decant/underdrain water from pond T4 would be pumped to the water treatment facility for treatment and release. Next, the reclaim pond sediment, rock slope protection, and liners would be excavated and dumped in pond T4. The remaining soil stockpiles and soil from the borrow area, if needed, would be used for the grading layer, bentonite-amended soil liners, and final cover. Any surface runoff from the soil grading layer would be channeled to a surface water sedimentation basin before release. Final reclamation at the tailings ponds would take two or three years. The final contours for the tailings ponds, landfill, and reclaim ponds are shown in Figure 1-18.

Reclaim Ponds - The dikes would be leveled and the geomembranes, rock slope protection, and sediment would be disposed in tailings pond T4. The site would be reclaimed to approximate the slopes existing prior to construction. After regrading, the site would drain toward Duck Lake.

Landfill - The last cell of this facility would be sealed at the end of the closure phase. Long-term groundwater monitoring of the landfill is an element of the overall MWDF monitoring program.

Water Treatment Facilities, Discharge Pipeline, and Haul Road/Slurry Pipelines
The treatment facilities and all aboveground pipeline segments would be removed after T4 was drained. Salvageable equipment would be removed while scrap and treatment plant sludges would be disposed in pond T4. The treatment plant site and the haul road/slurry pipeline corridor would be graded and revegetated for future recreational use. All buried segments of these pipelines would be left in place but the ends would be plugged to eliminate access. The concrete outlet structure at Swamp Creek would be removed and the site revegetated.

Electric Line - Sections of the line providing electric service to other consumers would be maintained. WPS has tentative plans to build a distribution substation along the transmission route to provide electrical support for the Crandon area. The section of transmission line between the Venus substation and the proposed Crandon area substation, if built, would probably remain in service indefinitely. The portion of the electric transmission line from the Crandon area substation to the mine/mill site would be taken down and salvaged. Reclamation would involve the removal of conductors, shield wires, and the wooden poles. Depending on condition and economic value, these materials would be reused or scrapped. The periodic tree and shrub clearing of the right-of-way would stop following line removal. The long-term condition and use of the right-of-way would depend on the actions of the landowners.

Natural Gas Service - Portions of the natural gas pipeline serving other customers after closure of the mine would continue to operate. The abandoned portion of the pipeline would be blocked off with the piping left in place.

Revegetation - The revegetation program is designed to establish a self-sustaining and maintenance-free plant cover. Once the mine/mill and ancillary facilities are dismantled and regraded, the stockpiled topsoil and silty subsoils would be spread and the site revegetated with a mixture of grasses and legumes. Landscape vegetation planted during the construction and operation phases together with the undisturbed forests surrounding the mine site would be sources of native shrubs and trees for the colonization of the newly revegetated areas. Supplemental plantings of native trees, shrubs, and ground cover to speed the rate of natural succession is anticipated.

Temporary erosion control techniques would be employed during reclamation of the mine/mill site. The techniques include use of fast-growing plants, mulching, and temporary features such as sediment traps, berms, slope drains, toe-slope ditches, and diversion channels. In addition, surface drainage basins #1 and #2 would be used as sedimentation basins during reclamation. After a vegetative cover at the site is established, all temporary structures would be removed and drainage basins #1 and #2 would be regraded and revegetated. Long-term maintenance would focus on establishing self-sustaining native plants and minimizing soil erosion.

Similarly, the tailings ponds, reclaim pond and landfill would be revegetated soon after reclamation. Supplemental plantings of native trees, shrubs, and ground cover to speed the rate of natural succession is anticipated.

Dust Control - Dust would be generated during the closure and reclamation of the mine and surface facilities due to the handling of cover soil and vehicle traffic on unpaved areas. The intensity of activity during reclamation would be considerably less than during project construction. Consequently, less dust is anticipated. Water spraying or chemical stabilizers, however, would be used as necessary to minimize airborne dust.

PROJECT WASTES

The construction, operation, and closure of the proposed mine/mill would produce a number of wastes. The wastes include waste rock, tailings, wastewater, refuse, wastewater and sanitary sludges, and air emissions. The physical, biological, and chemical characteristics of these wastes are discussed in the following sections.

WASTE ROCK

Chemical and Mineralogical Properties - Controlled laboratory studies were conducted to assess the chemical and mineralogical properties, acid generation potential, leaching, and hazardous waste characteristics of waste rock from the hanging wall and footwall. These tests indicate sulfide minerals in the waste rock can be weathered to produce sulfuric acid and soluble metals. In fact, waste rock may have a greater potential for generating acidic leachate than the tailings due to its high air and water permeability, and sulfide content. Though waste rock would not be considered a hazardous waste it must be confined to minimize environmental impacts. A summary of the results plus a radioactivity analysis follow.

Mineralogy - The sulfide mineral content of the rock fragments ranged between 2% and 25% pyrite. The sulfide mineral content is important because of the potential for acid production. Only minor quantities of acid-neutralizing minerals were present in the samples.

Hazardous Waste Testing - The results of the Extraction Procedure (EP) toxicity test indicate leachable metal concentrations were below state and federal standards threshold limits established for hazardous wastes.

Acid Generation Potential - Two types of acid production tests were performed: chemical titration and microbiological testing. The chemical titration tests, conducted on finely ground waste rock, showed four out of five samples to be net acid producers. The microbiological confirmation test involved inoculation of samples with an active culture of Thiobacillus ferrooxidans. This bacterium acts in the presence of oxygen and water to accelerate the decomposition of pyrite. This decomposition results in very acidic conditions which can release heavy metals from the sulfide minerals. The microbiological test confirmed the acid producing potential of four of the five samples. The final pH values of the lab samples supporting microbiological growth were very low (pH = 2 or less) indicating very acidic conditions.

Leaching and Environmental Contamination - Column leaching tests were conducted to determine the natural rainwater leaching characteristics of waste rock inoculated with Thiobacillus ferroxidans. All columns, except one nonacid producing sample, had active cultures and several samples leached metals and sulfates.

Radiological Properties - For all radiological parameters, the levels of radioactivity in waste rock were lower than values of the soils and granitic outcrops in the area. In addition, the scintillometer survey by the Wisconsin Geological and Natural History Survey on large diameter drill cores from the site as well as tests by Hazen Research on crushed ore confirmed the low radioactivity levels.

TAILINGS

The tailings would consist primarily of waste minerals (e.g., pyrite, quartz, and chlorite), and minor amounts of residual ore plus traces of reagents and process water. About 28.3 million tons of fine tailings would be pumped to the tailings ponds over the life of the project. The samples used to estimate tailings characteristics were taken from massive and stringer ore tailings generated during pilot plant investigations of the proposed milling process.



Figure 1-16. MWDF Construction and Reclamation Sequence

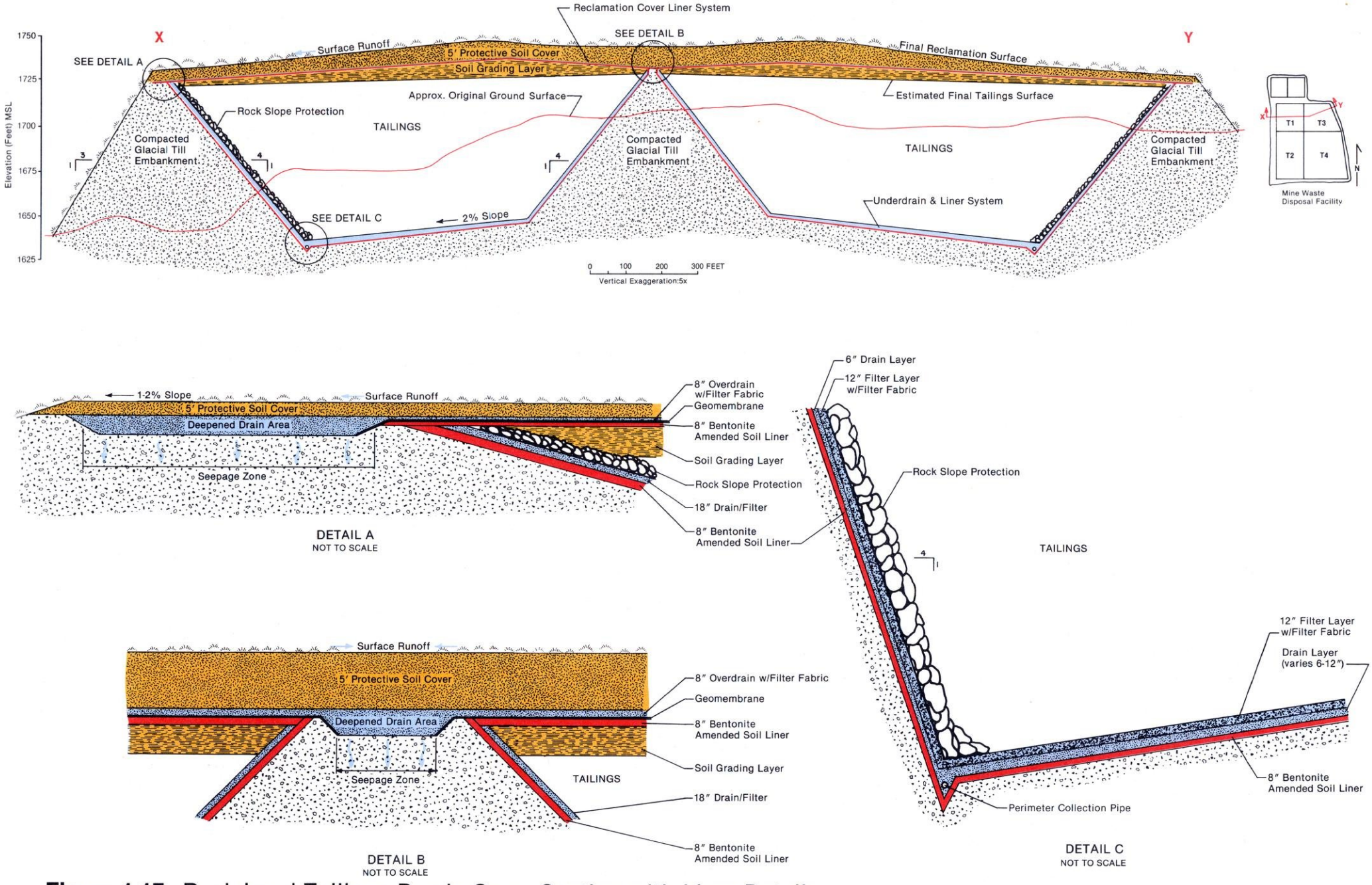


Figure 1-17. Reclaimed Tailings Ponds Cross-Section with Liner Details

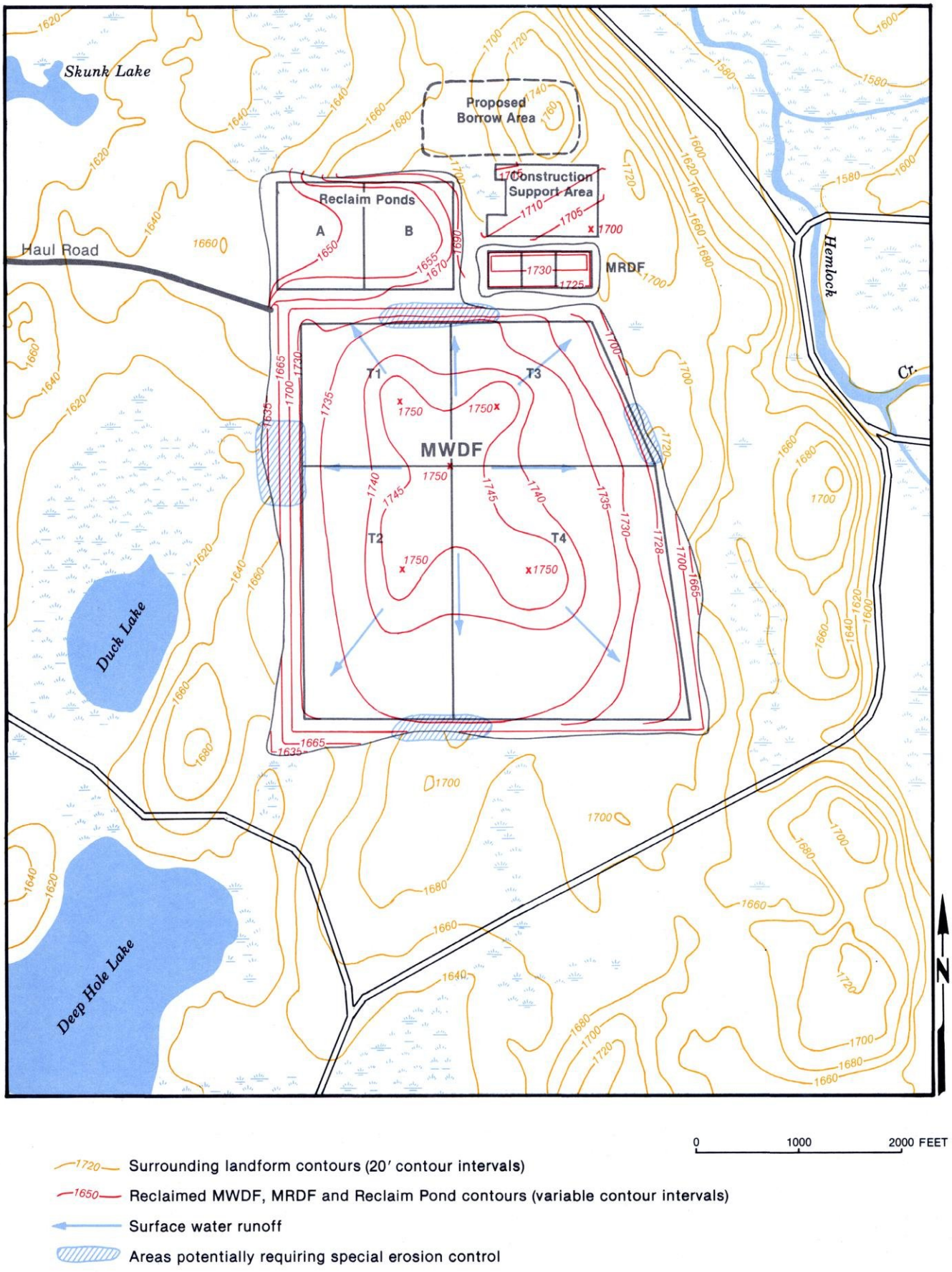


Figure 1-18. MWDF Final Reclamation Contours

Physical Properties - A number of tests were run to determine the physical characteristics of the tailings. Grain size analyses indicate the largest tailings particles would be the size of fine sand with the majority of the particles in the silt-size range. In engineering terms, the tailings would be classified as a uniformly graded silt. The tailings had a density greater than naturally occurring mineral soils due to the presence of sulfide minerals, such as pyrite, sphalerite, and chalcopyrite. Particle size analysis, particle density studies, and other laboratory tests indicate average permeabilities (0.014 feet/day) would be relatively high for a silt-sized material. The higher than expected permeability was caused by increased pore size and greater number of pores resulting from the angular shape of the tailings. Consolidation tests resulted in only a small reduction of tailings permeability.

The ore to be removed from the mine, particularly the stringer ore, is generally unweathered and clay minerals are scarce. Due to the lack of clay and anticipated particle density and shape, the tailings should rapidly settle and consolidate in the tailings ponds. Lab tests indicate additional consolidation during tailings accumulation, dewatering, and placement of the grading layer and final cover should be minimal.

Chemical and Mineralogical Properties - The chemical and mineralogical testing of the pilot plant tailings included elemental analysis, mineralogical examinations, EP toxicity tests (extraction procedure), potential acid generation tests, and agitation and column leaching tests. Results reported in this section were taken from analyses of tailings typical of those to be produced by the mill.

Elemental Analysis - The tailings samples were composed primarily of iron sulfide (FeS_2), silica (SiO_2), and silicates of aluminum, magnesium and potassium. Pyrite was the most abundant sulfide mineral in the samples and generally comprised over 45% by volume of the tailings fines. Sulfur content ranged from 22% to 41%. Minor amounts of copper, lead, zinc, arsenic-iron sulfides, and calcium/magnesium carbonate also were present. The following substances also were found: chloride (less than 120 ppm), chromium (18 to 27 ppm), cyanide (4 to 5 ppm), fluoride (450 to 730 ppm), gold (0.5 to 0.9 ppm), manganese (440 to 490 ppm), mercury (2.2 to 3.4 ppm), nickel (11 to 46 ppm), phosphorus (90 to 120 ppm), selenium (less than 40 to 110 ppm), silver (43 to 58 ppm), and titanium (360 to 660 ppm).

Potential Acid Generation - All tailings subjected to the acid generation tests (chemical and microbiological confirmation tests) were acid producers.

Leachate Properties - A series of tests were conducted to determine tailings leachate characteristics under varying conditions. The EP toxicity tests indicate more metals were leached from tailings compared with the waste rock but metal concentrations were still below the threshold levels established for hazardous wastes. Additional leaching tests also were conducted under acid and alkaline conditions. These tests indicate the tailings had a buffering effect on both acid and alkaline leaching solutions. The elemental composition of the leachate was generally similar but the columns alternately submerged and exposed to the air leached the most due to increased decomposition of sulfide minerals.

The amount and quality of the leachate was dependent on the amount of water and oxygen coming in contact with the tailings and the presence of the Thiobacillus ferrooxidans bacterium which is pervasive in the environment. Sulfide mineral decomposition is greatly accelerated by biological activity if the pore water becomes very acidic (pH less than 2.5). During the operation of each tailings pond the natural acid buffering capacity of the tailings, lime additions from the milling process, and lime added specifically for pH control would limit the potential for highly acidic conditions developing. The initial leachate quality is expected to include sulfate, calcium, magnesium, and manganese as the major constituents. The concentration of all the constituents is expected to decrease with time but sulfate, calcium, and magnesium should remain the major constituents.

Radiological Properties - A comparison of the radioactivity of tailings versus soil samples collected near the tailings ponds, the mine/mill, and one of the alternative tailings ponds locations was conducted. The tests indicate tailings radioactivity was lower than the radioactivity of the naturally occurring soil samples. Results obtained for the tailings and soils were within the ranges reported in the literature for glacial soils in northern Michigan and Wisconsin.

Asbestiform Mineralization - Asbestiform minerals are a group of fibrous minerals of which asbestos is one member. No evidence of asbestiform minerals were found in the thin-section bedrock samples from drill cores of the ore. This analysis was verified by geologists of the Wisconsin Geological and Natural History Survey.

REFUSE

Construction - About 405 acres of land would be cleared and grubbed during the first four years of the project, producing over 4,800 cords of marketable timber, nearly 22,200 cubic yards (yd^3) of chipped brush, and 10,250 $yd.^3$ of stumps (Table 1-10). Wood wastes would be chipped on-site and stored adjacent to the mine/mill facility for use as landscaping materials. Stumps not chippable would be burned in an air curtain destructor.

Table 1-10
Clearing and Grubbing Wastes

Facility	Construction Period Project Year(s)	Actual Acreage Cleared	Marketable Timber	Brush, Limbs Unmarketable Timber (Chipped)	Stumps (Chipped)
Access Road	1	29	270 Cords 6,000 Board Ft.	320 tons 1,175 yd^3	150 tons 540 yd^3
Railroad Spur and Siding	1	32	410 Cords 24,755 Board Ft.	500 tons 1,840 yd^3	230 tons 850 yd^3
Tailings Pipeline/ Haul Road	1	10	110 Cords 4,060 Board Ft.	130 tons 480 yd^3	60 tons 220 yd^3
Mine/Mill Site	1	115	1,570 Cords 105,940 Board Ft.	1,910 tons 7,070 yd^3	880 tons 3,260 yd^3
Excess Water Discharge Pipeline	1	35	160 Cords 8,250 Board Ft.	170 tons 610 yd^3	80 tons 280 yd^3
MWDF					
Tailings Pond T1, Reclaim Ponds, Construction, Support Area, landfill cell #1, and till stockpile	1-4	165	2,300 Cords 150,600 Board Ft.	2,800 tons 11,000 yd^3	1,300 tons 5,100 yd^3
T2 and landfill Cell #2	6-11	100	1,400 Cords 90,500 Board Ft.	1,700 tons 6,300 yd^3	800 tons 2,900 yd^3
T3 and relocation of till stockpile	12-16	65	900 Cords 58,800 Board Ft.	1,100 tons 4,100 yd^3	500 tons 1,900 yd^3
T4 and landfill Cell #3	19-23	125	17,500 Cords 113,000 Board Ft.	2,100 tons 900 yd^3	970 tons 3,600 yd^3
Borrow Area	33-36	40	560 Cords 36,200 Board Ft.	680 tons 2,500 yd^3	320 tons 1,200 yd^3

Inert solid wastes such as concrete and ballast (rock) would be stored on-site until used as fill. Most nonrecyclable construction wastes would either be burned or taken to the on-site landfill. Refuse generated during the first six months, before the on-site landfill was constructed, would be transported by private haulers and disposed at the City of Antigo or other regional landfill which would accept the waste.

Waste petroleum (oil, lubricants, hydraulic fluids, and fuels) would be generated at an average rate of 5,000 gallons per year while waste paint would amount to about 100 gallons per year. Nonhazardous wastes would be recycled or disposed at an approved site. Those wastes classified as hazardous would be handled, stored, transported, and disposed by firms licensed under NR 181.

Operations - The wastes generated during project operation can be divided into three general types: solid wastes (refuse), petroleum products, and hazardous wastes.

The refuse produced during operation would be generated at a rate of 2.5 tons per year per employee or 1,625 tons/year (3,000 yd^3 per year) for the entire project workforce. Refuse would consist of 75% paper and garbage, 10% metal, and five percent each of plastic, wood, and other refuse. Tires and scrap metal would be reused or sold to a salvage dealer as feasible. All nonrecyclable wastes would be taken to the on-site landfill. Approximately 88,500 yd^3 of refuse would ultimately be disposed in the three cells of the landfill.

Waste oils, hydraulic fluids, and lubricants would be generated at a rate of about 26,000 gallons per year. These wastes would be recycled on-site for secondary use or sent off-site for recycling or disposal. Petroleum product wastes classified as hazardous under NR 181 (i.e., solvents, degreasers, etc.) would be generated at a rate of about 730 gallons per year. These wastes would be handled in accordance with NR 181 and shipped off-site for recycling or disposal.

Liquid laboratory wastes would be disposed of via drains entering the mill water treatment system. Other potential hazardous wastes would be disposed of off-site in conformance with NR 181.

Closure - Inert solid wastes would be disposed of on-site or recycled if possible. Materials removed from the project site for reuse, scrap or disposal include aboveground and underground mechanical, processing, and electrical equipment, rail tracks and ties, fencing, guardrails, and bridge girders. Materials that would remain on-site or within their corridors include concrete, road base, asphalt, ballast, sub-ballast, and the wastewater discharge pipeline and the pipelines along the haul road corridor.

WATER TREATMENT SLUDGES

Sludges would be generated from several points in the water treatment systems:

1. The contaminated mine water lime softener;

2. Intercepted groundwater lime softeners;

3. Process water treatment lime-soda ash softener, brine softener operations and brine crystallizer centrifuge; and

4. Various line flushes and cleaning solutions from the reverse osmosis membranes.

The sludges would consist of rock particles and precipitates of calcium carbonate, calcium sulfate, metal hydroxides, and metal sulfides. About 14 tons of sludge would be generated daily from the lime-sulfide softeners and lime-soda ash softeners. These sludges would be pumped to the fine tailings thickener for disposal in the tailings ponds. Crystallized brine (sodium sulfate, often called salt cake) from the lime-soda ash/reverse osmosis treatment system may be of commercial quality. From zero to 11 tons of salt cake would be produced daily depending on the amount of water being treated in the reverse osmosis unit. Markets could be developed in Wisconsin, nearby states and provinces if the salt cake is of sufficient quality. If the salt cake cannot be marketed, it would be disposed of in a special cell constructed in each tailings pond.

Sediment also would accumulate in the reclaim ponds. Pond B would have sediments of fine tailings and calcium carbonate precipitates while pond A would have a calcium sulfate and metal hydroxide sediments. An estimated 140,000 cubic yards of sediment would accumulate over the life of the project. These sediments would be disposed periodically throughout operations and in tailings pond T4 at the time of closure.

SANITARY WASTES

During the first six months sanitary wastes (e.g., chemical toilet wastes) could be produced at a rate of 3,500 gallons per day. Disposal by a licensed sanitary hauler would be at an approved wastewater treatment plant, probably Crandon, or by landspreading at a location approved by the DNR. All sanitary wastes would be treated on-site during the operations phase. Sludge from the package treatment plant would be landspread.

AIR EMISSIONS

Construction and reclamation phase emissions would primarily be fugitive dust generated by blasting and excavation activities, and vehicle traffic on unpaved areas. Operation of the temporary diesel electrical generators during the first six months of the construction phase, natural gas air heating equipment, diesel vehicles, and burning of cleared brush and stumps would release gaseous pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons.

During the operation of the mine/mill and MWDF, dust emissions would be caused by production blasting, ore and soil handling and processing, and vehicle traffic on facility roads. During the operations phase excavation activities associated with tailings ponds T2, T3, and T4 construction and soil processing would contribute fugitive dust. Once in operation, however, the tailings ponds would have minimal dust emissions. The tailings ponds would receive a constant flow of tailings slurry thereby maintaining a wet pond surface. Any areas that did dry would be water sprayed to reduce dust emissions.

Estimated atmospheric discharges from the construction, operation, and reclamation of the proposed mine/mill and MWDF are summarized in Table 1-11. The dust emissions from all three phases reflect the use of dust suppressants.

Table 1-11
Estimated Maximum Discharges to the Air[1]
(short tons per year)

Construction	
Total Suspended Particulates (dust)	239.2[2]
Sulfur Dioxide	13.2
Nitrogen Oxides	27.1
Carbon Monoxide	65.9
Hydrocarbon	5.7
Hydrogen Sulfide	1.0
Lead	negligible
Operation	
Total Suspended Particulates (dust)	244.5[2]
Sulfur Dioxide	37.1
Nitrogen Oxides	62.9
Carbon monoxide	103.7
Hydrocarbons	33.1
Lead	0.1[1]
Reclamation	
Total Suspended Particulates (dust)	119.9[2]
Sulfur Dioxide	0.3
Nitrogen Oxides	2.0
Carbon monoxide	3.3
Hydrocarbons	0.5
Lead	negligible

[1] Lead discharges to air were assumed to comprise 0.5%, the average lead content of the ore, of the total suspended particulate emissions from ore mining and processing operations.

[2] Dust emissions would occur primarily during the grading of the mine/mill site, and construction and closure of the tailings ponds.

ENVIRONMENTAL MONITORING

The monitoring plan is designed to detect and evaluate environmental changes caused by the project. If monitoring indicates adverse impacts are occurring, the DNR would determine what, if any, change in project operations would be necessary to correct the situation.

Monitoring would begin approximately one year before the start of construction, continue through mine/mill operations, and be sustained over the 30 year long-term care period, especially for groundwater. Baseline data and operations monitoring data would be reviewed annually or when the operator requests any modification of the applicable permits or plans. The DNR may require the operator to perform additional monitoring during the course of the permitted activity and for a period of time following closure as is necessary to satisfactorily complete reclamation. The DNR also may independently monitor the environment for project related changes.

Details of sample collection and analytical procedures will be specified as part of the quality assurance/quality control document submitted to the Department for review and approval prior to implementation of the monitoring plan. Therefore, details and methods are not described below.

DRINKING WATER

A water well inventory has been conducted by Exxon in the four zones shown in Figure 1-19. The private water well inventory has been divided into four zones based upon the anticipated extent of groundwater drawdown. The amount of information needed from the well samples decreases with distance from the mine. All wells within Zone 1 would be sampled quarterly for the parameters listed in Table 1-12. Within Zones 2 an 3, representative wells would be sampled for the parameters listed in Table 1-12. Zone 4 represents the Mole Lake Indian Reservation. DNR has encouraged Exxon to obtain whatever information is available regarding the water supplies on the Reservation. The DNR would split a representative number of well water quality samples with Exxon for verification purposes.

Exxon must submit a private well water quality sampling program, including well locations, for DNR approval before construction commences. Well water quality information would be collected prior to construction to establish background conditions.

Table 1-12
Sampling Parameters for Private Water Wells

Field temperature (°C)	Aluminum
Total laboratory alkalinity	Barium
Total field alkalinity	Cadmium
Specific conductance (umhos/cm)	Calcium
Field conductivity (umhos/cm)	Chromium, total
Laboratory pH (standard units)	Cobalt
Field pH (standard units)	Copper
Total hardness	Iron
Total dissolved solids	Lead
Arsenic	Magnesium
Chloride	Manganese
Coliform Bacteria	Molybdenum
Fluoride	Nickel
Nitrate nitrogen (N)	Selenium
Phosphate (PO_4)	Silver
Sulfate	Zinc

SURFACE WATER AND AQUATIC ECOLOGY

The surface water monitoring program would provide data on water bodies and aquatic ecosystems potentially impacted by the mining activities (e.g., the discharge to Swamp Creek, runoff from the MWDF, and groundwater drawdown). The monitoring sites are indicated on Figure 1-20.

Wastewater Discharge - Water to be discharged to Swamp Creek would be monitored at three points in the system (Table 1-13). First, treated mine inflow water and intercepted groundwater would be monitored before entering the wastewater discharge lagoons. Second, all of the parameters listed in Table 1-13 would be checked at the discharge lagoon outlet to determine if chemical changes occur during storage. If the effluent limits are exceeded at the outlet, the water would be recycled to the water treatment plant. Finally, the Swamp Creek discharge point would be monitored for changes in water quality that might occur in transit from the discharge lagoon.

Table 1-13
Wastewater Discharge Monitoring

Parameter	Sampling Frequency	Sample Type
Flow - (million gals/day) (1)(2)	Daily	Continuous
pH (1)(2)	Daily	Continuous
Specific Conductance (1)(2)	Daily	Continuous
Dissolved Oxygen (1)(2)	Daily	Continuous
BOD_5 (1)(2)	Weekly	24-hr composite
Total Hardness (2)	Daily	24-hr composite
Total Suspended Solids (1)(2)	Daily	24-hr composite
Total Dissolved Solids (1)(2)	Daily	24-hr composite
Total Organic Carbon (2)	3 times per week	24-hr. composite
Arsenic, total (2)	Daily	24-hr composite
Barium, total (2)	Daily	24-hr composite
Cadmium, total (2)	Daily	24-hr composite
Fluoride, total (2)	Daily	24-hr composite
Lead, total (2)	Daily	24-hr composite
Mercury, total (2)	Daily	24-hr composite
Nickel, total (2)	Daily	24-hr composite
Selenium, total (2)	Daily	24-hr composite
Silver, total (2)	Daily	24-hr composite
Copper, total (2)	Daily	24-hr composite
Iron, total (2)	Daily	24-hr composite
Zinc, total (2)	Daily	24-hr composite
Trivalent Chromium (2)	Daily	24-hr composite
Hexavalent Chromium (2)	Daily	24-hr composite
Cyanide (2)(3)	Daily	24-hr composite
Chloride (2)	Monthly	24-hr composite
Sulfate (2)	Monthly	24-hr composite
Manganese, total (2)(4)	Monthly	24-hr composite
Aluminum, total (2)(4)	Monthly	24-hr composite

(1) Parameters to be monitored at the Swamp Creek outfall.
(2) Parameters to be monitored at the discharge lagoon outlet. The frequency of monitoring these parameters at the discharge lagoon inlets will be specified by an operations plan for the treatment facility.
(3) Test methods will include total cyanide and cyanide amenable to chlorination.
(4) Monthly testing may be reduced after one year dependent on results obtained and information available on the toxicity of these metals.

Sanitary Treatment Plant - Monitoring of this facility would conform to the requirements in the WPDES permit. Additional information concerning monitoring alternatives are discussed in Chapter Four.

Swamp Creek - Water samples would be collected on a quarterly basis near County Highway "M" above the discharge site, monthly in the mix zone of the discharge and Swamp Creek, and monthly at a site downstream of the discharge (Figure 1-20). Sampling at the three sites would be initiated at least six months prior to construction and would continue until the discharge was terminated. Water quality parameters analyzed at these sites are listed in Table 1-14.

Replicate bulk sediment samples for chemical analysis would be collected annually at stations U (above the outfall), A (in the mix zone), and DS (downstream of the discharge site) (Figure 1-20). Sediments would be chemically analyzed for the parameters listed in Table 1-14. These analyses would indicate if pollutants are being retained in the sediments below the outfall.

Fish would be collected at station DS during late summer for tissue analyses. The collections would be annually for the first three years of operations and once every five years thereafter. A minimum of three composite samples would be collected (two forage species and one predator specie). Each species composite would consist of three fish of the same age class. Analysis would be conducted on the whole fish for the parameters listed in Table 1-14. These collections also would be annually for the first three years of operations and once every five years thereafter.

Bioassay studies would be performed as part of the WPDES monitoring requirements. The bioassays would be initiated in the construction phase before any discharge occurs. An acute bioassay study would be conducted annually. Every five years, prior to WPDES reissuance, a chronic bioassay study also would be conducted. Specific procedures for conducting the bioassay studies would be developed by the DNR and Exxon prior to implementation and would follow guidelines established by EPA.

Benthos would be collected with artificial substrate samplers at stations U, A, and DS (Figure 1-20). Information collected would include total numbers of benthos, density per unit area, biomass, and species identification and enumeration. Invertebrate tissue would be stored for chemical analyses at a later date (Table 1-14). If significant differences between stations above and below the discharge site were detected, two more downstream sites would be established. Replicate collections would be made prior to snowmelt, and during summer low flow. Benthos sampling would begin at least one full sampling year prior to any wastewater discharge. Sampling would continue for the first three years of discharge after which the frequency of collection would be once every five years. Specimens collected for tissue analysis would be gathered from the natural stream substrate.

Biological monitoring of the fishery would include: species composition, relative abundance, length, weight, catch per unit effort (selected species only), and condition factor (selected species only). Fish sampling would be conducted at the same survey sites in Swamp Creek below and above Rice Lake and in Hoffman Creek as was done for the baseline studies (Figure 1-20). Fish collections would be made in the spring and late summer for the first three years of discharge and once every five years thereafter.

Other Water Bodies - The physical and chemical parameters, as well as the water bodies, to be monitored are presented in Table 1-14. The surface waters to be monitored include Hemlock Creek, Hoffman Creek, three sites on Swamp Creek above Rice Lake, Pickerel Creek above Rolling Stone Lake, Outlet (Metonga) Creek, Creek 11-4, Creek 12-9, Duck Lake, Deep Hole Lake, Little Sand Lake, Rice Lake, Rolling Stone Lake, Skunk Lake, Hoffman Springs and Martin Springs. Sampling frequency and parameters are listed in Table 1-14 while sampling sites are shown in Figure 1-20.

Water chemistry data would be collected for a period of one year prior to construction in Hoffman Creek, Pickerel Creek, and Creeks 11-4 and 12-9 to establish baseline water quality conditions. These streams would be sampled at the location specified in the monitoring plan. Monthly samples for the following parameters would be taken: arsenic, barium, cadmium, chromium, copper, iron, lead, mercury, selenium, silver, zinc, hardness, total dissolved solids, alkalinity, nitrates, total phosphorous, and sulfates. The following parameters would be sampled on an annual basis: nickel, chlorides, fluorides, and cyanide. Field measurements would be taken monthly for dissolved oxygen, pH, temperature, and specific conductance. This data would be used to document changes in water quality due to the addition of mitigation or mining activities.

The DNR would provide independent verification of the monitoring data collected by Exxon. Approximately 15% of the water and sediment chemistry samples collected would be split with and independently analyzed by the DNR. The fishery and benthic sampling would be verified by independent field studies conducted by the DNR. A monitoring site on the Wolf River at County "T", about 6.1 miles downstream of the mouth of Swamp Creek, was established in July, 1982 by the DNR. This station would be maintained for the duration of the project. Water chemistry parameters sampled at the Wolf River site are listed in the Table 2-7 of Chapter Two. Fish tissue analyses for heavy metals would continue at the Wolf River site.

Drainage Basins and Sedimentation Ponds - Runoff from the stormwater control basins around the mine/mill complex and the MWDF would be monitored (Table 1-14). Runoff would be collected during or just after storm events when discharge was occurring. Drainage basins #1 (X) and #2 (Y) would collect runoff from the mine/mill complex. After project month 30, #2 would discharge to the reclaim ponds via the tailings thickener overflow pipeline. Four sedimentation basins (D, E, F, and G) around the MWDF and adjacent facilities would collect runoff during construction and operation phases.

Reporting Requirements - Exxon would be required to submit data from the surface water monitoring program to the DNR on a quarterly basis. An annual report summarizing the water quality and biological monitoring information also would be required.

Table 1-14
Surface Water Quality and Aquatic Ecology Monitoring Program

Sampling Location	Type of Monitoring	Sampling Frequency	Station(s) Sampled	Parameters Measured
Swamp Creek	Water Quality	Annually, Monthly	Staff Gages 2, 3, & 5a	1,5
Swamp Creek	Water Quality	Quarterly	Location U	1
		Monthly	Locations A and DS	1
		Continuous	Location A	2
Swamp Creek	Sediment	Annually	Stations U, A and DS	3
Swamp Creek	Fish Tissue Analysis	Annually	Station A	3
Swamp Creek	Benthos Tissue Analysis	Annually	Stations U, A and DS	3
Pickerel Creek	Water Quality	Monthly	Stream Gage 19	5
Hemlock Creek	Water Quality	Annually, Monthly	Stream Gage 6	1,5
Creek 11-4	Water Quality	Monthly	Stream Gage 30	5
Creek 12-9	Water Quality	Monthly	Stream Gage 23	5
Hoffman Creek	Water Quality	Annually, Monthly	Stream Gage E	1,5
Outlet Creek	Water Quality	Monthly	Stream Gage 4	5
Martin Springs	Water Quality	Monthly		5
Hoffman Springs	Water Quality	Quarterly, Monthly	Lake Gage 31	4,5
Skunk Lake	Water Quality	Quarterly, Monthly	Lake Gage 15	4,5
Duck Lake	Water Quality	Quarterly, Monthly	Lake Gage 12	4,5
Deep Hole Lake	Water Quality	Quarterly, Monthly	Lake Gage 13	4,5
Little Sand Lake	Water Quality	Quarterly, Monthly	Lake Gage 7	4,5
Rice Lake (1)	Water Quality	Quarterly, Monthly		4,5
	Lake Level	Weekly (2)		
Rolling Stone Lake	Water Quality	Monthly	Lake Gage 9	5
	Lake Level	Weekly (2)		
Drainage Basins and Sedimentation Ponds	Water Quality	Weekly (when discharging)	D, E, F, G, X and Y	4

1 Chemical analysis for: aluminum, arsenic, cadmium, chromium (+3 and +6), copper, cyanide, lead, mercury, selenium, silver, zinc, manganese, BOD, total suspended solids, barium, fluoride, iron, total dissolved solids, sulfates, total sulfur, total organic carbon, nitrate, sodium, total alkalinity, and hardness. Field measurements for: dissolved oxygen, temperature, pH, conductivity, and flow rates (streams only) and water levels.

2 Continuous monitoring at the outfall for dissolved oxygen, flow rate, pH and specific conductance; daily composite sample for total dissolved solids and total suspended solids.

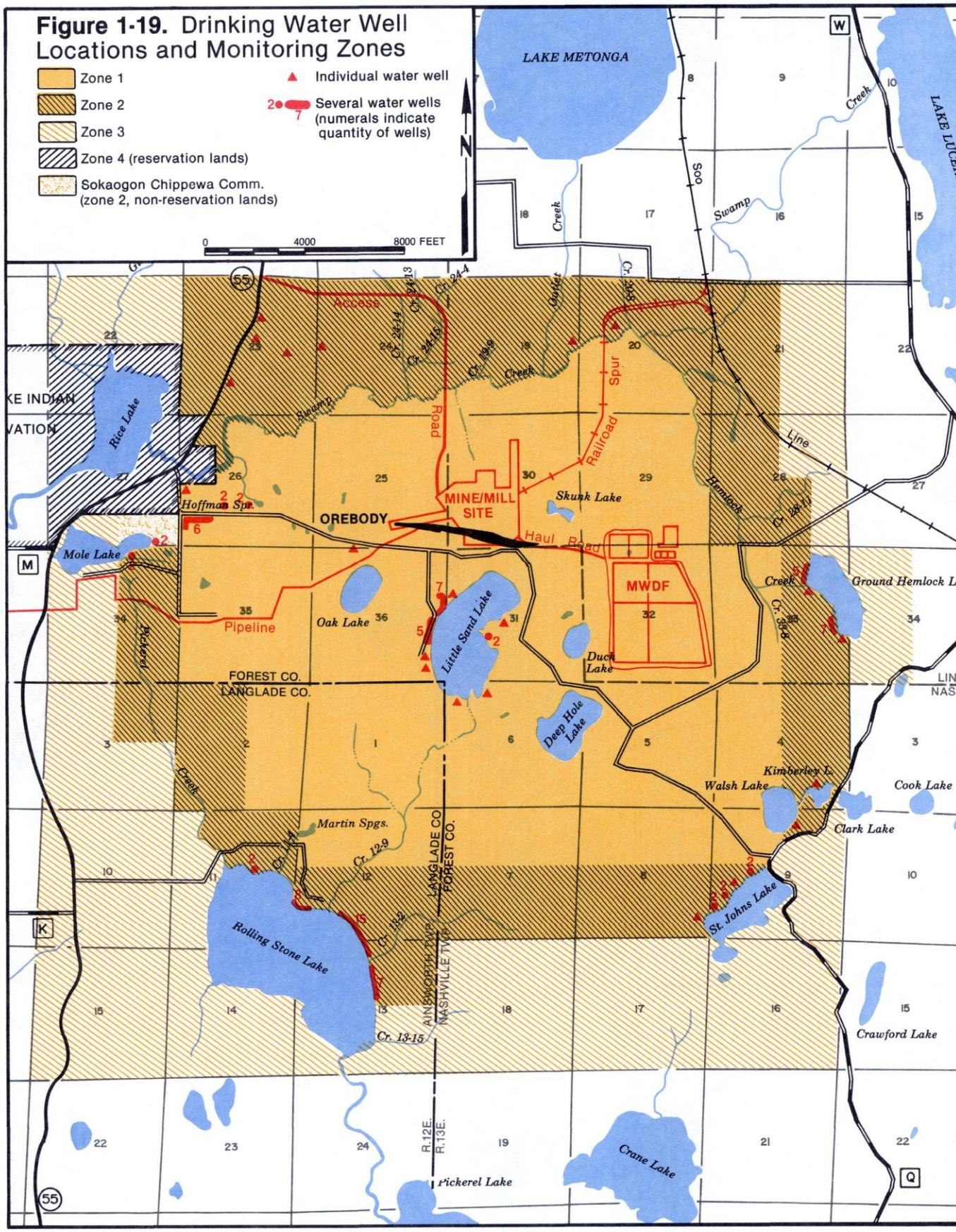
3 Chemical analysis for: aluminum, arsenic, cadmium, chromium (total), copper, iron, lead, mercury, selenium, silver, sulfate, sulfur (total), and zinc.

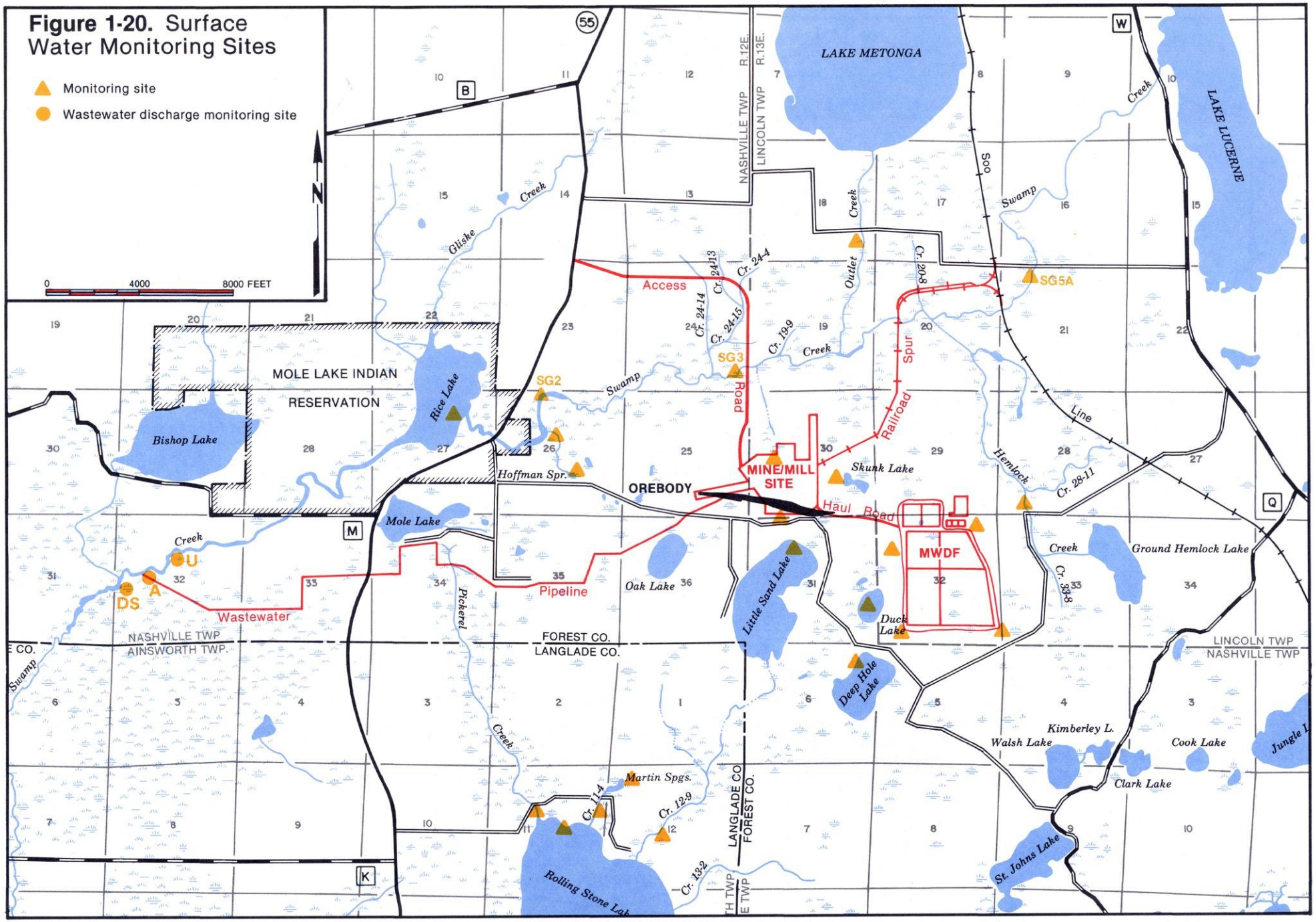
4 Chemical analysis for: total dissolved solids, total suspended solids, hardness, alkalinity, sulfate, and oil and grease. Field measurements for: specific conductance, pH, temperature and flow rates (streams only); and water level and surface temperature profile (lakes and ponds only).

5 Field measurements for dissolved oxygen, temperature, lake water level or stream discharge and velocity.

(1) Rice Lake monitoring would be contingent upon access approval from the Mole Lake Chippewa Tribal Council.

(2) June through March.


Figure 1-19. Drinking Water Well Locations and Monitoring Zones
Zone 1
Zone 2
Zone 3
Zone 4 (reservation lands)
Sokaogon Chippewa Comm. (zone 2, non-reservation lands)
Individual water well
Several water wells (numerals indicate quantity of wells)
0
4000
8000 FEET
N
LAKE METONGA
LAKE LUCE
Creek
Swamp
Soo
Access
Road
Spur
Railroad
Outlet
Line
Hemlock
Cr. 24-4
Cr. 24-13
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 39-5
Cr. 28-13
Cr. 39-8
Rice Lake
Hoffman Spr.
OREBODY
MINE/MILL SITE
Skunk Lake
Haul Road
MWDF
Mole Lake
Pipeline
Oak Lake
Little Sand Lake
Duck Lake
Deep Hole Lake
Ground Hemlock La
Kimberley L.
Walsh Lake
Cook Lake
Clark Lake
St. Johns Lake
Crawford Lake
Crane Lake
Pickerel Lake
Rolling Stone Lake
Martin Spgs.
Cr. 12-4
Cr. 12-9
Cr. 13-2
Cr. 13-15
FOREST CO.
LANGLADE CO.
AINSWORTH TWP.
NASHVILLE TWP.
R.12E.
R.13E.
KE INDIAN
VATION
LIN
NASH
W
M
K
Q
55


Figure 1-20. Surface Water Monitoring Sites
Monitoring site
Wastewater discharge monitoring site
N
0
4000
8000 FEET
LAKE METONGA
LAKE LUCERNE
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Oak Lake
Little Sand Lake
Deep Hole Lake
Duck Lake
Skunk Lake
Ground Hemlock Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Rolling Stone Lake
Martin Spgs.
Hoffman Spr.
Gliske Creek
Swamp
Outlet Creek
Soo Line
Hemlock Creek
Pickerel Creek
Jungle L
Access Road
Railroad Spur
Haul Road
Pipeline
Wastewater
OREBODY
MINE/MILL SITE
MWDF
SG2
SG3
SG5A
U
A
DS
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
FOREST CO.
LANGLADE CO.
NASHVILLE TWP
AINSWORTH TWP.
LINCOLN TWP
NASHVILLE TWP
B
K
M
Q
W
55

GROUNDWATER

The groundwater monitoring program serves the following two basic purposes:

1. To monitor groundwater drawdown and potential mine dewatering impacts.
2. To detect changes in groundwater quality and/or the presence of contaminants as a result of the construction and operation of the project facilities.

The tailings ponds, landfill, and reclaim ponds pose the greatest potential for groundwater contamination. For that reason, the groundwater quality monitoring program concentrates on these facilities.

Drawdown-Related Monitoring - Groundwater elevations would be monitored at 45 wells (piezometers) surrounding the project facilities to determine the extent of groundwater drawdown (Figure 1-21). The well locations provide spatial coverage within the anticipated area of drawdown and also provide groundwater elevation data in relation to potentially affected surface water bodies. Groundwater elevations would be measured quarterly starting one year prior to construction and continue until project year 66. The drawdown data would be used to assess the accuracy of the computer modeling of groundwater elevation changes and possible impacts on lake levels and streamflows.

In association with the groundwater elevation monitoring, seven of the 45 wells also would be monitored to establish a long-term record of groundwater quality (Figure 1-21). As indicated in Figure 1-21, samples would be obtained from these wells and analyzed for a suite of "indicator parameters" on a quarterly schedule. Groundwater sampling from the seven wells would begin one year prior to construction and continue until project year 66.

Groundwater Compliance Boundaries - The proposed compliance boundaries, utilizing NR 182.075 as cited in NR 132.17(9) to provide one overall regulatory authority for the project, were based upon the following factors:

1. Certain facilities (e.g., reclaim ponds) are designed not to seep but would require a rapid corrective response if a leak developed.

2. Adjacent facilities could have cumulative impacts (e.g. landfill and tailings ponds).

3. The glacial deposits are composed of highly permeable sandy materials.

4. The quantity and quality (physical and chemical characteristics) of the anticipated leachate(s) seeping from the facilities.

The proposed facility compliance boundaries are as follows:

1. MWDF, 1200 feet;

2. Reclaim Ponds, 100 feet;

3. Landfill, 150 feet;

4. Orebody/Abandoned Mine Workings, 1200 feet;

5. Mill and Related Facilities, 100 feet (including: preproduction ore storage pad, tailings thickener, wastewater storage lagoons, sedimentation ponds, and fuel storage) (Figure 1-22).

Contingency plans as specified in NR 182.075(1)(c) would be required for each of the five compliance boundary areas. The contingency plans address short and long-term events related to construction, operation and closure of the project which could adversely affect groundwater quality. For short-term events, such as spills, leaks and embankment failures, specific responses and remedial actions are delineated in the plans. The contingency plan establishes a systematic approach for detecting and assessing longer term problems such as higher than expected seepage from a lined facility. Specific remedial actions for long-term events are not included in the plan. The most appropriate response would be determined after completing an analysis of the nature and extent of the problem.

In addition, separate intervention boundaries must be established for each of the above mentioned facilities to comply with NR 182.075. The intervention boundary would be set at the perimeter of each facility. If a measured or interpolated exceedance of a groundwater standard occurs at the intervention boundary, a formal evaluation of facility performance would be conducted. This would include assessment of data from lysimeters, leak detection devices, wells and well nests, and construction and operational records. If the evaluation indicates the groundwater standard would be exceeded at the compliance boundary, an appropriate remedial action plan would be developed and implemented.

MWDF - Groundwater monitoring of the MWDF during the construction, operation and closure/reclamation phases is collectively referred to as operations monitoring. The monitoring wells are uniformly distributed around the MWDF, either near the compliance boundary or near the edge of the facility with most of the locations consisting of multi-level piezometers. These piezometers would provide access to the hydrologically significant deposits.

Baseline - Baseline groundwater quality would be established at the MWDF by monitoring on a monthly basis for at least twelve consecutive months prior to disposal of tailings. The well system would consist of 22 existing wells and 9 wells to be installed during the early stages of construction (Figure 1-23).

Operation - Monitoring well locations, schedule of operation, and water quality parameters for assessing groundwater quality changes near the MWDF during operations are shown on Figure 1-24. Monitoring to assess MWDF performance also would be conducted as part of the operations monitoring program. To determine the quality/quantity of leachate seeping through the soil liner, two collection lysimeters would be constructed immediately beneath the bottom liner of pond T1. Pairs of water level observation wells also would be installed within the underdrain and in the tailings above the filter layer. This system would provide data on the operating characteristics of the drainage system and the liner. In addition, the water quality of the leachate collected in the leachate collection system for treatment in the reclaim ponds would be sampled. Liquids collected in the monitoring wells and lysimeters would be analyzed on the schedule and for the parameters listed in Table 1-15.

To monitor the effectiveness of the MWDF reclamation cover, a moisture content measuring system would be installed to monitor performance. The specific type of moisture content measuring system installed would be specified in the MWDF plan of operation and possibly revised at the time of reclamation to assure the use of the latest technology.

The locations for the moisture content measuring devices would be selected during pond or reclamation cap construction. The results of the monitoring program for pond T1 would be used to evaluate the effectiveness of pond design and adequacy of the monitoring systems.

Closure - Exxon would be responsible for long-term care of the MWDF for a period of 30 years following issuance of a certificate of completion of reclamation for the last pond. The long-term care period starts for the entire MWDF at the completion of closure work on pond T4. Consequently, pond T1, at the end of the 30 year long-term care period, would have been monitored for a minmum period of 56 years. The anticipated sampling schedule and wells are shown in Figure 1-24 and Table 1-15.

MWDF features to be preserved and maintained during the long-term care period include selected monitoring wells, lysimeters, leachate collection system access pipes, a perimeter access road, and the encircling fence. An electricity supply may be needed at the site during closure and the long-term care period for monitoring well sampling and, if necessary, leachate pumping.

Monitoring activities would be conducted throughout the long-term care period. The monitoring program would include groundwater monitoring, lysimeter sampling below the base liner, settlement indicators, vegetational analysis, reclamation cover moisture content monitoring, and leachate collection system volume and quality analysis. The monitoring requirements, however, may change as data reflecting site performance are generated.

Monitoring wells not proposed for use during the long-term care period would be abandoned as part of closure activities. Well abandonment consists of removing pumps and pipes from the well casing, sealing of the well by filling the well casing with grout, and removing the pumphouse.

The company may apply for termination of responsibility 10 years after issuance of the reclamation certificate. The DNR must review site conditions and render a formal decision on an application for termination.

MRDF (Landfill) - Each refuse cell would be equipped with a collection lysimeter beneath the liner to collect leachate (Table 1-15). The proposed monitoring wells shown in Figure 1-24 and leachate from the lysimeters would be sampled and analyzed on a quarterly basis to assess the performance of the landfill.

Table 1-15
MWDF and Landfill Performance Monitoring

Sampling Location	Sampling Frequency	Project Years	Parameters Measured
Reclamation Cap Moisture Content (MWDF)	Quarterly	10-66	3
Bottom Lysimeters (MWDF)	Quarterly	4-66	1
Lysimeters (Landfill)	Quarterly	1-66	1
Underdrain Leachate (MWDF)	Quarterly	4-34	1
	Annually	4-34	2

1 Alkalinity, chemical oxygen demand, copper, hardness, iron, manganese, pH, sodium, specific conductance, sulfate, total dissolved solids, total organic carbon, water level, zinc.
2 Arsenic, barium, cadmium, chloride, chromium, cyanide, flouride, gross alpha radiation, gross beta radiation, lead, mercury, nitrate, radium-226, radium-228, selenium, silver, sulfide.
3 Moisture content.

Reclaim Ponds - The reclaim ponds would be constructed with the upper geomembrane acting as the primary means of wastewater containment while the underlying geomembrane would function as a monitoring lysimeter. Leachate moving through the upper geomembrane would drain into the leak detection/collection/vent system in the underdrain layer between the geomembranes. Since the water contained in the reclaim ponds would be untreated process water, leak detection/analysis and needed corrective actions must be rapid to prevent groundwater contamination. The proposed monitoring wells shown in Figure 1-24 would monitor this facility as well as the tailings ponds.

Mine/Mill Site - Extensive groundwater monitoring of the mine/mill site during operation would not be carried out because the groundwater would be flowing into the mine due to the drawdown. The only groundwater monitoring related directly to the mine/mill site area during operations would be quarterly sampling of a monitoring well near the preproduction ore storage pad to assess the performance of that facility.

After mine pumping ceases, a total of three wells would be installed within the reclaimed main/ventilation shafts or other boring locations (e.g., backfill delivery borehole) to sample mine water levels and quality. An additional six wells would be located in the glacial drift immediately above and adjacent to the abandoned mine. These nine wells would be monitored on a quarterly schedule for the indicator parameters listed on Figure 1-21 during the long-term care period (project years 32-66).

TERRESTRIAL ECOLOGY AND WETLANDS

The terrestrial ecology monitoring program would periodically evaluate the general conditions of wetland and terrestrial ecosystems within approximately three miles of the mine/mill site (Figure 1-25).

Three separate tasks would be accomplished as part of the terrestrial monitoring program. First, low flight color infrared photography (8 inches to the mile) would be taken to detect changes and possible stresses to ecosystems. Aerial photography would be taken in July when growing vegetation is best developed and most stresses would be visible. Detection of possible mine-related stresses would

prompt field investigations and comparison with air quality and groundwater data to determine possible causes and what corrective actions might be needed. Aerial photography frequency for this monitoring program would be related to that required for the MWDF inspection program [NR 182.14(1)(d)]. Photography would be obtained the year prior to the start of the construction phase activities and the year prior to the construction of and the year following closure of each tailings pond.

The second task of the monitoring program would be an annual sampling of soil, vegetation, and small mammals along a predominantly downwind transect during the operation of the first and second tailings ponds. The transect would be sampled in August or September, and the sampling would be spaced to include at least three collection points along the transect from the MWDF to the property fence. Samples would be analyzed for arsenic, cadmium, chromium (total), copper, lead, manganese, mercury, selenium, silver, and zinc.

The third task would be to monitor water table levels in selected groundwater discharge wetlands believed to be vulnerable to groundwater drawdown. These wells would be shallow, only as deep as the organic soils, and would be used to monitor fluctuations in wetland water levels. These wetland water table wells are shown in Figure 1-21.

AIR QUALITY AND METEOROLOGY

The four air particulate monitors would measure both total suspended particulates (TSP) and particles less than 10 microns in diameter (PM_{10}). Seven percent of the particulate monitor filters would be selected for characterization. All filters showing an exceedance of the standards would undergo particulate characterization. One filter from each sampling station would be analyzed annually for arsenic, cadmium, chromium, copper, lead, manganese, mercury and zinc. The air monitoring sites are shown on Figure 1-25.

The particulate monitor at site C would operate every day during excavation of the mine/mill site. At the end of this activity, the monitor would operate every six days until the mine/mill site construction phase was completed. This monitor would not operate during the mine operation or reclamation phases. The particulate monitors at sites U, A and B would operate every six days during the construction, operation and reclamation phases of the project. Monitors at site A and B, however, would sample every three days while a tailings pond was being excavated. The operating schedule for the particulate monitors would coincide with the schedule of all similar six day monitors in the state. If an exceedance of a short-term particulate standard occurred, the monitor indicating the exceedance would operate on a three day schedule until one year of monitoring passes without another exceedance.

Though laboratory analysis of crushed ore samples and pilot plant tailings did not reveal the presence of asbestiform minerals, the results were not deemed conclusive. For this reason, monitors at sites A and B would be operated for asbestiform fiber collection for two weeks during October of the fourth and fifth year of tailings pond T1 operation. Monitoring would be continued beyond the two year period if asbestiform fiber levels exceeded threshold values.

Stack testing at the east and west exhaust raises would be conducted after operation of the mine/mill begins. Specific procedures including testing frequency, quality assurance, verification, and those air pollutants to be tested, would be included in an air pollution control permit. Exhaust raise emissions have been estimated but stack tests would be required to verify the estimates.

Prior to operation of the mine/mill, a Malfunction Prevention and Abatement Plan must be reviewed and approved by DNR. This plan would address monitoring and maintenance of the air pollution control equipment. All testing procedures (including quality control of testing) would be reviewed and approved by the DNR.

At site U, meteorological monitoring would be conducted for wind direction and speed, precipitation, evaporation, temperature, and barometric pressure.

BLASTING AND NOISE

A pre-blasting survey of buildings within 0.5 miles of the access and ventilation shafts would be conducted immediately prior to project construction (Figure 1-25). The details of this plan are part of the Mining Permit Application.

DATA QUALITY ASSURANCE

All sample collection, preservation, storage, holding times, and testing procedures must be standard methods acceptable under state and/or federal laws. If standard procedures do not exist, the sampling method must be approved by the DNR before sample collection takes place. These methods would be updated, as appropriate, to reflect changes in sampling procedures and analytical capabilities. This oversight would provide a greater certainty over the quality of the results and enhance the usefulness of the data.

All samples must be sent to certified and registered laboratories. Air samples and other types of biological or physical samples shall be sent to a lab approved by the Department. Registered labs have acceptable quality assurance programs and are periodically tested to verify the accuracy of the analytical work. Quality assurance records in certified labs must be kept and made available upon Department request.

MITIGATION MEASURES

Exxon has proposed a complex mitigation plan to prevent the "unreasonable detriment of public water supplies...(or) public rights in the waters of the state" (sec. 144.855(3)(b), Stats.) due to mine pumping. Water augmentation for a given lake or stream would commence when the stream flow/lake level dropped to a "trigger point" (the "on" value in Tables 1-16 and 1-17). Augmentation could stop when the "off" value was reached. The proposed mitigation facilities would be implemented in the following fashion.

1. Construction phase mitigation facilities (i.e. mitigation wells, pipelines, electric transmission lines, aeration and outfall structures, and treated mine water connections) would be installed as the mine/mill facilities were being constructed (Figure 1-26). The waterbodies listed in Table 1-16 would be extremely sensitive to groundwater drawdown and impacts could occur early in the project.

2. Operations phase mitigation facilities would utilize augmentation wells, lake level control structures, and intercepted groundwater (Figure 1-27). These facilities would be installed and activated within 20 days of stream flows/lake levels falling below the predetermined minimum flow/levels (Table 1-17). Impacts could occur to these waterbodies but the timing is not known so facilities would be added as needed.

3. The glacial aquifer interceptor system would be installed if the mitigation measures installed up to that point were ineffective in mitigating stream flow/lake level reductions. This option would consist of a semi-circle of intercept wells on the west, south and east sides of the orebody. This option would involve the construction of additional pipelines to the various waterbodies proposed to receive mitigation waters (Figure 1-28).

Table 1-16
Construction Phase Mitigation Facilities and Monitoring Programs

Water Body	Mitigation Well Number	Mitigation Supplement (gpm)[1]	Additional Supplement (gpm)[1]	Flow Rate (cfs) On	Flow Rate (cfs) Off	Monitoring Device	Monitoring Frequency
Hoffman Spring/ Creek[2]	C-1	130	250	0.55	0.7	Flume	Weekly[4]
Martin Spring/ Creek 11-4	C-5	30	180	0.4	0.5	Staff Gage	Weekly[4]
Upper Pickerel Creek	C-6	150	450	1.0	1.3	Staff Gage	Weekly[4]
Skunk Lake	-[3]	150	---	NA	NA	Lake Gage	Weekly[4] Monthly[5]

1 Shows maximum amount of supplement to creek. The additional supplement refers to capacity that would be added within 20 days if the mitigation supplement was inadequate. For example, an additional 120 gpm would be added to the mitigation supplement to Hoffman Spring thus providing a total of 250 gpm.

2 A fish stocking program is included for this creek.

3 Potential sources of mitigation water include treated mine water and intercepted groundwater.

4 January, February March, June, July, August, September, October, November and December. Weekly monitoring would not occur during period of high precipitation.

5 April and May.

NA Lake supplement would begin at lake level 1597.01 ft. (MSL) and would be discontinued at 1597.05 ft (MSL) or above.

Table 1-17
Operations Phase Mitigation Facilities and Monitoring Programs

Water Body	Well Number	Mitigation Supplement (gpm)[1]	Flow Rate (CFS) or Lake Level (Ft. [MSL]) On	Off	Monitoring Device	Monitoring Frequency
Creek 12-9	C-2	250 (355)	2.5	3.0	Flume	Weekly Monthly
Swamp Creek Upstream from the Access Road	C-4 or intercepted groundwater	140	10.5 (Flow measured at SG 3 or DNR SG 1)	11.5	Staff Gage	Weekly Monthly
Swamp Creek Downstream from the Access Road	C-3 or intercepted groundwater	120	17.5 (Flow measured at Hwy 55)	18.5	Staff Gage	Weekly Monthly
Hemlock Creek	WS-2 or intercepted groundwater	290 (345)	2.7	3.4	Staff Gage	Weekly Monthly
Little Sand Lake	-[2]	190 (680)	1591.00 1591.51	1591.05[3] 1591.55[4]	Lake Gage	Weekly[5] Monthly[5]
Duck Lake	-[2]	6 (12)	1610.59	1610.65	Lake Gage	Weekly[5] Monthly[6]
Deep Hole Lake	-[2]	30 (100)	1605.00 1605.25	1605.05[7] 1605.30[8]	Lake Gage	Weekly[5] Monthly[5]

[1] Shows maximum volume of mitigation water added. The first number is Exxon's expected impact volume projection. The number in parentheses is the Geoflow models' volume projection for worst case. Volume to be set at permitted rate to replace lake water lost due to mine activities.
[2] Supplement to be provided from the mine groundwater intercept system, potable water tank, or well WS-2.
[3] Elevation for January through March and July through December.
[4] Elevation for April through June.
[5] January, February, March, June, July, August, September, October, November, and December.
[6] April and May.
[7] Elevation for December through March.
[8] Elevation for April through November.

Monitoring of water levels in Rolling Stone Lake and Rice Lake is proposed by Exxon (page 40). Readings would be taken weekly from June through March and monthly in April and May. Direct mitigation of the water bodies is not proposed.

Exxon could request to not activate or install the mitigation facilities/measures if stream flow/lake level reductions were not mine related. Other activities such as droughts, beaver activities, surface water diversions or well pumping could affect groundwater levels or stream hydrology which in turn could affect lake levels and stream flows. Due to these concerns, Exxon proposes to use Swamp Creek upstream of the Hemlock Creek confluence and Oak Lake (because it is perched) as "control" waterbodies. These two waterbodies were selected because of their proximity to the impact area yet they are not anticipated to be influenced by the groundwater drawdown.

Exxon's plan, in essence, is a tiered system of responses to impacts as they appear. The first tier consists of measures installed during the construction phase because of the sensitivity of these waterbodies to groundwater drawdown and the probable occurrence of impacts. The second tier or operations phase mitigation measures would be installed as needed. Thus, operations phase facilities only would be added if and where impacts developed. The glacial aquifer intercept system represents the third tier and could supply groundwater to the majority of sites.

This plan strives for maximum flexibility especially in terms of instituting the measures proposed for either the operations phase or the glacial aquifer interceptor system. For example, a portion of the interceptor well system might be placed in the glacial aquifer above the mine. This water could then be used for mitigating impacts to Swamp Creek thus reducing the need for installing mitigation wells C-3 and C-4. Other configurations of these two systems also would be possible if agreeable to Exxon and the DNR.

NOISE MANAGEMENT PLAN

Two types of mitigative controls would be used to manage construction, operation, and reclamation sounds (noises) at the project site. The first type, administrative controls, would modify operating procedures or work practices to reduce, eliminate, or shorten the duration of the noise source. This type of control is most effective for transient sources such as operating procedures. The second type would be engineering controls which physically change specific noise sources. This type of control may take the form of source relocation, source replacement and source modification (e.g., addition of a muffler to a diesel engine). A brief description of these control measures is presented below:

Administrative

1) Posting of speed limits;

2) Limiting tree removal to maintain sound barriers;

3) Limiting engine idling of mobile equipment during periods of inactivity;

4) Limiting certain activities to daytime hours, where feasible. Such activities will include: surface facility contruction (including MWDF), site grading and waste haulage. It must be recognized, however, that certain circumstances may result in periodic nighttime activities; and

5) Movement of trains by the Soo Line on the spur will normally occur during the daytime. However, concentrate loading occurs continuously, so there will be some movement and placing of rail cars within the plant area at night.

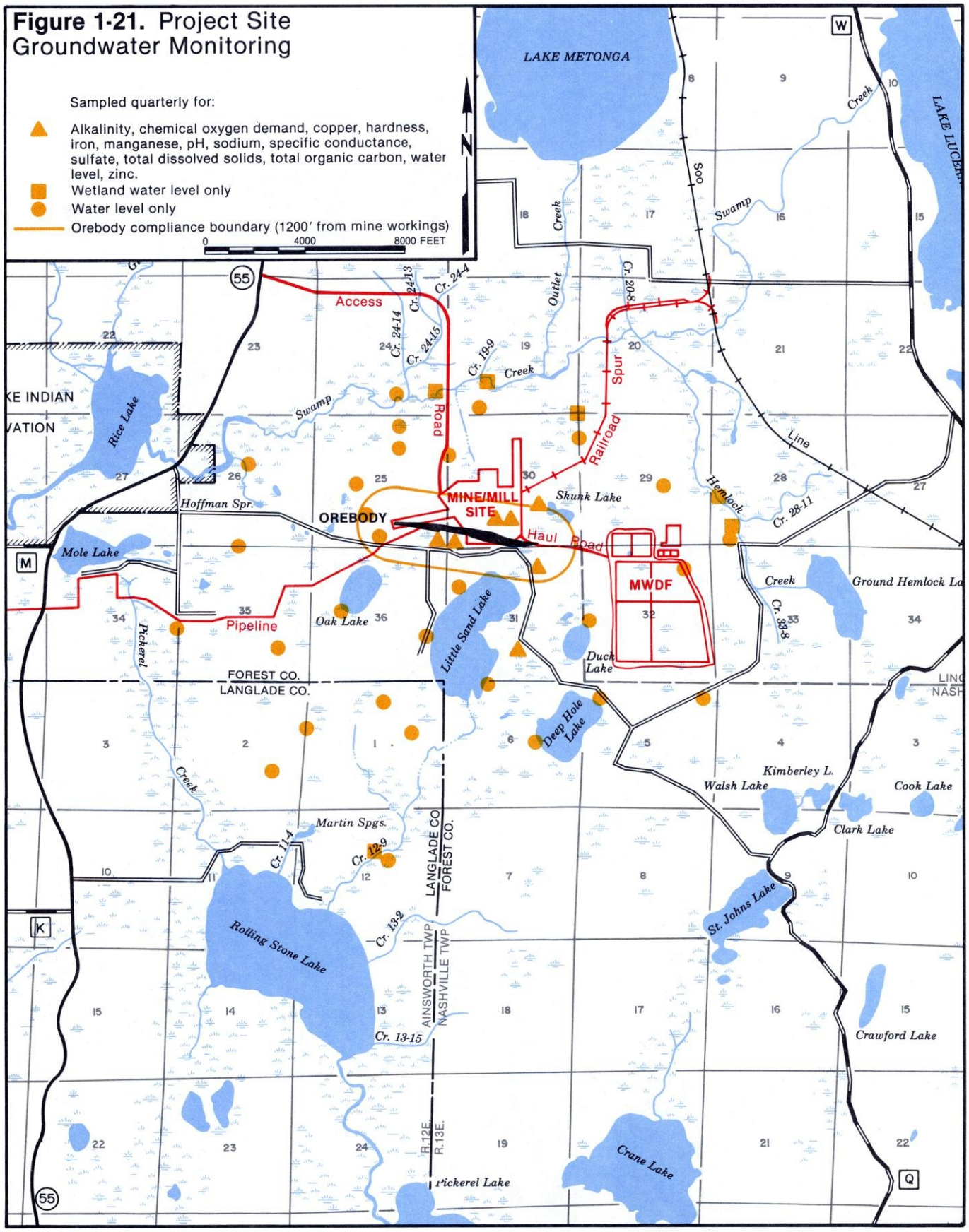
Engineering

1) Proper equipment maintenance and the use of mufflers on all internal combustion engines;

2) Ore processing equipment, air compressors and emergency electrical generators would be contained within buildings or other enclosures;

3) A criterion used in mine ventilation and heating fans selection would be overall sound power level. Discharging structures would be directed vertically to reduce noise levels off-site.

4) Noise associated with shaft blasting would be reduced by closing the shaft doors and because of the depth (70-170 feet).


Figure 1-21. Project Site Groundwater Monitoring
Sampled quarterly for:
Alkalinity, chemical oxygen demand, copper, hardness, iron, manganese, pH, sodium, specific conductance, sulfate, total dissolved solids, total organic carbon, water level, zinc.
Wetland water level only
Water level only
Orebody compliance boundary (1200' from mine workings)
0 4000 8000 FEET
N
LAKE METONGA
Creek
LAKE LUCE
Soo
Swamp
Outlet
Cr. 20-8
Spur
Railroad
Line
Access
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Creek
Road
Swamp
Rice Lake
Hoffman Spr.
OREBODY
MINE/MILL SITE
Skunk Lake
Haul Road
MWDF
Hemlock
Cr. 28-11
Mole Lake
Pipeline
Oak Lake
Little Sand Lake
Duck Lake
Creek
Ground Hemlock La
Cr. 33-8
FOREST CO.
LANGLADE CO.
Pickerel Creek
Deep Hole Lake
Kimberley L.
Walsh Lake
Cook Lake
Clark Lake
Martin Spgs.
Cr. 11-4
Cr. 12-9
Cr. 13-2
Rolling Stone Lake
St. Johns Lake
AINSWORTH TWP.
NASHVILLE TWP
R.12E.
R.13E.
Cr. 13-15
Crawford Lake
Crane Lake
Pickerel Lake
W
M
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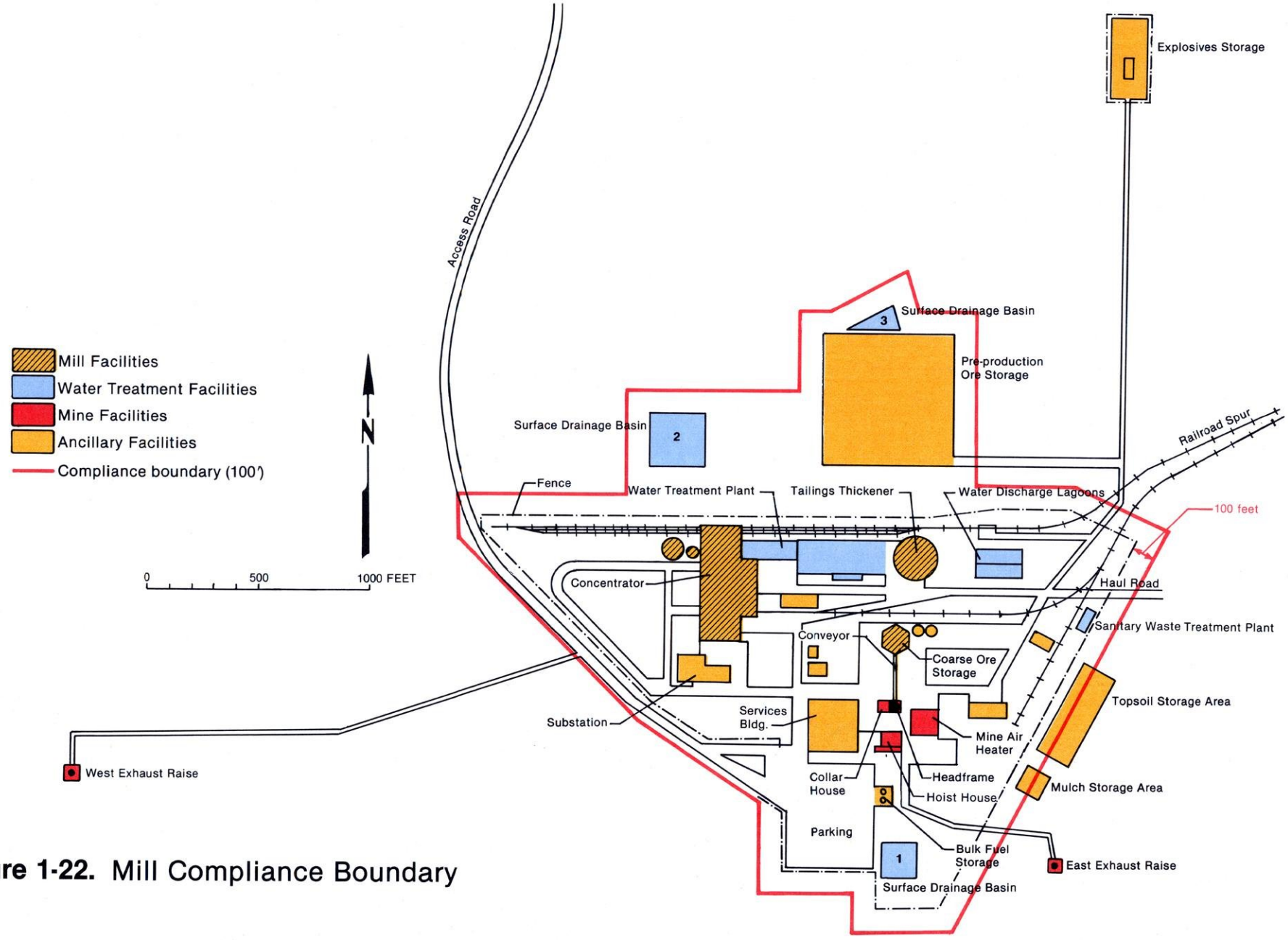


Figure 1-22. Mill Compliance Boundary

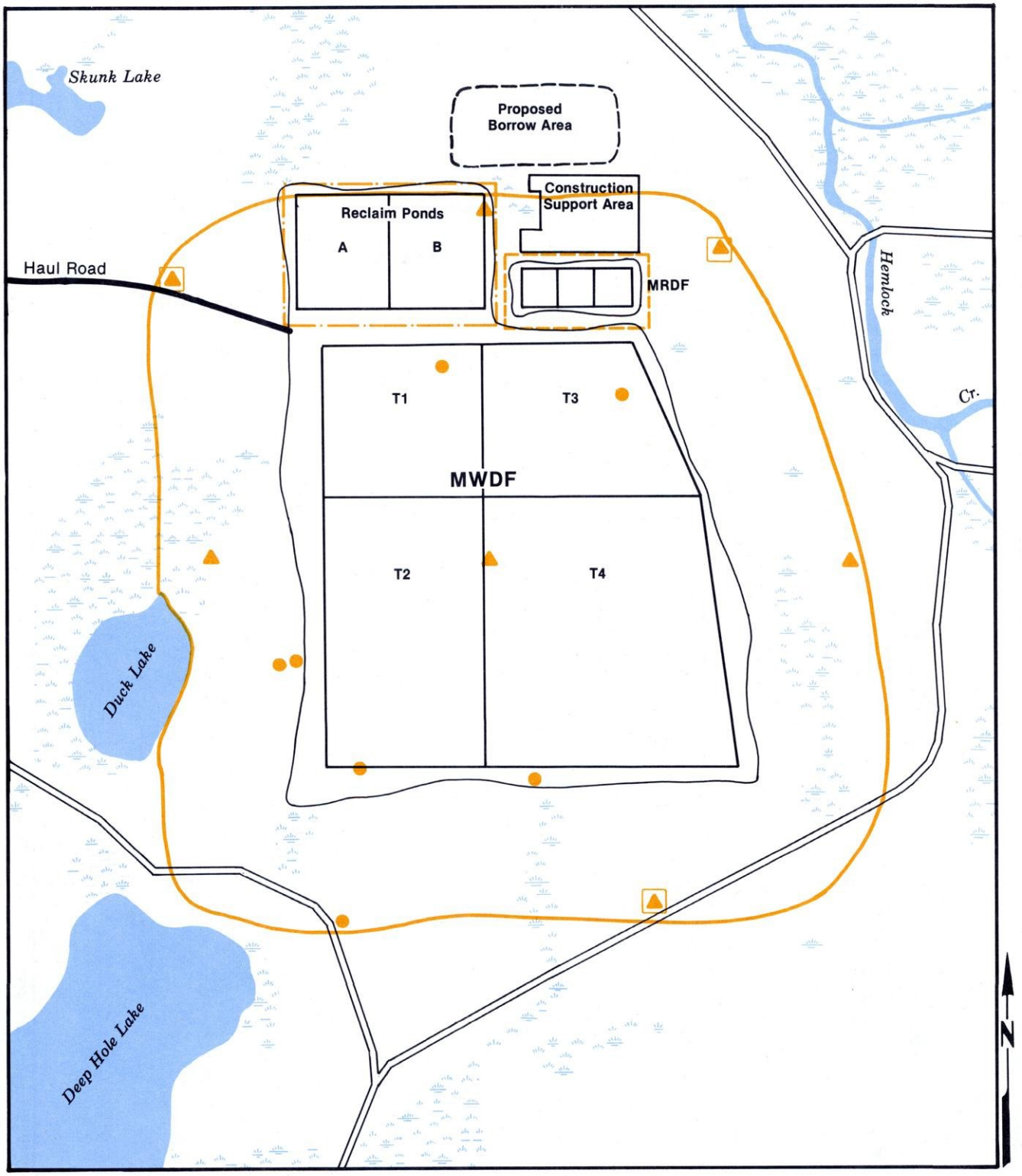


Figure 1-23. MWDF Site Preconstruction Groundwater Monitoring

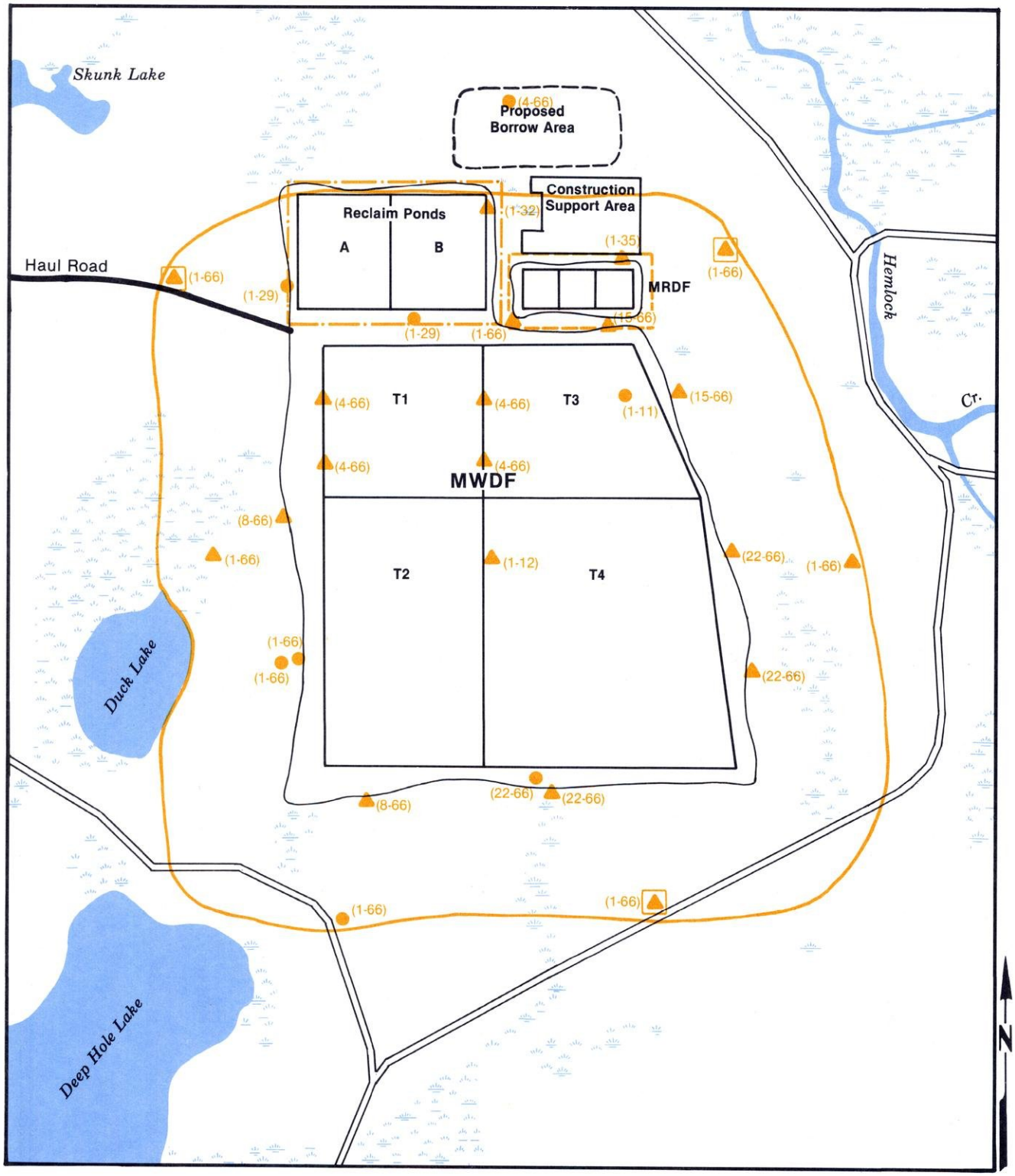
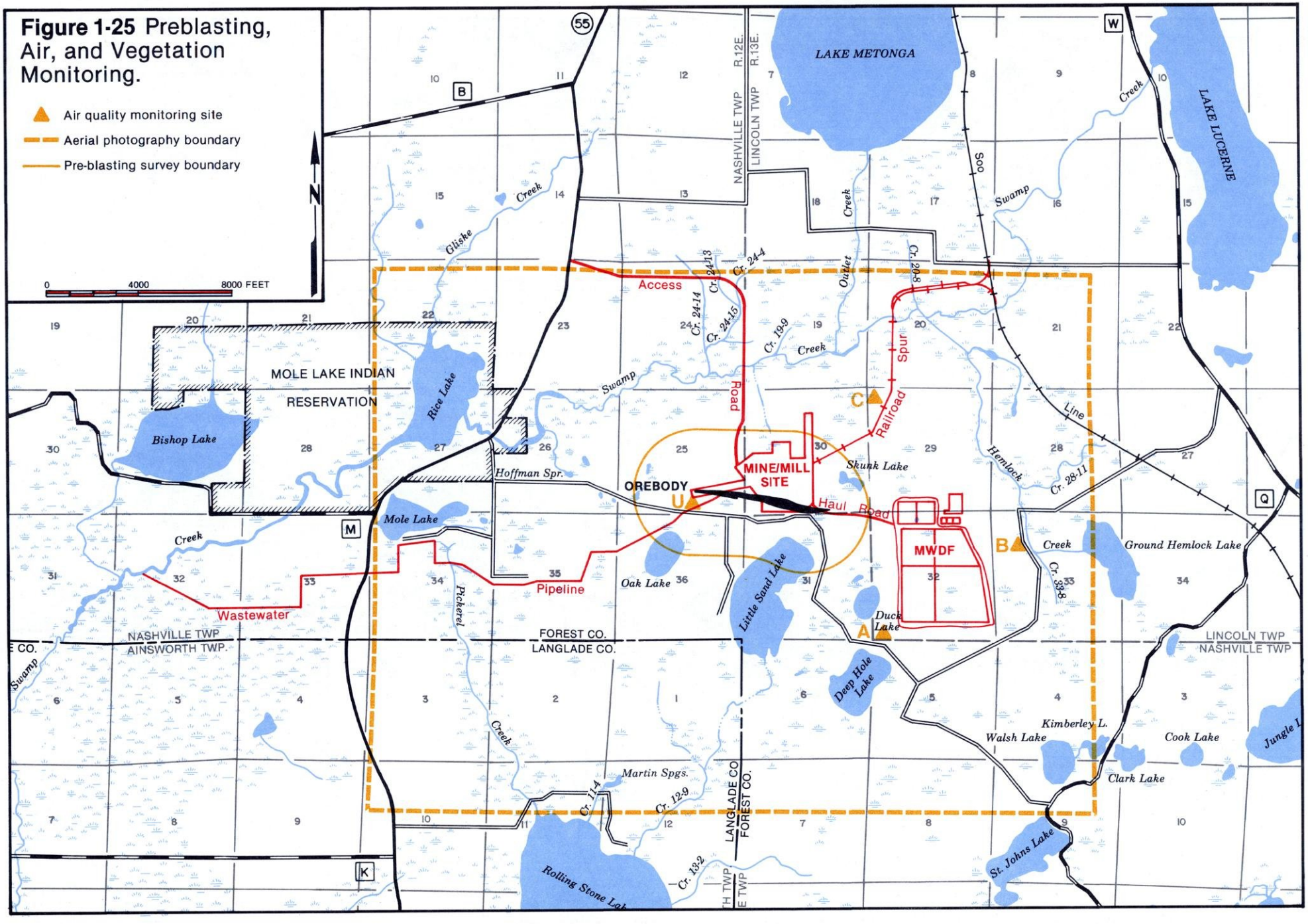
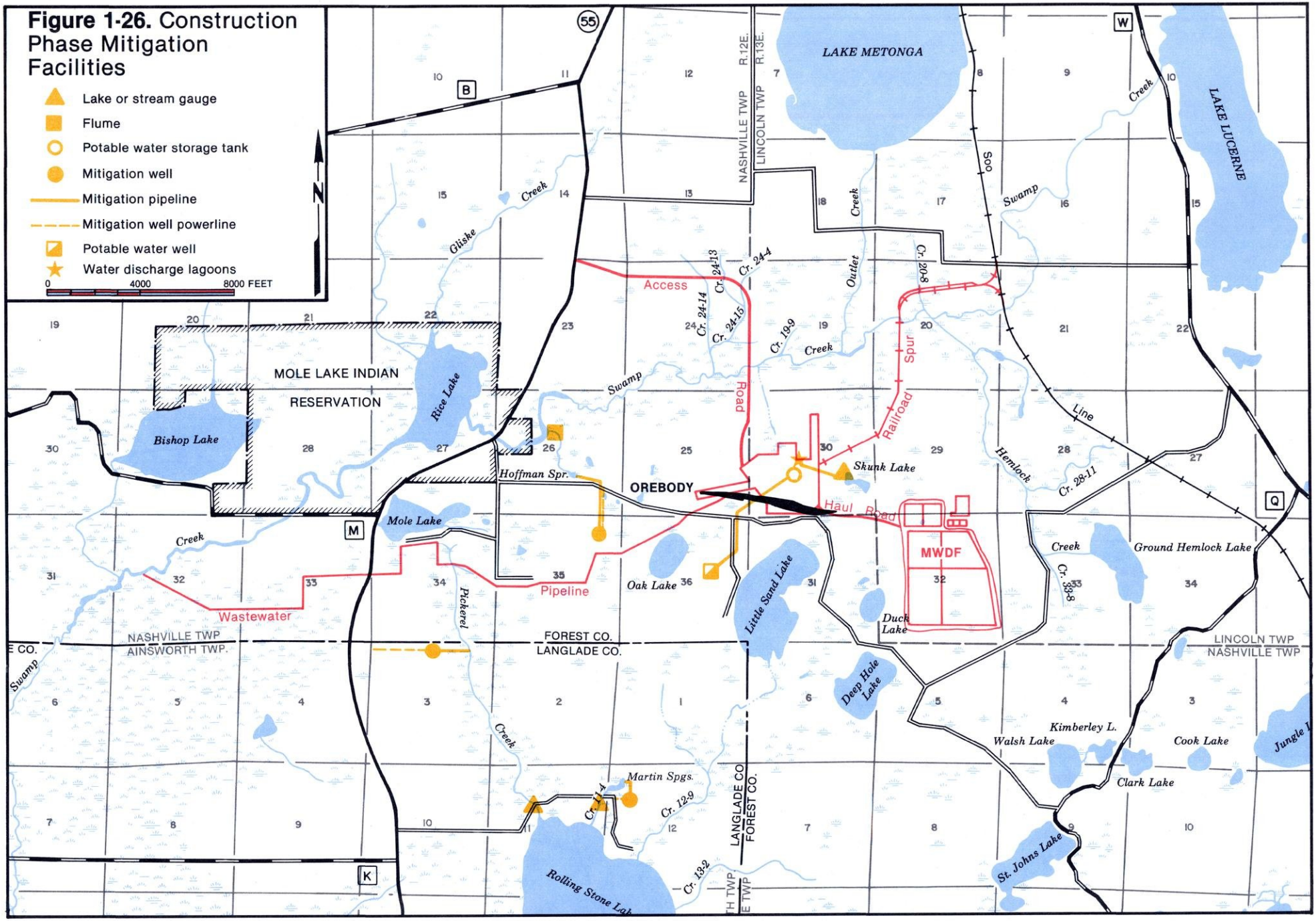
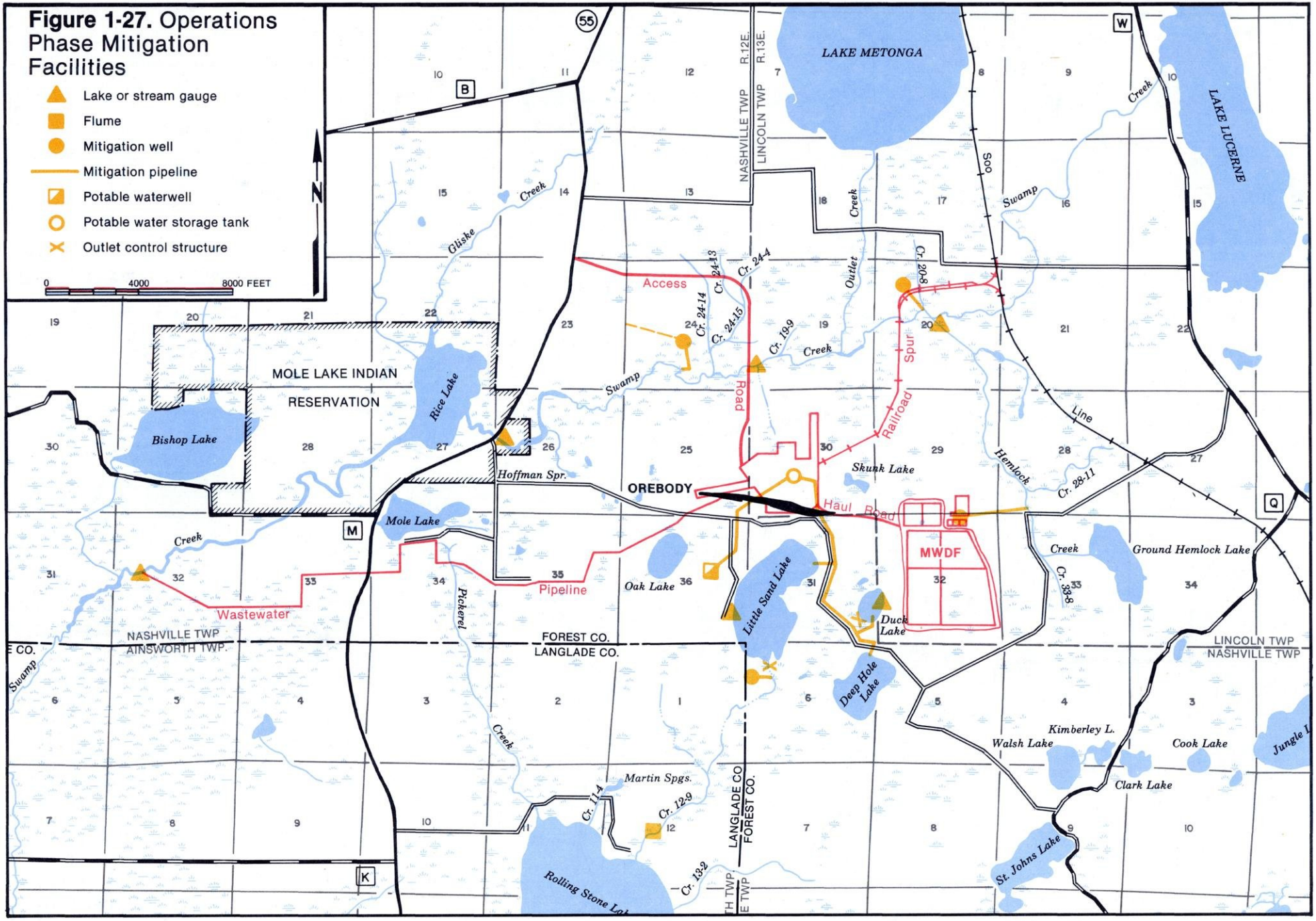
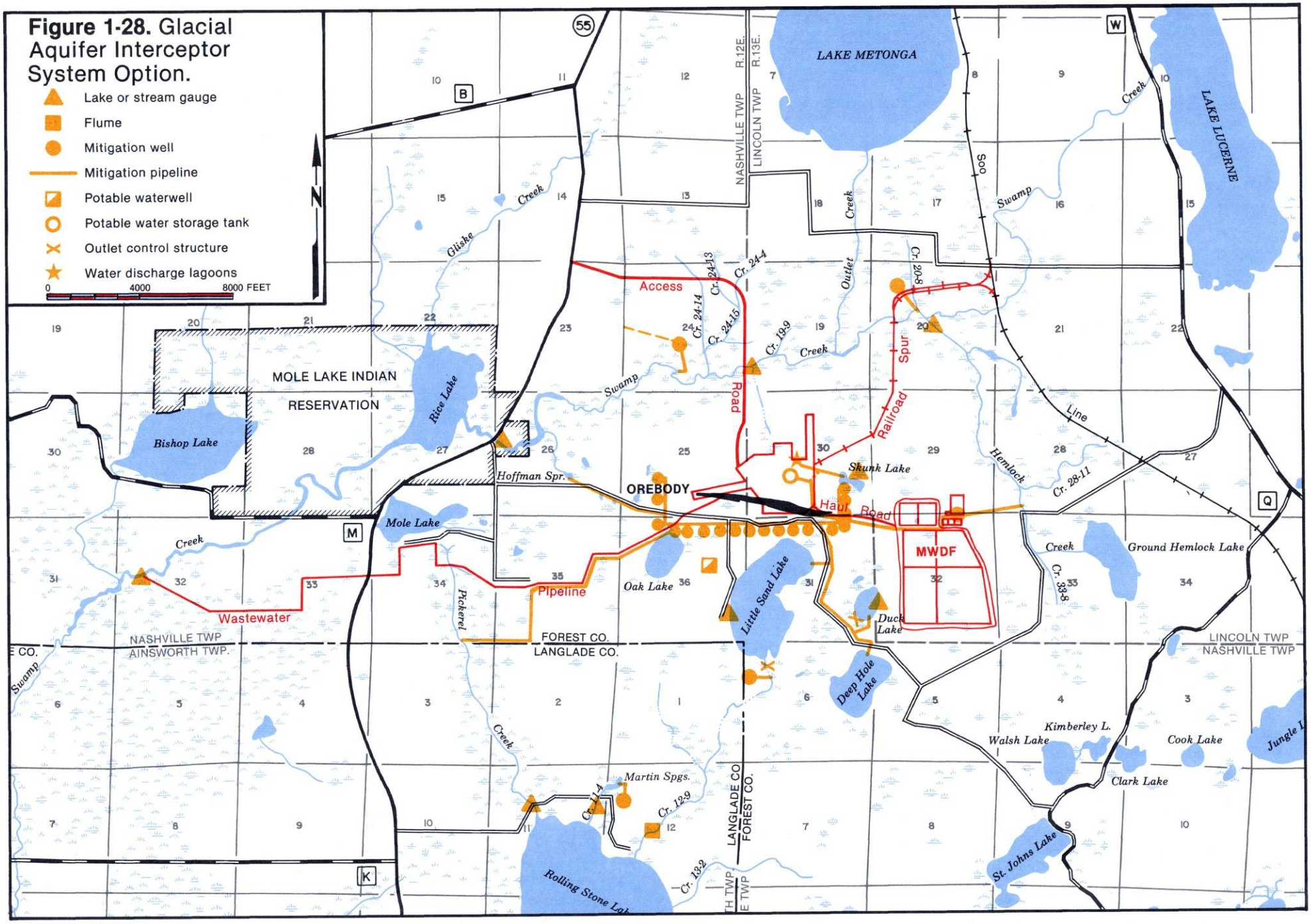


Figure 1-24. MWDF Site Groundwater Monitoring


Figure 1-25 Preblasting, Air, and Vegetation Monitoring.
Air quality monitoring site
Aerial photography boundary
Pre-blasting survey boundary
N
0 4000 8000 FEET
LAKE METONGA
LAKE LUCERNE
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
Creek
Gliske
Swamp
Soo
Outlet
Access
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Road
Spur
Railroad
Line
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Hoffman Spr.
OREBODY
MINE/MILL SITE
Skunk Lake
Haul Road
Hemlock
Cr. 28-11
MWDF
Mole Lake
Pipeline
Wastewater
Pickerel
Oak Lake
Little Sand Lake
Duck Lake
Ground Hemlock Lake
Cr. 33-8
NASHVILLE TWP
AINSWORTH TWP.
FOREST CO.
LANGLADE CO.
LINCOLN TWP
NASHVILLE TWP
Deep Hole Lake
Kimberley L.
Walsh Lake
Cook Lake
Clark Lake
Jungle L
Martin Spgs.
Cr. 11-4
Cr. 12-9
Cr. 13-2
Rolling Stone Lak
St. Johns Lake
A
B
C
U
M
K
Q
W
55


Figure 1-26. Construction Phase Mitigation Facilities
Lake or stream gauge
Flume
Potable water storage tank
Mitigation well
Mitigation pipeline
Mitigation well powerline
Potable water well
Water discharge lagoons
0 4000 8000 FEET
N
LAKE METONGA
LAKE LUCERNE
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Oak Lake
Little Sand Lake
Deep Hole Lake
Duck Lake
Skunk Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Rolling Stone Lake
Ground Hemlock Lake
Martin Spgs.
Hoffman Spr.
Gliske Creek
Swamp
Soo Line
Hemlock Creek
Outlet Creek
Pickerel Creek
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
Access Road
Railroad Spur
Haul Road
OREBODY
MWDF
Pipeline
Wastewater
FOREST CO.
LANGLADE CO.
AINSWORTH TWP.
LINCOLN TWP
NASHVILLE TWP
B
M
K
Q
W
55


Figure 1-27. Operations Phase Mitigation Facilities
Lake or stream gauge
Flume
Mitigation well
Mitigation pipeline
Potable waterwell
Potable water storage tank
Outlet control structure
0 4000 8000 FEET
N
LAKE METONGA
LAKE LUCERNE
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
Soo
Swamp
Creek
Outlet
Access
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Road
Spur
Railroad
Line
Hemlock
Cr. 28-11
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Gliske
Hoffman Spr.
OREBODY
Haul Road
Skunk Lake
MWDF
Mole Lake
Oak Lake
Little Sand Lake
Duck Lake
Deep Hole Lake
Ground Hemlock Lake
Cr. 33-8
Pipeline
Wastewater
Pickerel
NASHVILLE TWP
AINSWORTH TWP.
FOREST CO.
LANGLADE CO.
LINCOLN TWP
NASHVILLE TWP
Martin Spgs.
Cr. 11-4
Cr. 12-9
Cr. 13-2
Rolling Stone Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Jungle L
B
M
K
Q
W
55


Figure 1-28. Glacial Aquifer Interceptor System Option.
Lake or stream gauge
Flume
Mitigation well
Mitigation pipeline
Potable waterwell
Potable water storage tank
Outlet control structure
Water discharge lagoons
0 4000 8000 FEET
N
LAKE METONGA
LAKE LUCERNE
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Oak Lake
Skunk Lake
Little Sand Lake
Duck Lake
Deep Hole Lake
Ground Hemlock Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Rolling Stone Lake
Martin Spgs.
Hoffman Spr.
OREBODY
MWDF
Haul Road
Railroad Spur
Access Road
Pipeline
Wastewater
Gliske Creek
Pickerel Creek
Swamp
Outlet Creek
Soo Line
Hemlock Creek
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
AINSWORTH TWP.
FOREST CO.
LANGLADE CO.
LANGLADE CO
FOREST CO.
LINCOLN TWP
NASHVILLE TWP
E CO.
B
K
M
Q
W
55

COST OF PROPOSED FACILITIES

Project costs from the discovery of the orebody through construction of the mine/mill are estimated at $390 million (1985 dollars). Operation and reclamation expenditures would total an additional $144 million. Actual costs, however, would reflect inflation between the reference year and the years of actual construction and operation (Table 1-18). Exxon's estimated project expenditures within Wisconsin are listed in Table 1-19.

Table 1-18
Project Expenditures

Expenditure Category	Construction[1]	Operations[2]	Total
Mine/Mill Facilities & Land[3]	340	66	406
Pollution Control Facilities[4]			
Water Treatment	22	--	22
Tailings	28	43	71
Reclamation[5]	--	35	35
TOTAL	390	144	534

Costs are in millions of dollars (1985 base).

[1] Period from orebody discovery through the beginning of operations.
[2] Period from the start of production (project year 4) through termination of the mine (project year 32) and reclamation (project year 35) and post-operations maintenance and monitoring.
[3] Orebody delineation drilling; preliminary engineering; environmental studies and overhead expenditures; land acquisition; site preparation; construction of the mine, mill, office buildings, roads, railways, original and replacement equipment, and other surface facilities.
[4] Water treatment plant; sewage treatment plant, tailings disposal; and other pollution control facilities.
[5] Facilities removal; grading and revegetation of the mine/mill site, MWDF, and ancillary facilities.

Table 1-19
Exxon Estimates of Expenditures Within Wisconsin

Sector	Construction[1,2] (30 Months)	Operation[1,2] Each Year
Nonmetal, Nonfuel Mining	-	-
Construction	-	-
Lumber and Wood Products	5	1
Furniture and Fixtures	2	-
Paper and Allied Products	-	-
Chemicals	1	2
Petroleum and Coal	6	2
Rubber and Plastics	0	1
Stone, Clay, and Glass	5	4
Primary Metal Products	4	-
Fabricated Metals	36	1
Nonelectrical Machinery	14	5
Electric and Electronics	1	-
Transportation Equipment	1	-
Miscellaneous Manufacturing	2	-
Transportation, Communications, Utilities	10	14
Wholesale Trade	7	2
Hospitality, Recreation and Tourism	-	-
Other Services	-	1
Labor	118	16
Total	$212+	$49+

[1] Costs are in millions of dollars (1985 base)
[2] - means less than $1 million

The cost of constructing electric facilities by the Wisconsin Public Service Corporation (WPS) is estimated to be $4,220,000 (1987 dollars) (Table 1-20).

Table 1-20
Electric Transmission Line Construction Costs

Transmission Line		
	Land Rights (1987 Dollars)	$ 140,000
	Clearing Right-of-Way	210,000
	Poles and Fixtures	1,110,000
	Conductors, Devices	985,000
	Hwy. 8 Transmission Line	570,000
Venus Substation		
	Station Equipment	1,040,000
Exxon Substation (WPS costs only)		
	Station Equipment	165,000
	TOTAL	$4,220,000

No estimates are currently available for operation and maintenance costs, or removal and abandonment costs of the electric transmission facilities. In addition, this estimate does not include the costs of electric facilities constructed and operated by Exxon.

The construction costs for the WPS portion of the natural gas line and related facilities are estimated to be $1,330,000 (1987 dollars) (Table 1-21).

Table 1-21
Natural Gas Pipeline Construction Costs

Natural Gas Line	
Land and Land Rights (1987 Dollars)	$ 150,000
Gas Main	975,000
Metering and Regulating Equipment	205,000
Total	$1,330,000

Cost estimates are not yet available for the ANR Pipeline Company's portion of the natural gas line. The estimated construction costs for ANR range between $900,000 and $1,000,000 based on WPS costs and the relative lengths of the WPS versus ANR portions of the natural gas line.

No estimates are currently available for operation and maintenance costs or abandonment costs of the natural gas facilities.

WORK FORCE CHARACTERISTICS

Construction - The construction phase would span about 30 months. During the first year, construction work would be conducted throughout daylight hours. The second and third years would generally have construction activities on a 8 hour/day, 40 hour/week schedule except headframe/main shaft work would be 24 hours/day. The seasonal swings in construction phase employment and average employment for the year are shown in Figure 1-15. Table 3-34 (Chapter Three) provides a listing of job skills and approximate number of employees required during the peak construction phase.

Operations - By the beginning of project year 5 the mine would be fully operational with a sustained level of employment of 620 persons. Assuming full production, this level of employment is expected to continue until project year 32. During the operations phase, the anticipated work schedule is indicated in Table 1-22 while Table 1-23 displays estimated total employment and wages by employment category. A listing of job skills and approximate number of employees required during the operation phase is contained in Table 3-36 (Chapter Three).

Table 1-22
Operations Work Schedule

	Shifts/Day	Hours/Shift	Days/Year
Mine stope production and development	3	8	340*
Primary crushing and ore and waste rock hoisting	3	8	340*
Concentrator and Tailings Disposal	3	8	360
Mine backfilling	3	8	360
Waste disposal and water treatment	3	8	365

*Operations would be conducted on a 7-day per week basis.

Table 1-23
Exxon Employment and Wages During Project Operations

Employment Category	Rate/Hour[1]	Annual Wages	Number of Employees[2]
Administration	$11.90	$1,856,000	77
Mine Technical	14.95	808,000	26
Mine Operations	12.20	6,775,000	267
Mine Maintenance	13.85	2,477,000	86
Mill Technical	12.45	570,000	22
Mill Operations	14.10	1,672,000	57
Mill Maintenance	11.60	676,000	28
Central Maintenance	11.60	1,375,000	57
Total	N/A	$16,209,000	620

[1] Wages are composite, weighted averages from U.S. Bureau of Census data, excluding benefits, in 1985 dollars.
[2] This number maintained from project year 4 through project year 32.

Closure - After mine production ceased, a period of approximately 3.5 years would be required for closure and reclamation of the facilities. Peak employment estimates for the final three years (years 33 through 35) are 490, 250 and 80, respectively. The average number of employees during closure are shown in Figure 1-15. A small number of employees would remain after project year 35 to oversee long term reclamation and monitoring. Scheduling of reclamation activities is subject to variation and can only be detailed as the production phase draws to a close.

VEHICLE TRAFFIC TO THE SITE

Anticipated daily truck, bus, and passenger vehicle traffic during the project is shown in Table 1-24.

Table 1-24
Project Traffic

	Project Years	Cars	Buses	Trucks
Construction				
	1	250	5	15
	2	370	6	17
	3	820	9	15
Operation	4-32	320		6

Traffic during the construction and closure phases would predominately occur during daylight hours. During the operations phase, however, most of the vehicular traffic would be concentrated at the morning and afternoon shift changes (7-8 a.m. and 3-4 p.m.). Traffic during the closure phase would drop rapidly from operations levels, especially after the first year of reclamation.

PROPOSED ENERGY USE

Petroleum Energy Use - Fuel use would vary depending upon the type of equipment used, changes in schedules, weather conditions, and other factors. Early in the construction period, fuels and lubricants would be hauled to the site by truck and stored in tank trailers. The permanent on-site fuel storage areas would be completed during the second year of construction. Diesel fuel would be delivered to the mine/mill by either truck or rail car. Gasoline would be delivered by trucks and stored in an underground tank similar to those used at a commercial filling station. Diesel fuel would be used to power underground mining equipment, mobile surface equipment, emergency generators, and portable heating units while gasoline would be used for surface vehicles only. Projected fuel use during construction and operation is shown in Table 1-25.

Table 1-25
Petroleum Consumption

Project Year(s)	Daily Consumption Diesel Fuel Gallons	Daily Consumption Gasoline Gallons	Yearly Consumption Diesel Fuel Gallons	Yearly Consumption Gasoline Gallons
1	6,100	130	2,150,000	50,000
2	4,500	140	1,600,000	60,000
3	4,500	150	1,400,000	50,000
4-32	4,000	125	1,340,000	33,000

Overall fuel consumption during the reclamation phase would be about 4,640,000 gallons for diesel fuel and 150,000 gallons for gasoline.

Electric Service - Annual electrical consumption is estimated to be 7,800,000, 43,000,000 and 90,000,000 kilowatt-hours (kWh) during the three year construction phase. Power consumption is estimated to be 176 million kWh per year during the operations phase. Electric demand levels are projected to be 23.25 MW for average demand and 29.63 MW for peak demand when the mine is at full production. Itemized demand estimates for the various facilities are shown in Table 1-26.

Table 1-26
Electrical Demand

	Average Demand (MW)	Peak Demand (MW)
Mine	6.390	8.480
Mill	10.890	14.210
Water Treatment	1.900	1.900
Services Building	1.600	2.000
Miscellaneous	.350	.350
Total	21.130	26.940
w/10% Contingency	23.250	29.634

Natural Gas Service - Annual natural gas consumption for the second and third project years (construction phase) would be 1,700,000 and 1,800,000 standard cubic feet (scf), respectively. About 165 million scf of natural gas would be used yearly when the project is in full production. The maximum instantaneous demand is projected to be about 88,000 scf per hour. The projected yearly consumption of natural gas for specific uses is shown in Table 1-27.

Table 1-27
Natural Gas Consumption

Mine Air Heating	73.3 million scf
Building Heating	38.9 million scf
Water Heating	9.2 million scf
Water Treatment System	43.8 million scf
TOTAL	165.2 million scf

CHAPTER TWO
AFFECTED ENVIRONMENT

The following terms are used to refer to the study areas relative to the orebody.

Project Site - area within a two mile radius of the orebody; and
Environmental Study Area - area within a five mile radius of the orebody.

The actual study areas for groundwater, wetlands, archeological sites, air quality, and the other disciplines generally fall within the environmental study area. Two exceptions include surface water monitoring of the Wolf River and small portions of the groundwater study area near Pickerel Lake. The socioeconomic study area (see Figure 2-13) and the corridors for the natural gas and electric transmission line are outside the environmental study area. In addition, Exxon consultants examined potential tailings disposal sites up to 25 miles from the orebody.

PHYSICAL AND BIOLOGICAL ENVIRONMENT

TOPOGRAPHY

Introduction

The landforms and topographic patterns in the environmental study area are influenced by the bedrock and glacial materials (Figure 2-1). The irregular surface of the bedrock and the variable thickness of the glacial deposits results in moderate to low relief. Dominant surface features are drumlins, moraines, outwash plains, kettle holes and glacial lakebeds. The landscape is characterized by forested rolling hills and a mosaic of wetlands and lakes.

At the project site, elevations vary between 1,540 and 1,750 feet above mean sea level (MSL). The higher areas are drumlins located adjacent to Hemlock Creek near the MWDF and southwest of the mine/mill site between Oak Lake and Little Sand Lake. The lowest area, an old glacial lakebed, lies between the mine/mill site and Oak Lake. Overall relief is greater than 200 feet but individual landforms do not exceed 120 feet in height. The landscape appears as a series of southwest-northeast trending ridges and valleys.

Mine/Mill

The mine/mill site lies between 1,620 feet in the northeast and 1,695 feet in the south central part. The ground surface is variable with slopes ranging from nearly level to 25%. About half the area has less than six percent slopes. A topographic divide runs through the site with surface water on the north draining to Swamp Creek and on the south draining to Little Sand Lake and eventually to Pickerel Creek.

MWDF

The MWDF site lies between 1,620 feet in the southwest and 1,750 feet in the northeast. Ground features are variable, ranging from depressional to features with slopes greater than 25%. More than two-thirds of the area has less than six percent slopes. Slope direction is variable but surface water primarily drains into Duck Lake and Deep Hole Lake.

SOILS

Mineral soils cover about 85% of the project site. The most common mineral soil series are the Iron River Stony Loam and the Monico Stony Loam soil with smaller areas of Worchester Loam, Cable Stony Silt Loam, and Padus Loam. These soils also are found along the proposed electric transmission line corridor. The soils range from well drained to poorly drained and are formed in silt loams and loams over sandy loam till or sand and gravel. Slopes range from nearly level (1% to 3%) to steep (25% to 45%). These soils are commonly covered by tree species such as sugar maple, aspen, yellow birch, red maple, white ash, and American basswood. There are no prime agricultural lands located at the project site or along the access road, rail spur or electric transmission line corridor.

Organic soils occupy the remaining 15% of the project site. The dominant organic soil series is the Greenwood Peat, Lupton Muck, and Cathro Muck. These soils formed from decayed marsh and bog vegetation in depressions, low lying areas or along stream courses and are generally flat or very gently sloping. They support a limited variety of plant species and are often covered by black spruce and tamarack. The organic soils are corrosive to steel and have severe limitations for construction of roads and buildings due to wetness, frost action, and low bearing strength.

GEOLOGY

Regional Bedrock Geology

As in most of Wisconsin, the bedrock in this region is covered by glacial deposits of Pleistocene Age (1 million to 10,000 years before present). Determining the characteristics of the bedrock, therefore, is difficult because of the limited number of bedrock outcrops. Techniques ranging from drilling programs to obtain rock samples to sophisticated aerial surveys are required to determine the extent and variety of the bedrock. Results from these various techniques indicate the orebody is located in a belt of predominately metamorphic volcanic and sedimentary rocks. This belt is about 60 miles wide and extends from the Pembine area in Marinette County to Ladysmith in Rusk County. In addition to the Crandon deposit, the Ladysmith (Kennecott), Pelican River (Noranda), and several other mineral deposits have been discovered in this belt. At present, the region is seismically stable but the region underwent dynamic metamorphism (mountain building) about 1.8 billion years ago (middle Precambrian). During the mountain building period the rocks were tilted to their present near-vertical position.

Project Site Bedrock Geology

Bedrock at the site was formed during two distinct volcanic cycles. The rocks deposited during each of these cycles are divided into formations based upon structural, chemical or physical characteristics. The formations were laid horizontally initially but were tilted to a near vertical orientation by subsequent folding during mountain building. These formations roughly trend east-west with the original top surface of the formations now facing north. Two of the formations, the Sand Lake Formation and the Crandon Formation, contain economically attractive quantities of metal.

To provide a simplified frame of reference, bedrock at the site is divided into three categories: hanging wall, Crandon Formation, and footwall rock. The massive ore is contained within the Crandon Formation. Everything beneath (that is to the south due to tilting) the Crandon Formation is called footwall. The footwall is composed of volcanic ash and breccia and contains the stringer ore. Everything above (or to the north of) the Crandon Formation is called hanging wall. The hanging wall is composed of a wide variety of fine to coarse volcanic rocks, including lava flows. There is no ore in the hanging wall.

The orebearing deposits were formed on an ocean floor some 1.8 billion years ago. A hot spot deep within the earth's crust resulted in the development of a volcanic system. Violent explosions beneath the surface of the ocean shattered the ocean floor rock creating fractures and depositing volcanic breccias. Hot metal-bearing fluids moved upward into the porous breccias and fractured rock depositing copper, zinc, and iron-bearing minerals to form what is now called stringer ore. Some of these hot fluids, called brines, passed through the fractured rock and, being denser than sea water, pooled in depressions on the ocean floor. As the brines, rich in sulfur, iron, zinc, copper, and lead, mixed with the cool sea water, fine grained minerals of iron sulfide (pyrite), zinc sulfide (sphalerite), copper sulfide (chalcopyrite), and lead sulfide (galena) were deposited on the ocean floor. These precipitates accumulated over time to form the massive ore. The stringer and massive ores were eventually covered with a thick blanket of volcanic rock.

About 1.8 billion years ago, northern Wisconsin, Michigan, and Minnesota were involved in the previously mentioned mountain building episode. Rocks in the project site were tipped up on edge by these mountain building processes. Over the past 1.8 billion years, the mountains created during the dynamic metamorphism were leveled by erosion to the relatively flat topography seen today. During the past 70,000 years, several glacial advances stripped away weathered rock and soil and deposited the layers of silt, sand, and gravel creating the now familiar glacial topography.

Orebody Description - The zinc-rich massive ore is a 4,200 feet long tabular-shaped body of variable thickness (0-200 feet) which extends from the bedrock surface to 1,800 feet below the bedrock surface. Sulfides comprise about 70% of the massive ore by volume with iron sulfide being the most abundant. The ore contains economic quantities of zinc sulfide, copper sulfide, and lead sulfide. The nonsulfide portion of the massive ore is mostly quartz and chlorite with minor amounts of silver and gold. By comparison, the stringer ore consists of veinlets of quartz-copper sulfide-iron sulfide cross-cutting the host rock (breccias) of the Sand Lake Formation. The stringer ore underlies the western half of the massive sulfide orebody and is erratic and discontinuous in distribution. Most of the stringer ore is adjacent to or within 100 feet of the massive ore, but in some areas the two ore types are separated by as much as 400 feet of non-mineralized footwall rock. The stringer orebody parallels the massive ore and is 4,600 feet long, 2,300 feet deep, and 0-100 feet thick. Pyrite is the most common sulfide mineral while copper sulfide is the main economic mineral in the stringer ore. Zinc sulfide also is present. The ore grades and reserves are listed in Table 2-1.

Table 2-1
Ore Reserves and Metal Content of the Orebody

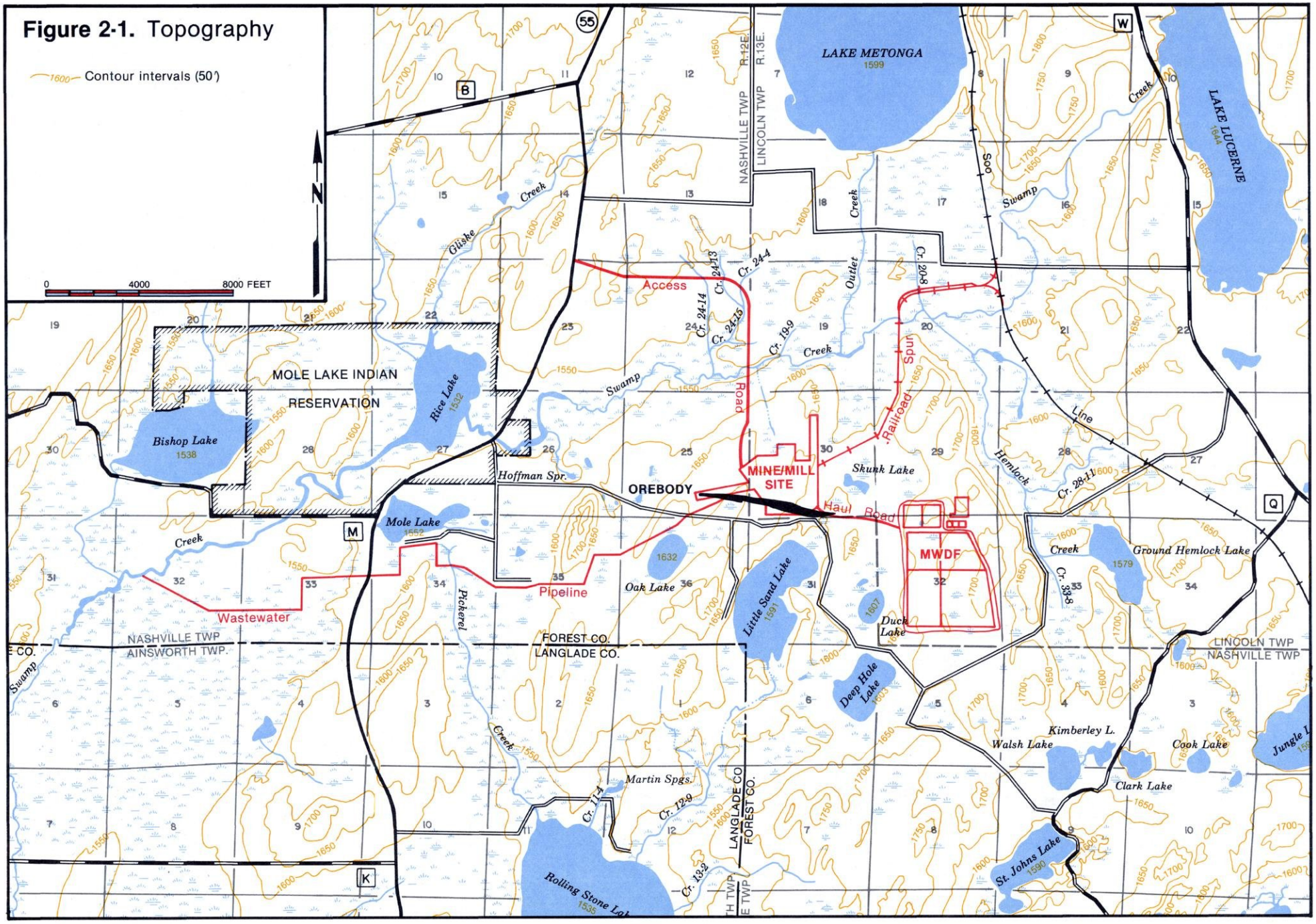
	Tons	Zinc %	Copper %	Lead %	Silver g/ton	Gold g/ton
Massive Ore	42,900,000	8.4	0.6	0.7	52.6	1.4
Stringer Ore	24,500,000	0.7	1.8	0.03	10.0	0.3

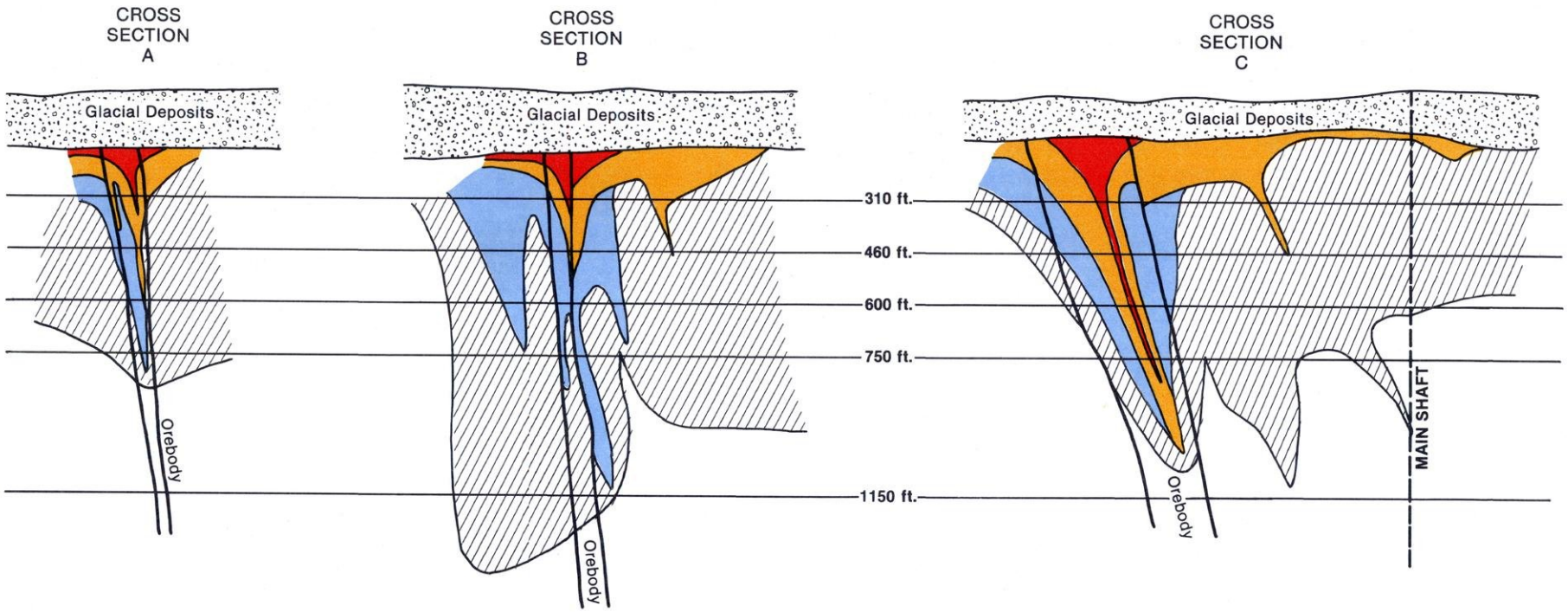
Bedrock Weathering - Weathering refers to the processes causing the physical and chemical disintegration of rock (Figure 2-2.). Variability in bedrock weathering, structural trends (faults and fractures), and bedrock drainage patterns produced the existing irregular bedrock surface (knobs, depressions, ridges, and valleys). These features are buried beneath the glacial deposits, but the cross sections in Figure 2-3 of the Glacial Geology section provide an idea of the bedrock topography.

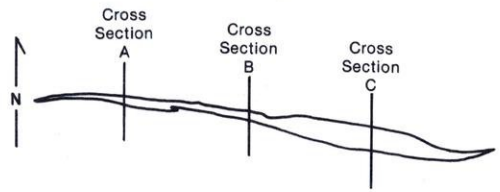
The type and degree of bedrock weathering would influence groundwater inflow into the mine. This inflow, in turn, could influence lake and stream levels. As noted earlier, bedrock at the site has been subjected to continuous weathering since Precambrian time. The degree of weathering, however, varies between the footwall, orebearing formations, and hanging wall due mainly to varying rock chemistry. The Crandon Formation contains a high percentage of easily weathered sulfide minerals and as a result is more deeply weathered than either the footwall or the hanging wall. The top of the Crandon Formation is highly oxidized resulting in a very permeable interface between the glacial aquifer and the upper portions of the proposed mine. Beneath this highly weathered zone, a weathering "spike" along the hanging wall extends the length of the formation and in some places may penetrate below the proposed 750 foot main level drift. In general, the footwall and hanging wall are only moderately to weakly weathered except near their contacts with the Crandon Formation.

Percolating groundwater has been the primary bedrock weathering agent at the project site with oxidation, leaching, and argillization the main processes. As a result of argillization, a process of replacement or alteration of certain minerals to form clay minerals, the strength of the bedrock has been reduced. Bedrock permeability, however, generally remains low because the weathering pores and fractures have been plugged by the residual clays. By comparison, oxidation and leaching reduce rock strength and, depending on the degree of weathering, may have significantly increased permeability. Bedrock permeability, therefore, is highly variable and is dependent upon the type and extent of weathering processes occurring in the rock.

Complicating factors in estimating water movement through bedrock is defining the type and permeability of the overlying glacial deposits. These two factors would influence the amount of water flowing into the mine and are discussed in the glacial geology and groundwater sections, respectively.


Figure 2-1. Topography
1600 Contour intervals (50')
N
0 4000 8000 FEET
LAKE METONGA
1599
LAKE LUCERNE
1644
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
MOLE LAKE INDIAN
RESERVATION
Bishop Lake
1538
Rice Lake
1532
Mole Lake
1552
Hoffman Spr.
Gliske Creek
Swamp
Creek
Access
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Road
Outlet
Cr. 208
Spur
Railroad
MINE/MILL
SITE
OREBODY
Haul Road
Skunk Lake
Hemlock Line
Cr. 28-11
MWDF
Ground Hemlock Lake
1579
Cr. 33-8
Duck Lake
1607
Little Sand Lake
1591
Oak Lake
1632
Pipeline
Wastewater
Pickerel Creek
NASHVILLE TWP
AINSWORTH TWP.
FOREST CO.
LANGLADE CO.
LINCOLN TWP
NASHVILLE TWP
Deep Hole Lake
1603
Kimberley L.
Walsh Lake
Cook Lake
Clark Lake
Jungle L
Martin Spgs.
Cr. 11-4
Cr. 12-9
Cr. 13-2
Rolling Stone Lake
1535
St. Johns Lake
1590
LANGLADE CO
FOREST CO.
B
M
K
Q
W
55





WEATHERING INTENSITY RATING

STRONG:	Strong development of two or more of the destructive processes. Rocks will have very low compressive strengths, and workings would have to be supported at all times.
MODERATE:	Strong development of one of the destructive processes (or moderate development of two) and weak to moderate development of at least one more. Mine workings may need to be supported depending upon the active destructive processes.
LOW:	Moderate leaching with only minor other effects. The compressive strength of rock is not seriously reduced.
WEAK:	Weak development of leaching and/or oxidization. Rock strengths are not affected.

Figure 2-2. Bedrock Weathering

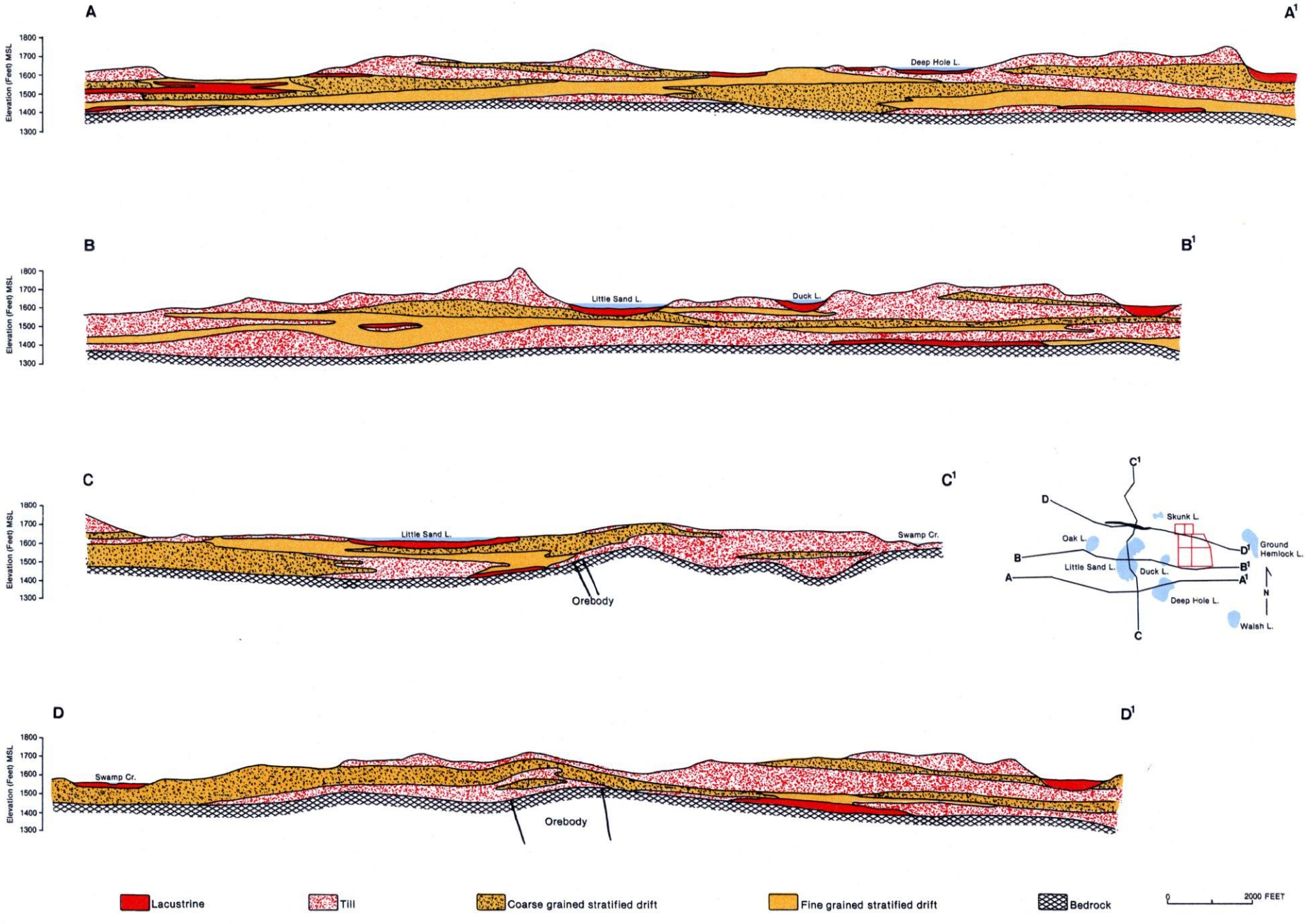


Figure 2-3. Glacial Deposit Stratigraphy

Asbestiform Minerals - In order to determine the presence of asbestiform minerals in the Crandon deposit, 66 thin sections were prepared from 14 drill cores intersecting representative portions of the orebody and adjacent host rocks. Asbestiform minerals were not observed in the thin sections. Moreover, asbestiform minerals would not be expected because the intermediate grade of metamorphorism present does not favor their formation.

Radiological Studies - The radiological properties of the ore were examined using a variety of techniques. Composite samples from the massive and stringer ores were analyzed in 1977 and 1978 and another set studied in 1980 and 1981. A beta-gamma survey was conducted in 1980 on 2,000 feet of cores obtained from the upper portions of the orebody. All the studies indicate radioactivity in the deposit is below or within the normal range for these rock types and is not significantly different from background levels. The radioactivity of the footwall and hanging wall rocks is similar to the orebody but lower than the granitic sample obtained from an outcrop near Jennings, Wisconsin.

Further, the geology and geochemistry of the orebody are such that elevated levels of radioactive materials would not be expected. While uranium enrichment does occur in the Lake Superior region, such occurrences are in geologic settings which are distinctly different than that of the project area.

Glacial Geology

Glaciers advanced and retreated over the environmental study area several times creating a complex and diverse geological environment. The lower glacial deposits can be generally described as sporadically occurring basal tills over bedrock. In turn, the basal tills are overlain by coarse and fine-grained glacial outwash (drift) of varying thickness. An additional layer of till covers the outwash, particularly in upland areas, such as at the MWDF site. Under the lakes and within the outwash and till deposits, layers of clays and silts associated with old glacial lakes can be found. The glacial deposits vary from 50 feet to 350 feet in thickness. Geologic cross sections through the site show the distribution of the various glacial deposits (Figure 2-3).

An understanding of the permeability, thickness and pollutant attenuating capacity, of the glacial deposits is important when evaluating potential project impacts. Additional information about the permeability and thickness of the glacial deposits is discussed in the following groundwater section. Pollutant attenuating capacity is addressed in Chapter Three.

GROUNDWATER

Study Area

The 20 square mile groundwater study area (see Figure 3-2) was selected because it represents a bounded system; precipitation entering recharge areas flows through the system and discharges at points along the study area boundary. Negligible amounts of groundwater flow outside the groundwater study area boundaries. The only exception is a small area southeast of the MWDF, between Ground Hemlock Lake and St. John's Lake, where the groundwater flow is parallel to the boundary. In total, 141 borings and 228 piezometers were installed to determine groundwater elevations, flow path, and water quality.

Hydrogeology

The key hydrogeologic (groundwater) processes discussed in the following sections are recharge, groundwater flow, and discharge. Water percolating through the glacial deposits recharges the aquifer, flows through the system, and eventually reaches discharge areas (lakes, springs, wetlands or streams). These three processes are discussed in greater detail here and in Chapter Three because of the potential impacts of the proposed project. These processes are discussed in the Surface Water write up (page 62).

Groundwater Recharge - Recharge comes in the form of rain, snow, and other forms of atmospheric precipitation which percolates through the soil. Recharge occurs throughout the hydrogeologic study area, except at discharge zones, but the area of greatest concern is centered around Little Sand Lake, Duck Lake, and Deep Hole Lake. The average recharge rate in the study area is between five and ten inches a year with recharge rates highest where the highly permeable outwash is on the surface. Perched lakes and wetlands are constant but minor sources of recharge. Perched lakes (e.g. Oak Lake) are separated from the regional water table by a zone of unsaturated soil. In contrast, seepage lakes (e.g. Little Sand Lake) are connected to the regional water table by a zone of saturated soils (see Figure 2-6). Groundwater "mounds" are common under this type of lake. Thus water levels in seepage lakes and wetlands are controlled by the permeability and thickness of the underlying lacustrine deposits, the depth of water in the lake or wetland, and the elevation difference between the lake water surface and the regional groundwater level. Increasing deposit permeability, decreasing deposit thickness, or increasing the elevational difference between the lake water surface and the groundwater table all tend to increase lake seepage rates. The interactions of these factors with groundwater drawdown are discussed in Chapter Three in the Lakes Impact section.

Groundwater Elevation and Flow - The nature and distribution of the geological deposits and topography affect the depth and movement of groundwater. The regional water table is plotted in Figure 2-4. Points of equal groundwater elevation are connected to form groundwater contour lines. The slope of the water table is called the hydraulic gradient. The steeper the slope (i.e. the closer the contour lines are together) the greater the hydraulic gradient (pressure) driving the water toward the discharge points. Water flows at right angles to the groundwater contour lines.

The glacial deposits are the primary medium for groundwater flow in the study area. Till deposits at the project site are extensive and have a wide range of particle sizes and permeabilities. Outwash, unlike the till, was washed and sifted by glacial meltwaters thus leaving sandy deposits with high permeability. These highly permeable outwash deposits range from 0 to 250 feet in thickness and are found throughout the study area. Outwash is particularly abundant to the south of Little Sand Lake. In contrast, the lenses of lacustrine silts or clays beneath the lakes and scattered within the outwash and till deposits have very low permeabilities which impede the movement of water. The presence of these lacustrine deposits maintains lake levels above the level of the regional groundwater table. Note in Figure 2-3 how the various glacial deposits, particularly the coarse and fine grained stratified drift (outwash), pinch out or thicken in the different cross sections. Determining the precise direction and velocity of groundwater flow in such a complex geologic environment is very difficult.

Groundwater flow occurs predominantly in the well sorted, coarse grained outwash; even where the deposit is thin. Where the outwash is absent, the majority of the groundwater flow is through the less permeable till deposits. Permeability tests and the local hydraulic gradient indicate groundwater may move through outwash deposits at a rate of 0.25 to 1.4 feet per day while the rate of movement in till is 0.025 to 0.14 feet per day or less. The till deposits have lower permeabilities because of greater quantities of silt-sized particles and smaller pore sizes than the outwash. The lowest permeabilities occur in the lenses of glacial lake sediments (silts and clays) found underneath several of the lakes. The glacial deposits are usually more permeable than the underlying unweathered or slightly weathered bedrock.

Groundwater flow in the bedrock is primarily limited to highly weathered zones near the bedrock surface (see Figure 2-2). The conductivity of these zones, especially within the orebody, approach those of the glacial materials. Outside of the weathered zones, flow is restricted to bedrock fractures. In general, groundwater flow through bedrock is insignificant compared to flow in the glacial materials.

Groundwater Discharge - The discharge zones (lakes, streams, springs, and wetlands) form part of the surface water system in the environmental study area. The groundwater discharge boundary consists of Hemlock Creek, Swamp Creek, Rice Lake, Mole Lake, Upper Pickerel Creek (upstream from Rolling Stone Lake), Rolling Stone Lake, Pickerel Creek (downstream from Rolling Stone Lake), and Pickerel Lake. Hoffman Springs, Martin Springs, Creek 12-9, Creek 11-4, and the wetland area northeast of Rolling Stone Lake are discharge points within the hydrogeologic study area.

Glacial Aquifer Water Quality

This aquifer presently provides drinking water to residents around the recharge area lakes and at the Mole Lake Reservation. The wells sampled to determine groundwater quality are shown in Figure 2-5. Groundwater within the aquifer with the exception of a few isolated values for cadmium, lead, and nitrate have met the applicable U.S. EPA drinking and municipal water supply standards. One cadmium, one lead, and two nitrate concentrations collected from different piezometers at different times exceeded the standards (Table 2-2). Approximately 50-60% of the groundwater samples had iron and manganese samples in excess of the secondary standard. Weathering of sulfide minerals or iron and manganese oxides/hydroxides is the probable source of the high iron, manganese, cadmium and lead values in the groundwater.

Groundwater quality in the glacial aquifer tends to change as water flows from the recharge to the discharge areas. The mean laboratory alkalinity, calcium, and hardness concentrations are highest near the Little Sand Lake, Duck Lake and Deep Hole Lake recharge area. These concentrations drop as groundwater flows towards discharge areas. This trend is the result of two occurrences: the thicker, unsaturated zone in the central recharge area allows longer contact between percolating water, and the tills in the central recharge area have a higher calcium carbonate content. Closer to the discharge areas, recharge water percolates rapidly through the highly permeable outwash and thin, low carbonate soils, thus diluting the groundwater flowing from the central recharge area.

Table 2-2
Groundwater Quality for the Glacial Aquifer in the Environmental Study Area

Parameter	Units	Range	Mean (x)	Standard Deviation (S)	Number of Samples	U.S./EPA Drinking Water Standards Primary	Secondary
Field temperature[1]	°F	37 - 54	45	3.2	220	-	-
Total lab. alkalinity	ppm $CaCO_3$	14 - 453	123.0	50	234	-	-
Total field alkalinity	ppm $CaCO_3$	11 - 487	127.0	53	221	-	-
Specific conductance	umhos/cm	50 - 1,300	237	107	235	-	-
Field conductivity	umhos/cm	29 - 1,150	178	92	218	-	-
Laboratory pH	standard units	6.1 - 11.0	7.6[2]	0.69	204	-	6.5 - 8.5
Field pH	standard units	5.5 - 12.2	7.7[2]	1.0	222	-	6.5 - 8.5
Total hardness	ppm $CaCO_3$	16 - 452	125.0	53	236	-	-
Total dissolved solids	ppm	14 - 836	166.0	84	235	-	500.0
COD[3]	ppm	<1 - 365[1]	<29.0	<56.0	143	-	-
Total phosphorus	ppm	<0.01 - 0.84	<0.06	<0.10	135	-	-
Anions:							
Arsenic	ppm	<0.001 - 0.004	<0.001	<0.001	236	0.5	-
Chloride	ppm	<1 - 78	<4.0	<10.0	236	-	250.0
Cyanide, total	ppm	<0.001 - 0.004	<0.001	<0.001	236	-	-
Fluoride	ppm	<0.12 - 0.57	<0.20	<0.09	142	1.4-2.4	-
Nitrate	ppm	<0.01 - 11.0	<.37	<1.04	235	10.0	-
Phosphate	ppm	<0.01 - 0.31	<0.06	<0.06	101	-	-
Sulfate	ppm	<1 - 86	<9.0	<9.0	232	-	250.0
Cations:							
Aluminum	ppm	<0.01 - 9.09	<0.53	<1.12	169	-	-
Barium	ppm	<0.01 - 0.24	<0.02	<0.03	142	1.0	-
Cadmium	ppm	<0.001 - 0.015	<0.002	<0.002	169	0.01	-
Calcium	ppm	4.9 - 92.4	29.8	12.6	94	-	-
Chromium, total	ppm	<0.001 - 0.021	<0.002	<0.003	169	0.05	-
Cobalt	ppm	<0.01	<0.01	0	169	-	-
Copper	ppm	<0.001 - 0.09	<0.007	<0.011	232	-	1.0
Iron	ppm	<0.01 - 38.9	<1.74	<4.34	236	-	0.3
Lead	ppm	<0.01 - 0.10	<0.01	<0.01	235	0.05	-

Table 2-2 (continued)
Groundwater Quality for the Glacial Aquifer in the Environmental Study Area

Parameter	Units	Range	Mean (x)	Standard Deviation (S)	Number of Samples	U.S./EPA Drinking Water Standards Primary	Secondary
Magnesium	ppm	<0.279 - 29.6	12.0	5.12	169	-	-
Manganese	ppm	0.001 - 10.2	0.423	0.989	236	-	0.05
Mercury	ppm	<0.0001 - 0.0010	<0.0001	<0.0001	169	0.002	-
Molybdenum	ppm	<0.01 - 0.03	<0.01	<0.01	169	-	-
Nickel	ppm	<0.01 - 0.04	<0.01	<0.01	169	-	-
Selenium	ppm	<0.001 - 0.001	<0.001	0	142	0.01	-
Silver	ppm	<0.001	<0.001	0	142	0.05	-
Zinc	ppm	<0.001 - 2.60	<0.052	<0.214	235	-	5.0

[1] Reflects seasonal temperature variation.
[2] Geometric mean of the negative log $[H^+]$.
[3] COD = Chemical oxygen demand
< indicates less than

Bedrock Water Quality

Results of water quality analysis for groundwater samples obtained from deep exploration boreholes in bedrock are summarized in Table 2-3 (Figure 2-5). These results indicate groundwater quality varies with depth and location within the bedrock. Two "types" of bedrock groundwater quality can be differentiated by comparing alkalinity, hardness, pH, and total dissolved solids values. From the bedrock surface (approximate elevation 1450 feet above MSL) to a depth of about 200 feet above MSL, the groundwater quality characteristics are similar to those of the overlying glacial aquifer. This indicates flow between the glacial aquifer and the upper weathered bedrock. Below this zone groundwater chemistry changes indicate limited flow occurs between the upper and lower bedrock areas.

Table 2-3
Results of Chemical Analyses of Bedrock Groundwater Samples Near the Orebody[1]

Bore-Hole No.	Zones[2] (feet)	pH	Total Laboratory Alkalinity (ppm $CaCO_3$)	Non-Total Hardness (ppm $CaCO_3$)	Total carbonate[3] Hardness (ppm $CaCO_3$)	Dissolved Solids (ppm)	Specific Conductance (umhos/cm)	Chloride (ppm)	Magnesium (ppm)	Calcium (ppm)	Sodium (ppm)	Salinity[4]
66	402-1078	8.1	142	175	33	198	289	2	19.3	38.6	-	0.0036
70	552-1334	8.0	160	194	34	170	312	8	23.4	39.1	-	0.0145
70c	552-1334	8.0	160	194	34	178	310	8	23.4	39.2	-	0.0145
70	302-1334	7.8	156	193	37	188	295	6	22.8	39.5	-	0.0108
77	602-1049	7.8	134	170	35	170	298	20	20.5	34.6	-	0.0361
91	852-1415	8.1	164	196	32	164	313	12	22.0	42.2	-	0.0217
155	362	-	-	-	-	-	-	3700	-	-	-	6.68
155	562	-	-	-	-	-	-	4200	-	-	-	7.59
155	842	-	-	-	-	-	-	4000	-	-	-	7.23
155	942	-	-	-	-	-	-	-	-	-	1670	-
155	942-3050	7.3	80	1532	1452	6112	10000	3600	127	404	-	6.50
155	1042	-	-	-	-	-	-	3300	-	-	-	5.96
155	1370	-	-	-	-	-	-	2900	-	-	-	5.24
155	below 2102	-	-	-	-	-	-	2550	-	-	-	4.61
155	2202-2215	7.4	86	961	875	3524	6500	2200	75.0	261	-	3.97
155	2202-2215	-	-	-	-	-	-	-	-	-	1060	-
155	2710	-	-	-	-	-	-	2100	-	-	-	3.79
155	2712-2725	-	-	-	-	-	-	2250	-	-	-	4.06
165	2300	-	-	-	-	-	-	1900	-	-	-	3.43
165	2920	-	-	-	-	-	-	-	-	-	1090	-
165	2920-2971	5.9	12	1930	1918	5194	7200	2650	185	468	-	4.79
181	-	7.0	48	3036	2988	-	-	4850	221	850	1810	8.76
192	-	7.0	112	3878	3766	-	-	5100	298	1060	2450	9.21
211	-	7.1	128	155	-	144	260	2	16.7	34.6	-	0.0036
211	-	7.1	138	146	-	162	210	12	16.0	27.5	-	0.0216
213	-	7.0	156	127	-	209	310	4	17.0	23.0	-	0.0072
213	-	7.4	156	130	-	215	280	6	15.0	26.6	-	0.0108

[1] Groundwater samples were collected during February and March of 1978, except boreholes 211 and 213 were sampled in 1981.
[2] Depth below ground surface.
[3] Values calculated using presented data.
[4] Salinity calculated as parts per thousand. Standard seawater has a salinity of 35 parts per thousand and a chlorinity of 19.38 parts per thousand.

AFFECTED ENVIRONMENT

SURFACE WATER

Hydrologic Cycle

The hydrologic cycle is the circulation and storage of water in various forms throughout the environment (Figure 2-6). A brief description of these hydrologic processes will help the reader to better understand the potential impacts of groundwater drawdown on lakes and streams discussed in Chapter Three.

Evaporated water, called evapotranspiration, rises from the earth's surface (e.g., plants, soils, wetlands, and lakes) into the atmosphere. This moisture condenses into water droplets to form clouds and eventually returns to earth as precipitation. Precipitation that infiltrates the soil is called recharge and enters the groundwater flow system. Runoff is precipitation that moves across the ground surface to lakes, streams, and wetlands. The numerous streams and lakes in the environmental study area occur because of the adequate supply of precipitation and the influence of the low permeability lacustrine deposits. An important component of the hydrologic cycle is the hydrogeologic cycle (groundwater) previously discussed in the groundwater section. The groundwater regime, in both the bedrock and glacial materials, is important because of its impact on stream flow and water quality.

The relative contribution of groundwater versus runoff to a lake or stream influences the character of the waterbody. The chemical and physical characteristics of the surface water, in turn, influence the aquatic plant and animal communities. Headwater streams are often very dependent on groundwater contributions for a large portion of their flow. Hoffman Creek is a headwater stream that supports a coldwater fishery (e.g., brook trout). In flat, wide streams, such as Swamp Creek below Rice Lake, groundwater contributions are a smaller proportion of the flow. In addition, the heavy plant growth in the summer, silty bottoms, and less shading from the sun create favorable conditions for a warmwater fishery (e.g., bass and northern pike). Thus, reductions in groundwater flows may have greater impact on headwater streams compared with other stream segments.

Aquatic Chemistry

Various water quality parameters, such as metals, nutrients, pH, alkalinity, and dissolved oxygen, were analyzed to determine the quality of the surface waters. Sediment and fish tissue chemistry tests also were conducted to determine background metal concentrations. An understanding of these background conditions is important when assessing potential impacts or devising mitigation strategies.

The surface water quality and aquatic ecology sampling sites are shown in Figure 2-7.

Metals - Sediment samples were analyzed for the following metals: chromium, arsenic, manganese, zinc, lead, cadmium, copper, mercury, sulfur, and iron. The ranges of metal concentrations generally fall within the limits of the non-polluted sediments based on the EPA classification of Great Lakes harbor sediments. The higher metal concentrations tend to be found in the finer grained stream sediments (silt and clay).

Productivity - Biological productivity of surface waters is frequently directly correlated with total alkalinity (available carbonates, bicarbonates and hydroxides). Many of the lakes in the environmental study area have low total alkalinity and low productivity.

pH - pH is a measurement of the hydrogen ion concentration and thus the acidity (below 7.0) or alkalinity (above 7.0) of a lake or stream. Fish diversity is greatest between pH values of 6.0 and 9.0. As pH increases or decreases outside this range, metal toxicity may become a problem for aquatic organisms. Lakes with bog mats and little or no water exchange (e.g., Skunk Lake) tend to have low natural pH values.

Transparency - The transparency of water is an indicator of clarity as well as the capacity to transmit light. The higher the transparency, the greater the light penetration. As transparency is reduced, the distribution and growth of aquatic plants and biological productivity tends to be reduced. Transparency is directly affected by factors such as the color of water, turbidity caused by suspended particles, and algal blooms.

Color - Water color in lakes and streams found in the environmental study area varies from clear to various shades of brown (stained). Stained water limits light penetration thereby reducing the zone of biological productivity; thus the darker the water the greater the reduction in productivity.

Water Levels

The fluctuations in water levels of Little Sand Lake, Ground Hemlock Lake, Rice Lake, Rolling Stone Lake, Duck Lake, Deep Hole Lake, Oak Lake, and Skunk Lake were monitored on a monthly basis (Figure 2-8). Beaver activity at the outlets of Little Sand Lake, Deep Hole Lake, and Duck Lake has affected water levels on these lakes. The fluctuations in water levels for the lakes are shown in Table 2-4.

Table 2-4
Lake Water Level Fluctuations

Lake (Period of Record)	Highest Level[1] and Date (ft)	Lowest Level[1] and Date (ft)	Range (ft)
Little Sand Lake (4/77 - 11/85)	1592.96 (4/79)	1590.82 (7/77)	2.14
Ground Hemlock Lake	1579.1	1578.5	0.6
Rice Lake	1535.2	1533.0	2.2
Rolling Stone Lake	1535.3	1535.0	0.3
Duck Lake (4/77 - 11/85)	1612.57 (10/85)	1610.23 (7/77)	2.34
Deep Hole Lake	1606.63 (11/85)	1604.96 (7/77)	1.67
Oak Lake	1634.2	1632.1	2.1
Skunk Lake (5/77 - 11/85)	1598.81 (11/85)	1596.48 (10/77)	2.33

[1] Referenced to MSL (mean sea level)

Stream Flows

The water levels of Swamp Creek, Hemlock Creek, Hoffman Creek, Upper Pickerel Creek, Metonga (Outlet) Creek, Wolf River, and Creek 12-9 were monitored (Figure 2-8). Table 2-5 lists several of the stream gauges and associated waterways while Table 2-6 provides estimates of flow duration for a number of the gaging stations. A duration table provides an estimate of the frequency or percent of time a given flow occurs in a stream. For instance, in Table 2-6, the flow in Swamp Creek at SG 1 is equal to or greater than 51 cubic feet per second approximately 50% of the time. At the same location, the flow exceeds 24 cubic feet per second approximately 95% of the time. All of these estimates are based on a correlation of measured discharge at the gaging stations with concurrent discharge for the Wolf River at Langlade. The correlations, however, should be considered provisional and may be revised as more data are collected.

Larger streams, such as Swamp Creek, have a large portion of their annual average flow derived from surface water runoff. By comparison, small streams like Hoffman Creek, Creek 11-4, and upper Pickerel Creek have a flow regime such that most of the annual average flow is from groundwater discharge. Creek 12-9 is also highly groundwater discharge dependent but does receive some influence from surface water runoff. Hoffman Creek, for example, has an approximate base flow of 0.5 cubic feet per second (cfs). The $Q_{7,2}$ ranges between 0.1 cfs and 0.3 cfs while the $Q_{7,10}$ is probably less than 0.2 cubic feet per second. Base flow is a period of time when the entire flow of a stream is attributable to groundwater inputs. The smaller streams have little seasonal fluctuations in flow because of this groundwater input.

Table 2-5
Stream Gaging Stations in the Environmental Study Area

Gaging Stations	Location/Name
Swamp Creek Drainage Basin	
SG 1	Swamp Creek at County K
SG 2	Swamp Creek above Highway 55
SG 3	Swamp Creek at Swampy Lane
SG 4	Metonga Creek at Keith Siding Road
SG 5A	Swamp Creek at Keith Siding Road
SG 5B	Swamp Creek at Railroad Bridge

Table 2-5 (continued)
Stream Gaging Stations in the Environmental Study Area

Gaging Stations	Location/Name
Pickerel Creek Drainage Basin	
SG 6	Hemlock Creek at Berry Lane
SG E	Hoffman Creek
SG 8	Creek 12-9 Immediately South of Little Sand Lake
SG 19	Pickerel Creek northwest of Rolling Stone Lake
SG 23	Creek 12-9 northwest of Rolling Stone Lake
Continuous Gaging Stations	
USGS at Hwy 55	Swamp Creek at Highway 55
USGS at County M	Swamp Creek at County M

Table 2-6
Flow Duration Table for Select Gaging Stations

	Percent of Time Stream Discharge (CFS) Is at or Above Listed Flow							Base Flow		Drainage Area
Station	50%	70%	75%	80%	85%	90%	95%	$Q^{1}_{7,2}$	$Q^{2}_{7,10}$	Square Mile[3]
SG-4	2.0	1.4	1.3	1.2	1.1	1.0	0.8	0.8	0.6	13.6
SG-6	4.8	3.5	3.2	2.9	2.6	2.3	2.0	2.0	1.4	3.5
SG-19	1.4	1.0	1.0	0.9	0.8	0.7	0.6	0.6	0.4	2.46
SG-23	3.8	2.7	2.5	2.2	2.1	1.8	1.5	1.5	1.1	6.0
SG-5A	3.5	2.5	2.3	2.1	1.9	1.7	1.4	1.4	1.0	15.0
SG-3	16.0	12.0	11.0	9.7	8.8	7.8	6.7	6.7	4.7	39.2
USGS[4]	27.0	20.0	18.0	17.0	15.0	13.0	11.0	11.0	8.0	46.2
USGS[5]	41.0	31.0	29.0	27.0	25.0	22.0	19.0	19.0	15.0	56.7
SG-1	51.0	39.0	36.0	33.0	31.0	28.0	24.0	24.0	18.0	76.5

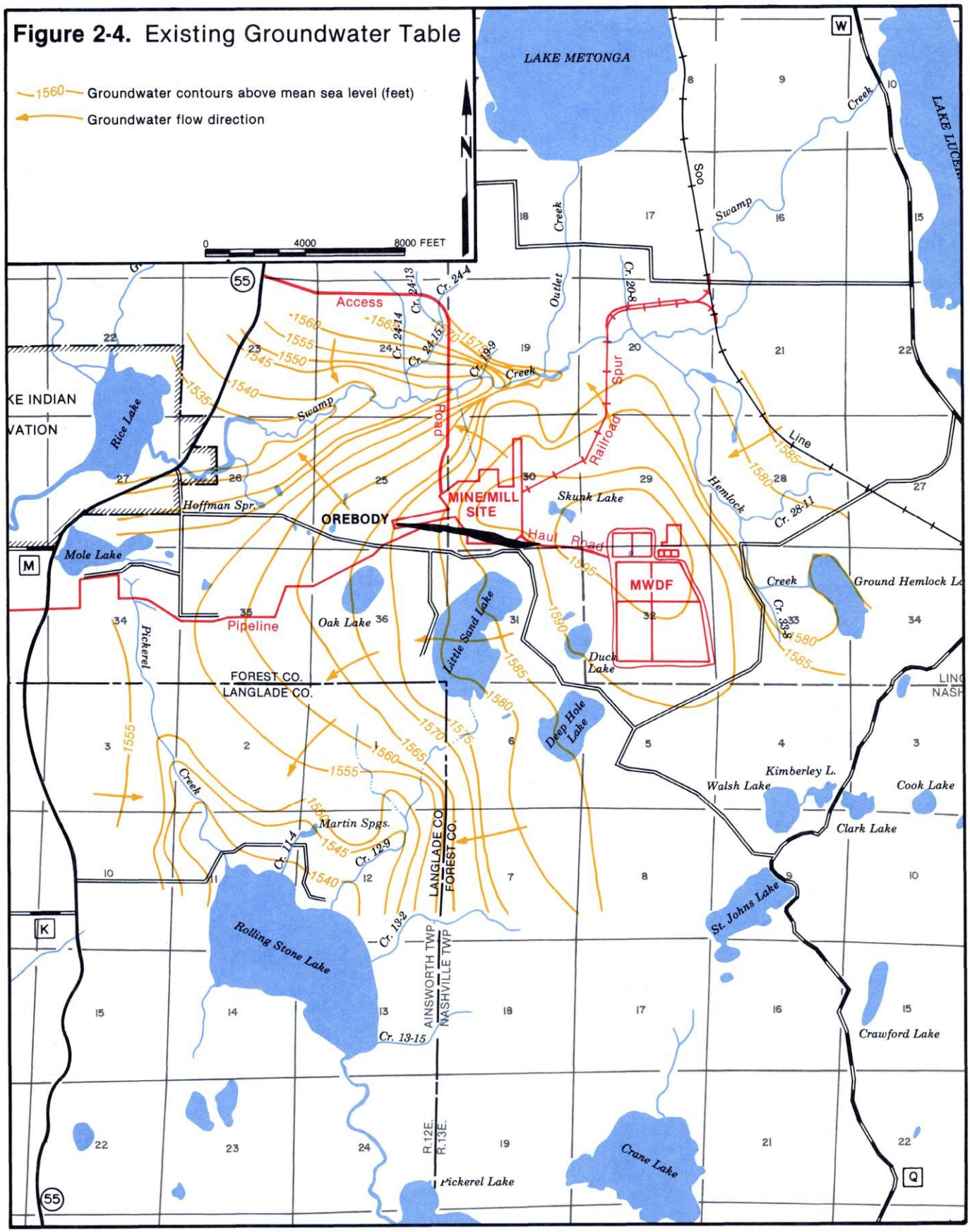
1 $Q_{7,2}$ = average minimum flow in a stream over a seven day period occurring every two years.
2 $Q_{7,10}$ = average minimum flow in a stream over a seven day period occurring every ten years.
3 The drainage area noted is the portion of the watershed upstream of the stream gage.
4 Station at Highway 55.
5 Station at County Trunk Highway M.

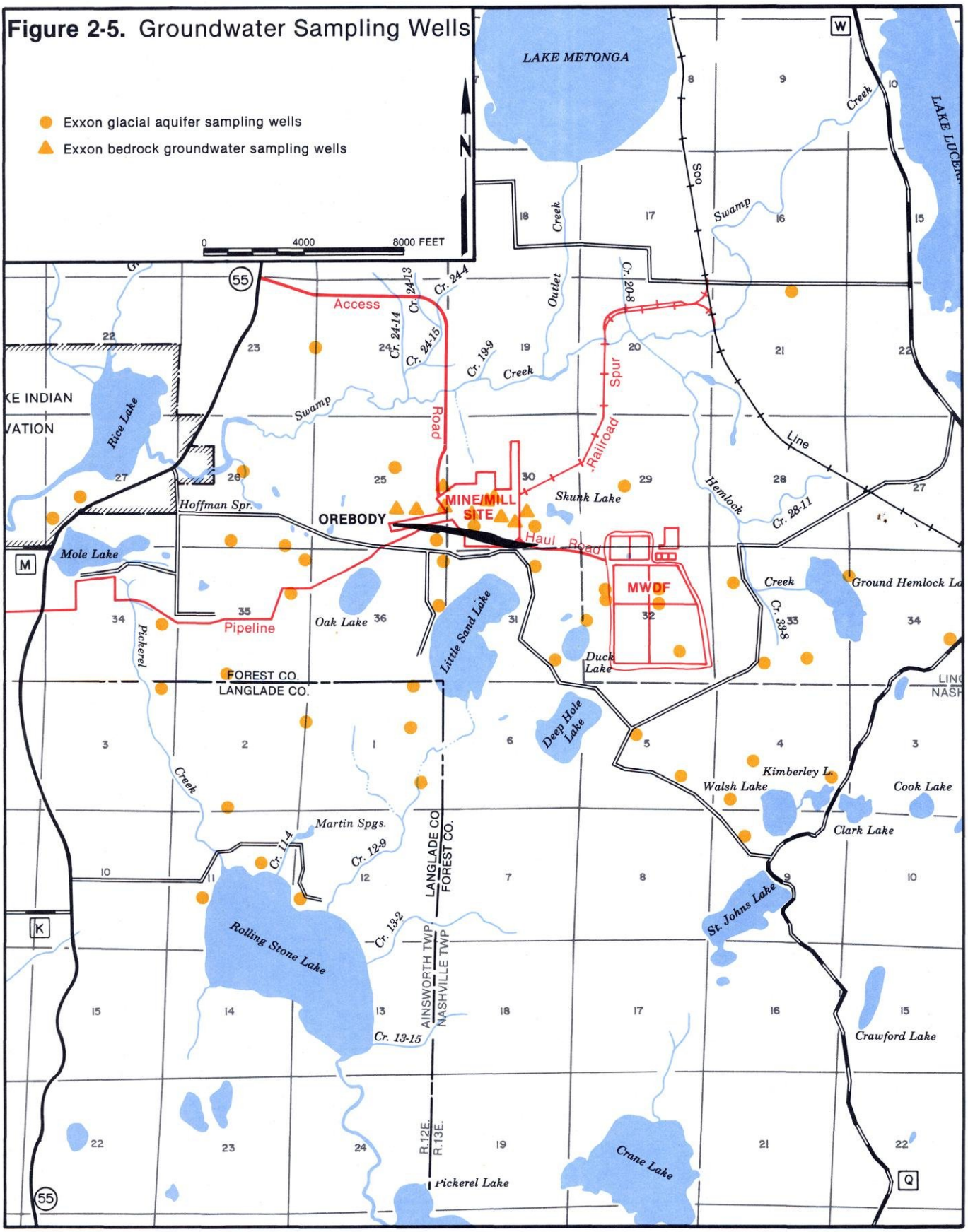
Lake Characteristics

Little Sand Lake - Little Sand Lake is a seepage lake about 0.5 miles south of the orebody. The lake has a surface area of 244 acres and a maximum depth of 21 feet. The effective watershed is 1,867 acres and the shoreline is 90% upland hardwoods with the remainder being wetland. The lake intermittently receives water from Duck and Deep Hole Lakes via an inlet stream on the east shore. An intermittent outlet on the south shore is affected by beaver activity. Little Sand Lake has a warmwater fishery dominated by largemouth bass and panfish, primarily yellow perch. Walleye, northern pike, mudminnow, and Iowa darter are present in low densities.

Little Sand Lake is an unstratified, soft water (mean hardness of 11 ppm (parts per million)), acidic (average pH of 5.4) lake with high transparency. Depth profiles of water quality parameters indicate the lake is generally well mixed during the ice-free period. The deepest parts of the lake, however, weakly stratify during the summer. Metal concentrations in the lake water are either below or slightly above detection limits.

Ground Hemlock Lake - Ground Hemlock Lake is a spring lake about 2.4 miles east of the orebody. The watershed is 0.9 square miles and the shoreline vegetation is 95% upland hardwoods and conifers, and five percent coniferous wetland. The lake has a surface area of 88 acres and a maximum depth of 42 feet. Marl also is present in this lake. The lake outlet forms the headwaters of Hemlock Creek. Ground Hemlock Lake has a diverse warmwater fishery with northern pike, largemouth bass, and walleye being the dominant predators and yellow perch, bluegill, and black crappie being the primary panfish.


Figure 2-4. Existing Groundwater Table
1560 Groundwater contours above mean sea level (feet)
Groundwater flow direction
N
0 4000 8000 FEET
LAKE METONGA
LAKE LUCE
Creek
Soo
Swamp
Outlet
Cr. 20-8
Access
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Spur
Railroad
ROAD
Line
Hemlock
Cr. 28-11
MINE/MILL SITE
OREBODY
Skunk Lake
Haul Road
MWDF
Hoffman Spr.
Rice Lake
Mole Lake
Pipeline
Oak Lake
Little Sand Lake
Duck Lake
Deep Hole Lake
Ground Hemlock Lake
Cr. 33-8
Pickerel
Creek
FOREST CO.
LANGLADE CO.
Martin Spgs.
Cr. 11-4
Cr. 12-9
Cr. 13-2
Cr. 13-15
LANGLADE CO
FOREST CO.
AINSWORTH TWP.
NASHVILLE TWP
Rolling Stone Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Crawford Lake
Crane Lake
Pickerel Lake
R.12E.
R.13E.
KE INDIAN
VATION
1535
1540
1545
1550
1555
1560
1565
1570
1575
1580
1585
1590
1595
W
M
K
Q
55


Figure 2-5. Groundwater Sampling Wells
Exxon glacial aquifer sampling wells
Exxon bedrock groundwater sampling wells
N
0
4000
8000 FEET
LAKE METONGA
LAKE LUCE
Soo
Swamp
Creek
Outlet
Cr. 20-8
Cr. 24-4
Cr. 24-13
Cr. 24-14
Cr. 24-15
Cr. 19-9
Access
Road
Spur
Railroad
Line
Hemlock
Cr. 28-11
Cr. 33-8
Rice Lake
Swamp
Hoffman Spr.
MINE/MILL SITE
OREBODY
Haul Road
Skunk Lake
MWDF
Mole Lake
Oak Lake
Pickerel
Pipeline
Little Sand Lake
Duck Lake
Deep Hole Lake
Ground Hemlock La
Kimberley L.
Walsh Lake
Cook Lake
Clark Lake
St. Johns Lake
Crawford Lake
Crane Lake
Pickerel Lake
Rolling Stone Lake
Martin Spgs.
Cr. 11-4
Cr. 12-9
Cr. 13-2
Cr. 13-15
FOREST CO.
LANGLADE CO.
AINSWORTH TWP.
NASHVILLE TWP.
R.12E.
R.13E.
KE INDIAN
VATION
LING
NASH
W
M
K
Q
55

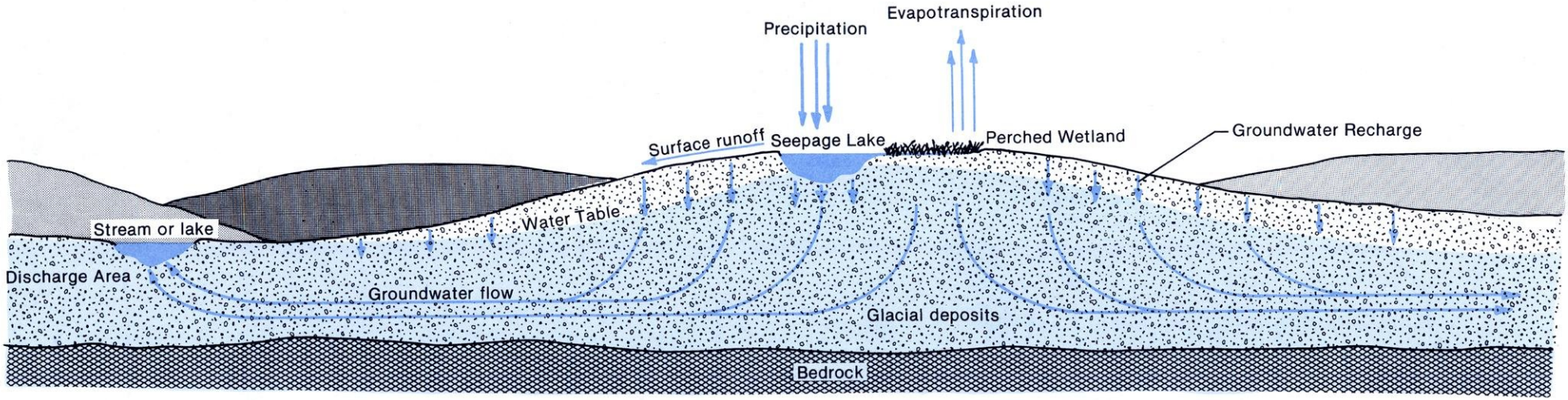
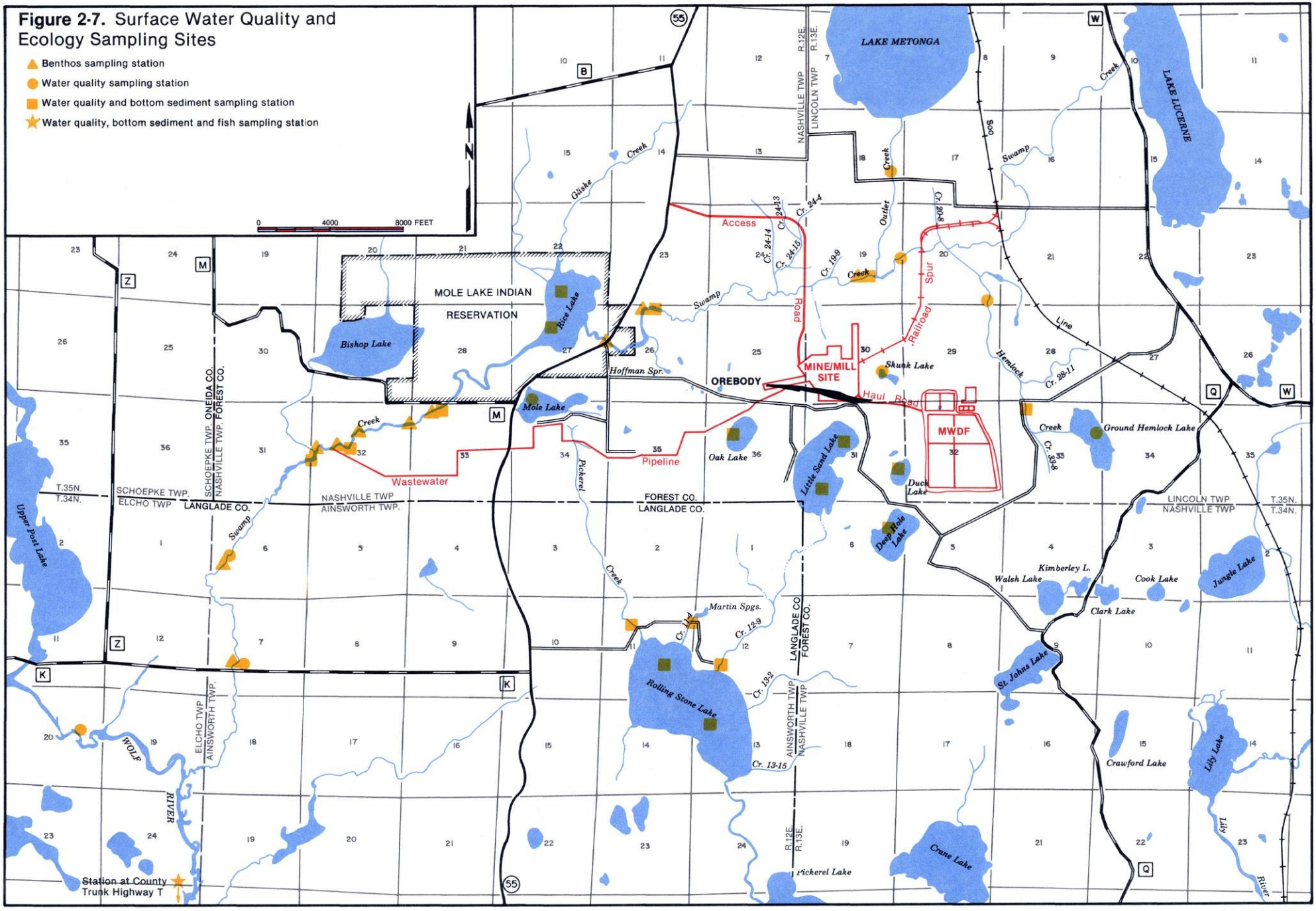
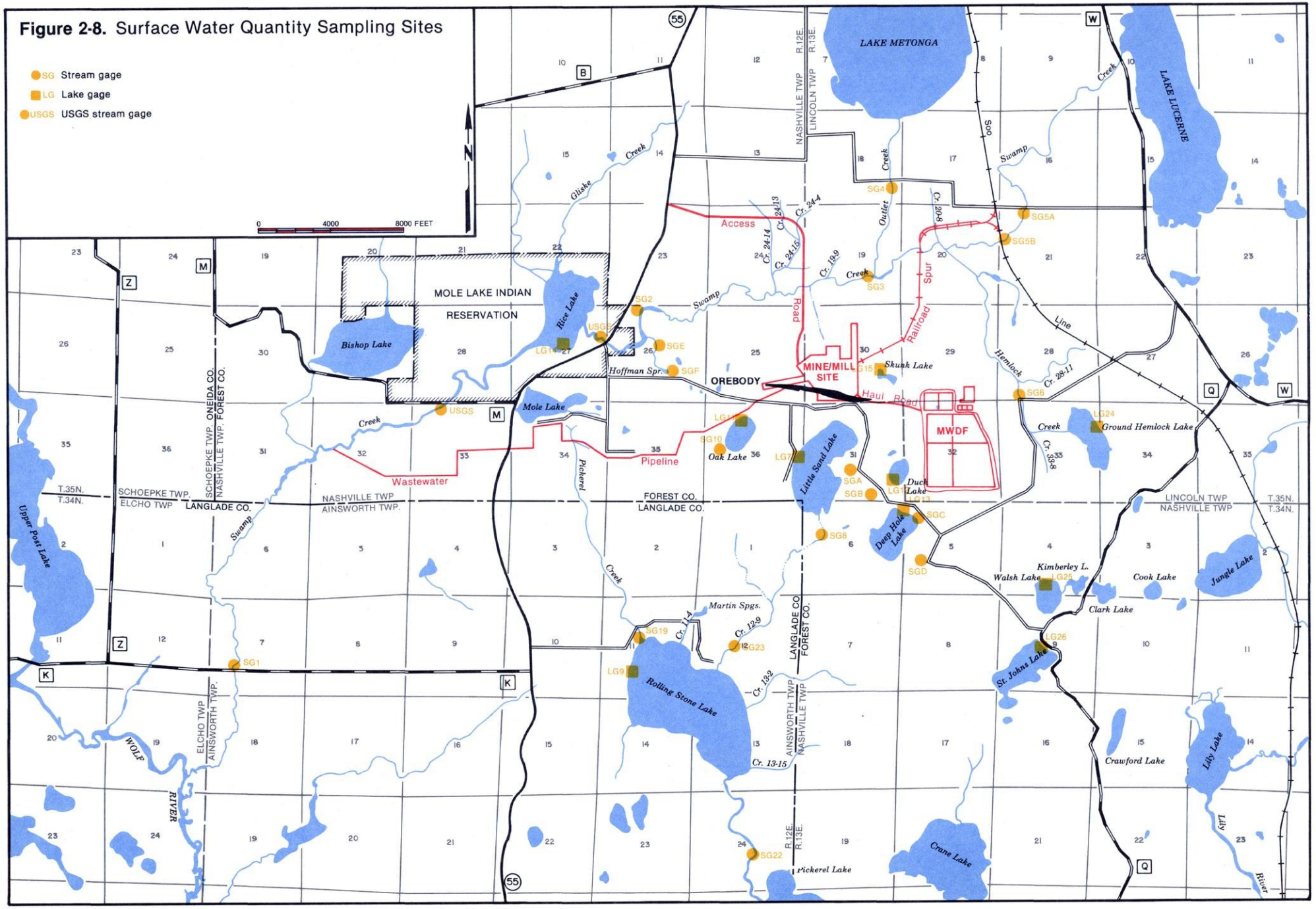


Figure 2-6. Hydrologic Cycle


Figure 2-7. Surface Water Quality and Ecology Sampling Sites
Benthos sampling station
Water quality sampling station
Water quality and bottom sediment sampling station
Water quality, bottom sediment and fish sampling station
N
0 4000 8000 FEET
MOLE LAKE INDIAN RESERVATION
LAKE METONGA
LAKE LUCERNE
Bishop Lake
Rice Lake
Mole Lake
Oak Lake
Skunk Lake
Little Sand Lake
Duck Lake
Deep Hole Lake
Ground Hemlock Lake
Upper Post Lake
Rolling Stone Lake
Walsh Lake
Kimberley L.
Cook Lake
Jungle Lake
Clark Lake
St. Johns Lake
Crawford Lake
Lily Lake
Crane Lake
Pickerel Lake
Martin Spgs.
Hoffman Spr.
Access Road
Haul Road
Railroad Spur
Outlet
Pipeline
Wastewater
MINE/MILL SITE
OREBODY
MWDF
Gitske Creek
Swamp
Creek
Pickerel Creek
Hemlock Line
Soo Line
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 28-8
Cr. 28-11
Cr. 33-8
Cr. 13-4
Cr. 12-9
Cr. 13-2
Cr. 13-15
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
SCHOEPKE TWP.
ONEIDA CO.
NASHVILLE TWP.
FOREST CO.
ELCHO TWP
LANGLADE CO.
AINSWORTH TWP.
T.35N.
T.34N.
WOLF RIVER
Station at County Trunk Highway T


Figure 2-8. Surface Water Quantity Sampling Sites
SG Stream gage
LG Lake gage
USGS USGS stream gage
0 4000 8000 FEET
N
LAKE METONGA
LAKE LUCERNE
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Oak Lake
Little Sand Lake
Deep Hole Lake
Duck Lake
Skunk Lake
Ground Hemlock Lake
Kimberley L.
Walsh Lake
Cook Lake
Jungle Lake
Clark Lake
St. Johns Lake
Crawford Lake
Lily Lake
Rolling Stone Lake
Crane Lake
Upper Post Lake
Pickerel Lake
Martin Spgs.
Gliske Creek
Swamp Creek
Hemlock Creek
Outlet Creek
Pickerel Creek
Wolf River
Lily River
Access Road
Railroad Spur
Line Road
Haul Road
Pipeline
Wastewater
Hoffman Spr.
OREBODY
MINE/MILL SITE
MWDF
Cr. 24-13
Cr. 24-14
Cr. 24-15
Cr. 24-4
Cr. 19-9
Cr. 28-11
Cr. 33-8
Cr. 12-9
Cr. 11-4
Cr. 13-2
Cr. 13-15
SG1
SG2
SG3
SG4
SG5A
SG5B
SG6
SG8
SG10
SG19
SG22
SG23
SGA
SGB
SGC
SGD
SGE
SGF
USGS
LG7
LG9
LG10
LG11
LG13
LG15
LG24
LG25
LG26
NASHVILLE TWP
LINCOLN TWP
SCHOEPKE TWP.
ELCHO TWP
AINSWORTH TWP.
ONEIDA CO.
FOREST CO.
LANGLADE CO.
T.35N.
T.34N.
R.12E.
R.13E.

Ground Hemlock Lake is a stratified, moderately hard water (mean hardness of 112 ppm), alkaline (average pH of 7.9), clear lake. Low dissolved oxygens levels, typically lower than one ppm, occur from June through September in the hypolimnion and blue-green algal blooms frequently occur in June, July, and August. Metal concentrations in lake water are below or slightly above detection limits.

Rice Lake - Rice Lake is a drainage lake about two miles northwest of the orebody. The lake has a surface area of 208 acres and a maximum depth of six feet. The lake bottom is predominantly muck. Much of the lake has depths of four feet or less and supports extensive beds of wild rice as well as floating and submergent aquatic vegetation. Rice Lake has five inlets (the largest being Swamp Creek) and one outlet (Swamp Creek) which flows to the Wolf River. The outlet has a water control structure that partially maintains water levels. The watershed is 43 square miles and the shoreline consists entirely of wetlands. Black bullhead and pumpkinseed are the dominant fish species with northern pike also present.

Rice Lake is an unstratified, moderately hard water (mean hardness of 105 ppm), neutral (average pH of 7.2), light-brown stained lake. Low dissolved oxygen concentrations occur in Rice Lake during the winter and the summer. Metal concentrations in lake water are below or slightly above detection limits.

Rolling Stone Lake - Rolling Stone Lake is a drainage lake about 3.5 miles south of the orebody. The lake has a surface area of 672 acres and a maximum depth of 12 feet. The lake bottom is primarily sand and gravel or muck. About 60% of the shoreline is forested while the remaining 40% is wetlands. Three streams on the north shore drain from the hydrologic study area (Upper Pickerel Creek, Creek 11-4, and Creek 12-9). Three smaller streams, Creeks 13-2 and 13-5 and Agnes Creek also enter the lake. The Pickerel Creek outlet has a rocky substrate which partially maintains lake water levels. Rolling Stone Lake has a diverse warmwater fishery with walleye and northern pike the dominant predators. The abundant panfish community consists largely of yellow perch.

Rolling Stone Lake is an unstratified, moderately hard water (mean hardness of 93 ppm), slightly alkaline (average pH of 7.7), light-brown stained lake. During the winter of 1978, low dissolved oxygen levels caused a partial fish kill. Low winter dissolved oxygen levels chronically stress the lake's fishery. High levels of phosphorous and chlorophyll-a occur and aquatic vegetation is abundant. Metal concentrations in lake water are below or slightly above detection limits.

A lake district was established in 1975 to provide lake protection and rehabilitation. The lake district, with assistance from the DNR, has been active in managing the lake's resources.

Duck Lake - Duck Lake is a seepage lake about one mile southeast of the orebody with an effective watershed of 306 acres. The lake has a surface area of 26 acres, a maximum depth of 10 feet, and a predominantly muck bottom. The shoreline is about 60% wetlands (53 acres of wetland, swamp conifer or bog vegetation). The remaining 40% of the shoreline vegetation consists of upland hardwood and pine. The lake receives surface runoff but does not have any well-defined permanent inlets. An intermittent outlet stream flows to Little Sand Lake during high water levels. This bog lake has a warmwater fish community of yellow perch, black bullhead, and mudminnow. These three species are tolerant of the low dissolved oxygen concentrations which occur during the winter.

Duck Lake is an unstratified, acidic (average pH of 5.0 during prepump conditions - see following paragraph), soft water (mean hardness of 16 ppm), medium-brown colored lake. The lake, typical of acid bog lakes, is high in humic content and low in nutrients. Metal concentrations in Duck Lake water samples are below or slightly above detection limits.

In June and July 1980, Exxon conducted groundwater pumping tests adjacent to Duck Lake. The groundwater discharged to the lake during the pumping test altered the lake water chemistry. Data (pH, alkalinity, conductivity, hardness, and total dissolved solids) collected in 1984 indicates all parameters except for pH have values within the normal seasonal range found during pre-pump conditions. The average pH in Duck Lake was 5.6 during 1984.

Deep Hole Lake - Deep Hole Lake is a seepage lake about 1.5 miles southeast of the orebody. The lake has a surface area of 101 acres and a maximum depth of 10 feet. The lake bottom is 45% sand, 40% muck, 10% gravel, and 5% rubble. The watershed is 886 acres and the shoreline vegetation consists of hardwood forests and 28 acres of adjoining shrub-meadow wetlands. An intermittent inlet enters through a wetland on the east shore. During high water levels, water flows through wetlands on the west shore to Little Sand Lake and through the wetland on the south shore to Creek 12-9. In 1970, the lake was chemically treated by the DNR with rotenone to remove the existing fish. The lake was used as a walleye rearing pond and presently has a warmwater fishery dominated by golden shiner, yellow perch, and walleye.

Deep Hole Lake is an unstratified, soft water (mean hardness of 16 ppm), slightly acidic (average pH of 6.0), light-brown colored lake. Low dissolved oxygen levels, below the five ppm standard, occur frequently under ice cover. Metal concentrations in water are either below or slightly above detection limits. Nutrient levels also are low.

Oak Lake - Oak Lake is a perched lake about 0.5 miles southwest of the orebody. The lake has a surface area of 52 acres and a maximum depth of 47 feet. The lake bottom is 70% sand, 20% muck, and 10% gravel. The effective watershed is 352 acres and the shoreline vegetation consists of 80% upland hardwoods plus 18 acres of adjoining bog, meadow, and shrub wetlands. The lake does not have defined inlets but during high flow periods surface runoff enters Oak Lake from the north through a culvert under Little Sand Lake Road. Oak Lake has an intermittent outlet to Hoffman Pond. The lake supports a warmwater fishery dominated by largemouth bass, yellow perch, bluegill, and pumpkinseed.

Oak Lake is a stratified, soft water (mean hardness of 11 ppm), slightly acidic (average pH of 6.0), clear water lake. Metal concentrations in lake water are below or slightly above detection limits.

Skunk Lake - Skunk Lake is a seepage lake about 0.4 miles east of the orebody. The lake has a surface area of nine acres, a maximum depth of six feet and a muck bottom. The watershed is 106 acres and the shoreline vegetation is mostly upland hardwoods with seven acres of lakeside wetlands. Skunk Lake does not support a fish population because of chronic winterkill problems.

Water samples indicate the lake is an unstratified, soft water (mean hardness of 15 ppm), acidic (average pH of 5.8), dark-brown colored lake. Low dissolved oxygen concentrations (below five ppm) were recorded in both the summer and the winter. Metal concentrations in lake water are below or slightly above detection limits.

Hoffman Spring - Hoffman Spring is a 0.2 acre spring pond about 1.8 miles west of the orebody. This pond is surrounded by wetlands, springs, and groundwater seeps, has a maximum depth of seven feet, and a muck bottom. Water in the spring pond is hard, slightly alkaline, clear, and unstratified. The fishery consists of brook trout (both native and stocked), minnows, and white sucker. An outlet stream, Hoffman Creek, flows to Swamp Creek.

Hoffman Pond - This man-made pond has a fishery comprised primarily of minnows. Bluegill, mudminnow, and brook stickleback also are present. An intermittent outlet to Hoffman Spring is present.

Unnamed Ponds - The unnamed ponds (6-8, (Township 34 North, Range 13 East), 12-6 (Township 34 North, Range 12 East), 25-11, 35-7 and 34-1 (Township 35 North, Range 12 East), and 31-13 (Township 35 North, Range 13 East) are all seepage ponds except for spring pond 12-6 (Martin Springs). These ponds range in size from 0.6 to 4 acres and are 2 to 15 feet deep. The seepage ponds support minnows while spring pond 12-6 (Martin Springs) contains several panfish and minnow species. Additional information on these unnamed ponds can be found in the DNR Surface Water Resources reports for Forest County and Langlade County.

Stream Characteristics

Swamp Creek - Swamp Creek is about 15.5 miles long and originates in Lake Lucerne 4.5 miles northeast of the orebody. The stream flows west along the northern edge of the project site to Rice Lake. From Rice Lake, the creek flows south through a wetland corridor and ultimately joins the Wolf River. Swamp Creek has eight tributaries: Hemlock Creek, Metonga (Outlet) Creek, Hoffman Creek, Squaw Creek, and Creeks 24-15, 6-10, 7-5, and 7-9. Swamp Creek has a total watershed of 151 square miles dominated by woodlands and wetlands. The stream has a well defined channel, an average width of 22 feet and an average depth of 0.8 foot. The stream bed consists of muck, sand, gravel, rubble and boulders. About 10% of the watershed is used for agriculture.

Between Lake Lucerne and Rice Lake the stream supports a cold water fishery of native and stocked brook trout along with 25 other fish species. By comparison, Swamp Creek between Rice Lake and the Wolf River is a warmwater fishery. Thirty-one species of fish were found in the stream below Rice Lake. Fish tissue samples, collected in the stream below Rice Lake during 1982 and 1983, were analyzed for seven metals. Arsenic, cadmium, copper, lead, and zinc concentrations in fish tissue were low. Total chromium concentrations were in the high range (72.0 ppm dry weight) in northern pike, white sucker, and rock bass. Mercury levels also were in the high range (from less than 0.42 ppm in white sucker to 3.57 ppm in rock bass).

Swamp Creek has moderately hard water (mean hardness of 102 ppm), neutral pH (average pH of 7.1) and is clear to light-brown in color. Low dissolved oxygen concentrations, below five ppm, occur in Swamp Creek downstream of Rice Lake during the winter. Metal concentrations in water samples from Swamp Creek are below or slightly above detection limits.

Water quality samples were also collected above and below the proposed wastewater discharge location to determine background conditions. Swamp Creek in the vicinity of the discharge has moderately hard water (mean hardness of 94 ppm) and a neutral pH (average pH of 7.2). Metal concentrations in stream water are below or slightly above detection limits. Dissolved oxygen concentrations ranged from four to six ppm during January and February but were not low enough to stress aquatic organisms. The summer dissolved oxygen survey revealed major fluctuations in dissolved oxygen concentrations and temperature. Dissolved oxygen and temperature peaked in the afternoon while extremely low dissolved oxygen concentrations (one ppm) occurred during the night. The wide fluctuations in dissolved oxygen during the summer are caused by the large number of aquatic plants present in Swamp Creek.

Hemlock Creek - Hemlock Creek, east of the orebody, is 2.4 miles long and originates in Ground Hemlock Lake. The stream has a well-defined channel, flows in a northerly direction, and drains into Swamp Creek. Two small tributaries from nearby wetlands and spring ponds flow into the creek. The total watershed is 4.3 square miles and the shoreline is primarily wooded wetlands. The stream has an average width of 14 feet, an average depth of one foot, and the stream bed is muck or sand and gravel.

Hemlock Creek has a native population of brook trout. Beaver dams, however, are adversely affecting the quality of the coldwater habitat and may be affecting spawning areas. The coldwater fishery could recover if the beaver dams are removed or fail naturally. Twenty-three warmwater fish species also are known to be present.

Water samples were collected at two locations on Hemlock Creek, 0.7 mile downstream from Ground Hemlock Lake and 0.8 mile upstream from the Swamp Creek confluence. Hemlock Creek has moderately hard (mean hardness of 111 ppm), neutral (average pH of 7.3), clear water. Metal concentrations in stream water are below or slightly above detection limits.

Hoffman Creek - Hoffman Creek originates from Hoffman Spring and flows north about 0.5 mile to Swamp Creek. The creek is 1.8 miles west of the orebody. The total watershed is 1.7 square miles and consists mostly of wetland and woods with some cleared land. The creek bottom is primarily sand and gravel in the upper two-thirds of the stream and muck in the lower one-third.

Hoffman Creek has an average width of eight feet and an average depth of 0.5 feet. There are no tributaries other than spring seeps and perenial flow from Hoffman Spring and intermittent contributions from Hoffman Pond. Hoffman Creek is a clear, hard water, slightly alkaline stream. A population of native brook trout is present as are eight other fish species. The stream channel is well defined and instream cover, primarily undercut banks, provides excellent habitat for brook trout. Spawning redds for brook trout have been observed throughout the upper reaches of this stream. Groundwater discharge and the good habitat sustain the brook trout population. This stream provides adult brook trout for Swamp Creek.

Upper Pickerel Creek - Upper Pickerel Creek is 2.5 miles long and originates in a large wetland south of Mole Lake. This stream is 2.9 miles west of the orebody and flows south to Rolling Stone Lake. The stream has a total watershed of 2.2 square miles and the drainage basin is mostly wooded with large areas of adjoining wetlands. The stream has an average width of 10 feet and an average depth of 0.5 feet. The stream bed is primarily muck. The creek has a population of native brook trout and a few warmwater fish species.

Upper Pickerel Creek has moderately hard water (mean hardness of 102 ppm), neutral pH (average pH of 6.9), and the color is light brown. Dissolved oxygen concentrations ranged from 5.5 ppm to 12.2 ppm with an average concentration of 9.0 ppm. Metal concentrations in stream water are either below or slightly above detection limits. Water chemistry samples indicate nutrients and dissolved solids also are at low concentrations.

Metonga (Outlet) Creek - Metonga Creek flows south from Lake Metonga to Swamp Creek. The creek has a total watershed of 11.4 square miles and the shoreline is mostly wooded with some adjoining wetlands. The stream has an average width of 13 feet and an average depth of one foot. The stream bed is mostly sand with some gravel and muck. Metonga Creek has a well-defined channel with no tributaries. Metonga Creek does not have brook trout reproduction but suitable instream habitat provides a trout fishery. This stream is also inhabited by 16 other fish species.

Samples for water chemistry analysis were collected from a station one mile upstream from the confluence with Swamp Creek. The water chemistry data indicate Metonga Creek has moderately hard (mean hardness of 93 ppm), slightly alkaline (average pH of 7.6), clear water. Dissolved oxygen concentrations are high, ranging from 9.1 to 16.0 ppm. Metal concentrations in stream water are either below or slightly above detection limits.

Wolf River - The Wolf River originates in Pine Lake (Forest County) and flows south for 233 miles until it enters Lake Poygan in Winnebago County. The major tributaries to the Wolf River in Langlade County are Swamp Creek, Pickerel Creek, Hunting River, Lily River, and Ninemile Creek. The Wolf River through Forest and Langlade Counties is 46 miles long with a total watershed of 500 square miles. The river has an average width of 176 feet and an average depth of 1.8 feet. About 95% of the Wolf River watershed is forests or wetlands with the remainder in agriculture. The river supports a diverse fishery of brown trout, brook trout, small and largemouth bass, northern pike, panfish, and numerous minnow species. The trout fishery essentially begins at the Hunting River (CTH "T").

Samples for water chemistry were collected upstream from the confluence with Swamp Creek (Station Y) and downstream from the confluence with Pickerel Creek at the crossing of County Highway "T" in Pearson (Station Z). The Wolf River is a soft water (mean hardness of 63 ppm), neutral pH (average pH of 7.0) stream and the color varies from light to dark brown. A permanent monitoring station on the Wolf River at County Highway T in Langlade County, downstream of the Swamp Creek confluence, was established in August, 1982 by the DNR. Samples from this station are used to establish background water quality conditions (Table 2-7). Fish tissue samples also are collected to determine metal levels. Mean metal concentrations for the water samples (August 1982 through December 1984) indicated all metals, except iron (mean concentration of 0.4 ppm), are below detection limits.

Table 2-7
Water Quality Parameters being Monitored on the Wolf River at Station Z

Monthly and Quarterly	Quarterly	Quarterly
Dissolved Oxygen (field)	Total organic nitrogen	Cyanide
Temperature (field)	Nitrite-N + Nitrate-N	Selenium
pH (field	Soluble Phosphorus	Silver
Chemical Oxygen Demand	Ammonia	Barium
Biochemical Oxygen Demand	Arsenic	Fluoride
Conductivity	Cadmium	Total Suspended Solids
Total Phosphorus	Copper	Total Dissolved Solids
Total Nitrogen	Chromium, Total	
Chloride	Mercury	
	Iron, Zinc, Lead	

Annual fish samples are being analyzed for the following parameters:

Chromium	Cadmium
Arsenic	Mercury
Copper	Lead
Selenium	Zinc
Silver	

Creek 11-4 (T34N, R12E) - Creek 11-4 originates from spring pond 12-6 (Martin Springs) north of Rolling Stone Lake. The original spring pond has been flooded due to beaver activity in the headwaters. The stream has a total watershed of 0.4 square mile and flows 0.5 mile before entering Rolling Stone Lake. Creek 11-4 has an average width of five feet, an average depth of 0.3 foot and the stream bed consists of sand or muck. Instream habitat consists primarily of undercut banks and fallen logs. This stream has a diverse minnow population and a few largemouth bass and panfish.

Water chemistry samples were collected 0.3 mile upstream from Rolling Stone Lake. The creek has moderately hard water (mean hardness of 93 ppm), neutral pH (average pH of 6.9), and is clear to dark brown in color. Dissolved oxygen concentrations range from 3.0 to 9.0 ppm with a mean value of 5.9 ppm.

Creek 12-9 (T34N, R12E) - Creek 12-9 originates in a wetland south of Little Sand Lake and flows south 1.6 miles before entering Rolling Stone Lake. The creek has a total watershed of six square miles with 23 acres of wetlands adjoining the stream. Creek 12-9 has an average width of nine feet and a mean depth of one foot. The stream bed consists of sand, gravel, rubble, and muck. The stream supports native brook trout and several warmwater species. Instream habitat consists of undercut banks, fallen logs, and an occasional boulder.

Water chemistry samples were collected about 300 feet upstream from Rolling Stone Lake. The creek has moderately hard (mean hardness of 108 ppm), neutral pH (average pH of 7.4), clear water. Metal concentrations in stream water are below or slightly above detection limits.

Drake Creek - Drake Creek, northwest of Lake Metonga, is 4.8 miles long and a tributary to the South Branch of the Peshtigo River. The creek has a total watershed of 2.7 square miles with a high percent of the land in agricultural use. The remainder is wetland and forests. Drake Creek has an average width of 8.5 feet and an average depth of 0.8 foot. The creek is slightly alkaline (average pH of 7.4) with clear water.

This stream supports brook trout. Beaver and waterfowl also are known to use this stream. Public access points are found at three road crossings and there is one mile of public stream frontage controlled by the Division of Trust Lands and Investments.

Rocky Siding Creek - Rocky Siding Creek, north of the orebody (T36N, R13E, Sec. 31), is 1.7 miles long and enters Lake Metonga from the west shore. The creek has a total watershed of 2.1 square miles with 50% of the land in agriculture and the remainder wooded and wild. Rocky Siding Creek has an average width of eight feet and an average depth of one foot. The creek is a slightly acidic (average pH of 6.8), medium hard water stream with medium brown color. The entire length of Rocky Siding Creek has high reproduction and suitable densities of wild brook trout for satisfactory fishing. Five species of forage fish also inhabit the stream. Beaver are present. There is no public frontage.

Creeks 13-2, 13-15, 24-15, 20-13, 28-11 and 33-8 - Creek 13-2 and 13-15 are tributaries to Rolling Stone Lake, 24-15 is a tributary to Swamp Creek, and 20-13, 28-11 and 33-8 are tributaries to Hemlock Creek. Each creek, except 33-8, supports native brook trout.

AQUATIC BIOLOGY

Fisheries

The fishery is typical for this region of Wisconsin. Tables 2-8 and 2-9 list the fish species collected in the sampled lakes and streams, respectively. No rare or endangered fish species have been captured.

Benthos

Benthic macroinvertebrates (benthos) are free living aquatic animals without backbones, such as insects, clams, and snails, that inhabit the bottom of lakes and streams. Benthos are major constituents of lake and stream faunas and form an integral part of the food chain. The distribution of benthos depends on the physical, chemical, and biological factors at the site, e.g. bottom type, water fertility, and interactions with the rest of the aquatic community. These organisms are used to calculate biotic index values which provide estimates of water quality.

The Biotic Index values for Swamp Creek ranged from good around the proposed discharge site to fair or poor further downstream. This variability in values is primarily related to cyclic, low dissolved oxygen levels caused by nighttime aquatic plant respiration, and secondarily to differences in substrate (e.g. sand and gravel versus muck). This index is useful for evaluating the water quality of streams affected by organic residues. Organic residues, whether from sewage treatment facilities or plant-rich marshes and bogs, can create wide dissolved oxygen swings that may have negative consequences on aquatic species intolerant of low oxygen conditions.

Common benthic macroinvertebrates in the environmental study area include segmented worms, scuds, aquatic sow bugs, insects, clams, snails, roundworms, leeches, flatworms, and seed shrimp. The aquatic insects are represented by true flies (particularly midges), mayflies, and caddisflies. Midges and scuds are the most common benthic organisms in the environmental study area.

Plankton and Periphyton

Plankton and periphyton play a major role in the food web of aquatic communities. The term plankton covers both "phytoplankton" which are free-floating microscopic plants (algae) and "zooplankton" which are small aquatic animals that feed on phytoplankton. Phytoplankton provide a major source of oxygen in lakes through photosynthesis. Zooplankton, together with benthic organisms are a primary food source for small fish. The term "periphyton" refers to attached algae growing on rocks, vegetation, and other surfaces in streams and lakes. Periphyton are an important food source for microscopic animals and benthic organisms.

The major phytoplankton classes found in environmental study area lakes include golden-brown algae, green algae, blue-green algae, diatoms, and cryptomonads. The golden-brown algae commonly occur in acidic to neutral pH lakes, reach peak abundance during the summer, and are the predominant phytoplankton group in environmental study area lakes. Green algae are common and also usually reach peak abundance during the summer.

Blue-green algae also are present and are often associated with nuisance algae blooms in nutrient-rich lakes. Diatoms are the most abundant phytoplankton class in the lakes during coldwater seasons (winter, early spring, and late fall). Cryptomonads were found in several lakes, but were less abundant than other phytoplankton classes. Diatoms dominate periphyton communities throughout the year in rivers and streams.

Zooplankton

Seven lakes in the environmental study area were sampled for zooplankton during the open water season. An integrated sample of the water column was collected from the following lakes: Little Sand Lake, Rice Lake, Rolling Stone Lake, Duck Lake, Deep Hole Lake, Oak Lake, and Skunk Lake. Rotifers and copepods dominated the zooplankton samples. In general, copepods are dominant in clear water, seepage lakes (e.g., Little Sand Lake and Oak Lake), while rotifers dominate brown-stained, seepage lakes (e.g., Duck Lake and Deep Hole Lake). The dense vegetation of Rice Lake favors cladocerans.

In addition to the lake sampling for zooplankton, Swamp Creek below Rice Lake, in the vicinity of the proposed wastewater discharge point, was sampled for zooplankton. The limited number and species of zooplankton observed are characteristic of near shore areas of lakes (possibly carried downstream from Rice Lake).

Table 2-8
Fish Species Collected From Lakes in the Environmental Study Area

Fish Species*	Deep Hole Lake	Duck Lake	Ground Hemlock Lake	Hoffman Pond	Hoffman Spring	Little Sand Lake	Mole Lake	Oak Lake	Rice Lake	Rolling Stone Lake	Pond 12-6 Martin Spring T34N, R12E
Brook trout					X				X		
Central mudminnow	X	X		X		X			X		X
Northern pike			X			X	X		X	X	
Muskellunge										X	
Largescale stoneroller											
Brassy minnow				X	X						X
Hornyhead chub										X	
Golden shiner	X		X		X		X	X	X	X	
Common shiner			X		X				X	X	X
Blackchin shiner			X						X		
Blacknose shiner			X								X
Northern redbelly dace				X	X						
Southern redbelly dace											
Finescale dace				X	X						X
Bluntnose minnow			X							X	
Fathead minnow											X
Longnose dace								X			
Creek chub			X	X	X						X
Pearl dace					X						X
White sucker	X		X		X	X	X	X	X	X	X
Northern hog sucker											
Shorthead redhorse			X						X		
Black bullhead		X	X			X		X	X	X	X
Yellow bullhead						X		X	X		X
Brown bullhead										X	
Brook stickleback				X							X
Rock bass			X						X		
Pumpkinseed			X		X	X	X	X	X	X	X
Bluegill	X		X	X		X	X	X	X	X	
Smallmouth bass											
Largemouth bass			X			X	X	X		X	
Black crappie			X			X	X			X	
Iowa darter			X			X				X	
Johnny darter			X							X	
Yellow perch	X	X	X			X	X	X	X	X	X
Walleye	X		X			X	X			X	
Mottled sculpin			X		X						

*This table represents a compilation of data collected by Exxon consultants and the DNR.

Table 2-9
Fish Species Collected From Creeks in the Environmental Study Area

Fish Species*	Hemlock Creek	Hoffman Creek	Pickerel Creek (Mole Lake to Rolling Stone Lake)	Swamp Creek (Lucerne Lake to Rice Lake)	Swamp Creek (Rice Lake to Wolf River	Creek 11-4 T34N, R12E	Creek 12-9 T34N, R12E	Creek 24-14 T35N, R12E
Brown trout				X	X			
Brook trout	X	X	X	X			X	X
Central mudminnow	X	X	X	X	X	X	X	
Northern pike	X	X		X	X			
Muskellunge								
Largescale stoneroller					X			
Brassy minnow	X			X	X	X		
Hornyhead chub	X			X	X			
Golden shiner	X			X	X			
Common shiner	X	X		X	X			
Blackchin shiner	X				X			
Blacknose shiner	X				X	X	X	
Northern redbelly dace	X			X		X		
Southern redbelly dace					X			
Finescale dace						X		
Bluntnose minnow	X			X	X			
Fathead minnow	X			X		X		
Blacknose dace	X	X		X	X			
Longnose dace				X				
Creek chub	X	X		X	X	X		X
Pearl dace	X			X	X	X		
White sucker	X	X	X	X	X			
Northern hog sucker					X			
Shorthead redhorse				X	X			
Black bullhead	X			X	X			
Yellow bullhead				X	X		X	
Brown bullhead								
Tadpole madtom					X			
Brook stickleback	X			X	X	X		
Rock bass	X			X	X			
Pumpkinseed	X			X	X			
Bluegill	X	X			X	X		
Smallmouth bass								
Largemouth bass			X	X	X	X	X	
Black crappie					X	X		
Iowa darter				X	X	X	X	
Johnny darter	X			X	X	X		
Yellow perch	X		X	X	X	X	X	
Walleye								
Mottled sculpin	X	X	X	X	X	X	X	X
Unidentified minnow	X			X				

*This table represents a compilation of data collected by Exxon consultants and the DNR.

AFFECTED ENVIRONMENT

Macrophytes

Macrophytes are the rooted submerged or emergent vegetation in lakes and streams. Macrophytes are an important component of the aquatic ecosystem because they add oxygen to the water through photosynthesis, provide habitat (food and shelter) for fish and other aquatic life, and may provide wave buffering to reduce shoreline erosion. The macrophytes found in the environmental study area are similar to those found in most soft water lakes of the upper Great Lakes region.

About 70 macrophyte species have been found in the lakes and streams of the environmental study area. Some of the seepage lakes studied are nutrient-limited and lack extensive aquatic weed beds. These nutrient-limited lakes contain distinctive, small, bottom-dwelling species such as quillwort (Isoetes sp.), water lobelia (Lobelia dortmanna), dwarf water milfoil (Myriophylium tenellum), pipewort (Eriocaulon septangulare), and waterwort (Elatine minima). Lakes with this characteristic flora include Little Sand Lake, Duck Lake, Deep Hole Lake, and Oak Lake.

Drainage lakes, such as Rolling Stone Lake and Rice Lake, have more extensive and diverse macrophyte communities than the seepage lakes. Aquatic weed beds are well developed in drainage lakes largely due to the greater availability of nutrients. Characteristic species of drainage lakes include pondweeds (Potamogeton epihydrus, P. zosteriformis, plus several other species), water milfoil (Myriophylium exalbescens), yellow water lily (Nuphar variegatum), white water lily (Nymphaea tuberosa), spike rush (Eleocharis smallii), waterweed (Elodea canadensis), and coontail (Ceratophyllum demersum). Though these species occur in the seepage lakes, they are not as common or extensive.

Two species found in the environmental study area require special attention. Algal-leaved pondweed (Potamogeton confervoides), a Wisconsin threatened species, was found in July, 1980 in Duck Lake. A groundwater pump test, conducted by Exxon later in 1980, discharged a large volume of groundwater to Duck Lake and the pondweed has not been observed since. The other macrophyte, wild rice (Zizania aquatica), occurs predominantly in Rice Lake and at scattered sites downstream of the lake in Swamp Creek. Rice Lake is listed under Wisconsin Administrative Code NR 19.09 as a significant wild rice lake. The DNR and the Mole Lake Sokaogan tribe regulate wild rice harvesting in the lake. The wild rice in Rice Lake has been an important economic and cultural crop to the Mole Lake Chippewas and is an important food source for waterfowl using the lake.

TERRESTRIAL ECOLOGY

Vegetation

The vegetation patterns (Figure 2-9), types and percent rankings for the project site and environmental study area are noted in Table 2-10. For comparison purposes, the amount of developed and water acreage also is included.

Table 2-10
Vegetation Types and Percent Rankings in the Project Site and Environmental Study Areas

Type	Project Site (%)	Environmental Study Area (%)
Northern Hardwood (including Aspen-Birch)	59	65
Swamp Conifer	20	14
Shrub Swamp	3	3
Bog	>1	1
Marsh	2	-
Urban or Developed	>1	2
Old Field and Clearcut	4	3
Agriculture	4	4
Water	7	8
TOTALS	100%	100%

Northern Hardwood - The entire project site has been logged and northern hardwood second-growth forests cover uplands. The sugar maple (Acer saccharum), basswood, yellow birch (Betula alleghaniensis), and eastern hemlock (Tsuga canadensis) association as well as the early successional stages of aspen (Populus tremuloides) and paper birch (Betula papyrifera) are present at the project site.

Swamp Conifer - Various types of swamp conifer wetlands cover the project site. White cedar (Thuga occidentalis)-balsam fir (Abies balsamea) wetlands are found along Swamp Creek and between Rolling Stone Lake and Little Sand Lake. Black spruce (Picea mariana)-tamarack (Larix laricina) wetlands are found in most of the remaining swamp conifer wetlands.

Shrub Swamp - Shrub wetlands are dominated by speckled alder (Alnus rugosa), sedges, and blue-joint grass (Calamagrostis canadensis).

Bog and Marsh - Representative bog species are leatherleaf (Chamaedaphne calyculata), labrador tea (Ledum groenlandicum), cottongrass (Eriophorum spissum), sphagnum moss, sedges, and blue-bead lily (Clintonia borealis). Marshes are dominated by sedges (59% of the cover), and blue-joint grass (28% of the cover). Other representative species are bulrush (Scirpus cyperinus and others), goldenrod (Solidago uliginosa), northern manna grass (Glyceria borealis), and steeplebush (Spiraea tomentosa). Many of the marshes in the project site occur adjacent to lakes.

Forest Cover and Ownership - The three counties (Forest, Langlade, and Oneida) adjacent to the project site are heavily forested. Approximately 78% of the three-county area is commercial forest land. By comparison, 77% of the environmental study area is commercial forest land. The environmental study area has less public and more private individual ownership than the surrounding three-county area (Table 2-11). Consolidated Paper Company is the largest corporate landowner in the environmental study area.

Table 2-11
Forest Ownership

Area	Public	Private Company	Private Individual	Total Acres
		Percent		
Environmental Study Area	18	44	38	48,760
Three County Area	43	46	11	1,476,500

Wetlands

Approximately 11,700 acres of the project site were surveyed and a total of 158 wetlands of at least one-quarter acre were identified. Wetlands in this area totaled 1,712 acres and consisted of 946 acres of coniferous swamp, 321 acres of bog, 146 acres of deciduous swamp, 146 acres of shrub swamp, 148 acres of marshes, and five acres of aquatic beds in the shallow waters of lakes (Figure 2-9). These wetlands constitute 2.8% of the total wetlands in the upper Wolf River watershed. Wetlands constitute twenty percent of the total land area in the upper Wolf River watershed (upstream from Langlade, Wisconsin).

Wetlands are common in the upper portions of the Hemlock Creek, Swamp Creek and Pickerel Creek watersheds. All wetlands and surface waters eventually drain into the Wolf River via Hemlock Creek or Swamp Creek on the east and north, and Pickerel Creek on the west and south. Wetlands also occur along groundwater discharge areas, such as the south side of Swamp Creek north of the orebody and the Martin Spring area. Except for wetlands along Swamp and Hemlock Creeks, most wetlands in the environmental study area have a slow rate of runoff, few permanent stream channels and small water budgets. Many wetlands have only intermittent inlets and/or outlets, and some wetlands dry out completely during the summer months.

The majority of the upland wetlands are perched above the groundwater. These wetlands exist because glacial till or lacustrine deposits at the surface limit percolation. Wetlands are found in kettle holes, meltwater channels, erosion basins, and valleys. In many basins an accumulation of plant matter over thousands of years has created organic soil and/or peat which, in many cases, has partially or completely filled the former ponds and lakes.

Threatened/Endangered Plant Species

Endangered species are plant or animal species in danger of extinction throughout their range or a significant portion of their range. Threatened species are likely to become endangered in the future. Endangered and threatened species status is based on available scientific evidence of population numbers and range. This status qualifies species for some level of legal protection.

There are no federally designated or candidate endangered or threatened plant species known to occur in the environmental study area. Of the 107 plant species listed as endangered or threatened by the state (Chapter 29.415, Wis. Stats.; Wisconsin Administrative Code NR 27), three endangered species and six threatened species have ranges and habitat preferences that include the environmental study area. The three endangered species are small yellow water crowfoot (Ranunculus gmelinii), foamflower (Tiarella cordifolia), and goblin fern (Botrychium mormo). The six threatened species are ram's head lady's slipper (Cypripedium arietinum), tubercled orchid (Habenaria flava), small round-leaved orchid (Orchis rotundifolia), New England violet (Viola novae-angliae), sheathed pondweed (Potamogeton vaginatus), and algal-leaved pondweed (Potamogeton confervoides). Algal-leaved pondweed was the only listed species (threatened) observed during several surveys of the environmental study area. This species was observed in Duck Lake and voucher specimens collected from the lake in 1980. Although Duck Lake has been resurveyed since 1980, additional specimens have not been found.

Another rare species, the calypso orchid (Calypso bulbosa), is known to occur in the large cedar swamps adjacent to Swamp Creek and between Little Sand Lake and Rolling Stone Lake. The species is known to occur in about 25 other sites in northern and eastern Wisconsin and has been considered for listing.

Natural and Scientific Areas

Natural areas are tracts of land and water containing remnants of presettlement native biotic communities, unique biotic features, or significant geological or archeological sites. Natural areas have largely escaped or recovered from disturbances occurring since settlement. Scientific areas are natural areas of statewide significance, designated under the provisions of Chapter 23.27, Wis. Statutes. There are no designated scientific areas within the environmental study area. Two recent inventories have identified four natural areas within the environmental study area: three in Forest County and one in Langlade County. A description of these areas follows:

1. Oak Lake (Forest County, T35N R12E Section 36, NW 1/4) - This lake is a deep, clear, soft water seepage lake with high transparency. An abundant, fairly diverse, rosette-forming vascular flora is present on the sandy bottom. Large bur oaks ring the lake on the north and west sides. Oak Lake is of county-level significance and privately owned.

2. Swamp Creek Cedars (Forest County, T35N R13E Sections 19, 20, 29, 30) - This parcel is dominated by large, mature white cedars associated with spruce, fir, tamarack, and black ash. A lush growth of mosses, ferns, sedges, and ericads dominate the ground layer. An osprey nest, on a platform placed in a snag, is in the swamp. The area covers about 90 acres and is of county-level significance and privately owned.

3. Bur Oak Swamp (Forest County, T35N R13E SW 1/4 of Section 29) - Bur Oak Swamp contains a second growth hardwood swamp of peculiar composition. The dominant canopy species are bur oak, elm, red maple, and black ash. This area ranges to 40 acres and is of local significance and is owned by the county.

4. Upper Pickeral Creek Cedars and Pines (Langlade County, T34N R12E W 1/2 of Section 2 and E 1/2 of Section 3) - This area, situated along a small stream, has a relatively undisturbed pine stand on the adjacent uplands. In both the cedar and pine forests selective cutting has occurred. One tree supports a bald eagle nest. Cape May warblers probably breed in this area. The area encompasses about 360 acres and is of county significance with a mix of public and private ownership.

Heavy Metals in Terrestrial Vegetation

New growth from three terrestrial plant species was analyzed to establish background heavy metals levels in the environmental study area. The species sampled, balsam fir (Abies balsamea), red raspberry (Rubus idaeus), and Pennsylvania sedge (Carex pennsylvanica), are widely distributed throughout the environmental study area. The nine metals selected for analysis were those generally found in base metal sulfide ores: manganese, zinc, cadmium, copper, arsenic, lead, mercury, cobalt, and total chromium. The 27 sampling locations were divided into three sectors as shown in Figure 2-10.

The results indicate little difference in heavy metal concentrations within and between the plant species sampled. Portions of the vegetation from the three samples were combined to form composites for the three geographic sectors examined. The values of the composites compared reasonably with those of the individual samples. The mean values for all composite and individual samples compared reasonably to values reported in the literature for background levels of these elements.

Natural concentrations of these heavy metals in soil and plant materials are indicated in Table 2-12. Also shown is the range of heavy metal concentrations that cause toxic effects in plants. Examination of this table indicates that heavy metals in soils near to and/or similar to those at the Crandon site, as well as vegetation from the Crandon site, contain low concentrations of heavy metals. The heavy metal levels are well below the concentrations at which they become toxic to plants (phytotoxicity).

Table 2-12
Concentrations of Heavy Metals
in Soils and Plants

Element	Soil Concentration (ppm)	Soil Conc (mg./sq.m.)	Average Concentration in Vegetation (ppm), Exxon Site	Phytotoxic Concentration (ppm)
Zinc	37.2-54.2 (Antigo Silt Loam)	558-813	38.5 (sedge)	300-400
	45.7-83.1 (Langlade Silt Loam)	686-1,246	62.3 (red raspberry)	
	25-155 (forest soils, US)	375-2,325	58.1 (balsam fir)	
	47-131 (soils on glacial till/drift)	705-1,965		
Copper	12.1-33.4 (Antigo Silt Loam)	181.5-501	9.1 (sedge)	50
	13.5-47.2 (Langlade Silt Loam)	202.5-708	12.6 (red raspberry)	
	25-155 (forest soils, US)	105-2,250	9.5 (balsam fir)	
	15-50 (soils on glacial till/drift)	225-750		
Lead	9-12 (Antigo Silt Loam)	135-180	2.6 (sedge)	100-200
	9-11 (Langlade Silt Loam)	135-165	3.2 (red raspberry)	
	10-50 (forest soils, US)	150-225	2.5 (balsam fir)	
	10-30 (soils on glacial till/drift)	150-450		
Arsenic	1.5-16 (forest soils, US)	22.5-240	< 0.01 (all species)	25-50
	2.1-12 (soils on glacial till/drift)	31.5-180		
Manganese	150-1500 (forest soils, US)	2,250-22,500	191.5 (sedge)	1,500-3,000
	200-700 (soils on glacial till/drift)	3,000-10,500	352.2 (red raspberry)	
			387.5 (balsam fir)	
Cadmium	0.180-0.360 (Antigo Silt Loam)	2.7-5.4	0.4 (sedge)	5-8
	0.170-0.290 (Langlade Silt Loam)	2.5-4.3	0.5 (red raspberry)	
	0.5-1.5 (forest soils, US)	7.5-22.5	0.7 (balsam fir)	
	0.49-0.61 (soils on glacial till/drift)	7.3-9.1		
Chromium	152-1384 (forest soils, US)	2,280-20,760	0.5 (sedge)	75-100
	12 (mean) (soils on glacial till, Norway)	180	1.3 (red raspberry)	
			0.1 (balsam fir)	

Wildlife

Mammals - Fifty-five species of mammals could occur in the environmental study area. Thirty-six species of mammals reside in Forest County and 29 species of mammals were observed in the environmental study area.

White-tailed Deer - Regional white-tailed deer populations vary between eight and 25 deer per square mile. These population levels are similar to those for other forested areas in northern Wisconsin. The environmental study area lies within Deer Management Unit 43 (west of State Highway 55) and Unit 44 (east of State Highway 55). The management goal for these two units is 15 deer per square mile after hunting harvest. The 1984 deer population estimates for Units 43 and 44 are 24 and 14 deer per square mile, respectively. The 1984 harvest was 1,218 deer in Unit 43 and 731 deer in Unit 44.

The project site is not high quality habitat for deer because of the large acreage of pole-sized northern hardwoods. Five deer yards lie totally or partially within the environmental study area while the project site encompasses the Swamp Creek deer yard and a portion of the Rolling Stone deer yard (Figure 2-11). The deer yard boundaries and usage change depending on deer populations, severity of the winter, and forestry activity.

Black Bear - The estimate of the black bear population in the environmental study area, based on countywide densities of one animal per four square miles and available habitat, is 30 to 40 black bear. Black bear sign were frequently observed in the environmental study area.

Small Game - Snowshoe hare, eastern cottontail, and gray squirrel reside in the environmental study area. The snowshoe hare is cyclically abundant and commonly hunted where there are large areas of preferred habitat. The eastern cottontail is much less abundant because preferred habitat is limited. Moderate populations of gray squirrels exist in the mature hardwood forests.

Furbearers - Important furbearers of the environmental study area are bobcat, river otter, red fox, coyote, beaver, raccoon, muskrat, mink, and fisher. Bobcat densities range from one bobcat per five square miles to one bobcat per 20 square miles in Wisconsin's northern forest. Bobcat tracks were observed in the environmental study area. The fisher, river otter, and beaver are common in the environmental study area and the project site. The red fox, coyote, raccoon, muskrat, and mink occur in the environmental study area and the project site.

Nongame Mammals - Twenty-one species of nongame mammals live in Forest County. Their abundance varies from rare to abundant and depends upon the availability of preferred habitat and their statewide range. The five most abundant species are the deer mouse, red-backed vole, masked shrew, short-tailed shrew, and eastern chipmunk. At the project site, the northern hardwood forest has a higher small mammal density (127.1 captured per 1,000 trapped nights) and diversity than the swamp conifer forest (72.7 captured per 1,000 trapped nights) or the aspen-birch forest (57.4 captured per 1,000 trapped nights). In the wetland areas, the meadow jumping mouse, masked shrew, red-backed vole, deer mouse, and meadow vole are the most abundant. Two southern flying squirrels also were captured at the project site. Southern flying squirrels previously have not been reported in Forest County.

Birds - Two hundred forty-four species of birds have been documented in Forest, Oneida, and Vilas Counties, most of which could be expected to occur in the environmental study area. In the environmental study area 164 species of birds were observed, and at the project site 150 species of birds were observed. About 80% of the bird species breeding at the project site seasonally migrate. Densities during summer were roughly 500 individuals per 100 acres compared to less than 100 individuals per 100 acres during the winter.

Permanent Residents - Twenty-four species of permanent resident birds were observed in the environmental study area. Ruffed grouse populations are low in both the environmental study area and the project site. Ruffed grouse populations are cyclic and are estimated at 2.8 (plus or minus 1.3) grouse per 100 acres.

Summer residents - Up to 133 species of summer resident birds could occur in the environmental study area. These include 11 raptors (nine observed), nine waterfowl species (eight observed), 24 species of marsh and shorebirds (16 observed) and 89 species of songbirds (84 observed). The summer density of songbirds at the project site varied from 193 (plus or minus 62) to 378 (plus or minus 98) per 100 acres.

Summer resident game birds include waterfowl and American woodcock. The American woodcock populations in the environmental study area and the project site are average for Wisconsin's northern forest with four to six males per four-mile transect. The best waterfowl habitat in the environmental study area does not support an average density of breeding waterfowl. The best areas are Rice Lake, Bishop Lake, Rolling Stone Lake, Lily Lake, and the Swamp Creek, and Hemlock Creek bottomlands.

Winter Residents - Three species of winter resident birds, the pine grosbeak, common redpoll, and snow bunting reside in the environmental study area.

Migrants - A wide variety of migrant birds pass through the region. Thirty-six species of migrant marsh and shorebirds may use the area. The cattle egret, solitary sandpiper, herring gull, and ring-billed gull were observed. Twenty-four species of migrant waterfowl (eight observed) may use the environmental study area. Bishop Lake, Rolling Stone Lake, Pickerel Lake, Rice Lake, and Lake Metonga, and the Wolf River are important to migrating waterfowl. Rice Lake, Duck Lake, Rolling Stone Lake, and Skunk Lake are important feeding and resting areas.

Amphibians and Reptiles - Twenty-nine species of amphibians and reptiles could occur in the environmental study area including seven salamanders, eight frogs, one toad, five turtles, and eight snakes. Fourteen species of amphibians and reptiles were observed at the project site.

Small, ephemeral, woodland ponds in the environmental study area provide habitat for amphibians during the breeding and larval portions of their life cycles. Blue-spotted salamanders and spotted salamanders live near most woodland ponds during spring, but migrate to uplands during summer. American toads, spring peepers, wood frogs, green frogs, and chorus frogs are common in ponds and lakes during spring. During summer, wood frogs and American toads frequently are found in uplands and near water bodies. The eastern gray treefrog, bullfrog, mink frog, and leopard frog are present but less frequently observed or heard.

The four species of reptiles present in the environmental study area are painted turtles, snapping turtles, garter snakes, and fox snakes. Painted turtles and snapping turtles are common in ponds, lakes and streams. Garter snakes are uncommon while fox snakes are rare.

Wisconsin Endangered Species - The bald eagle, osprey, timber wolf, and pine marten live or could live in the environmental study area. The three known active bald eagle territories in the environmental study area each contain an alternate nest. Bald eagles use the lakes and streams in the environmental study area for feeding. Six active osprey territories are in the environmental study area and one territory contains an alternate nest. Two of these osprey pairs nest in the project site area (Figure 2-11).

The peregrine falcon is a rare migrant in the region.

Only 25 timber wolves are known to reside in Wisconsin. In 1981 and 1983, timber wolves were observed north and west of Crandon. Timber wolf habitat exists in the environmental study area and the project site but no sign of timber wolves was observed.

A small, expanding population of pine martens exists in north central Forest County and a pine marten was observed near Lake Lucerne in 1983. Pine marten habitat exists in the environmental study area and the project site.

Wisconsin Threatened Species - Small numbers of Cooper's hawks and red-shouldered hawks occur in the environmental study area. Habitat for both species is common in the environmental study area and the project site. Wood turtles were not observed in the environmental study area but have been reported in Forest County. Tremblay's salamanders have not been recorded in Forest County but their preferred habitat exists in the environmental study area. A loon was observed on Duck Lake in May, 1985.

Wisconsin Watch Species - Twenty-three species whose populations in Wisconsin are of unknown, declining, or sensitive status live in the region. A variety of species live in the site area: leopard frog, fox snake, garter snake, common loon, great blue heron, black duck, black tern, common flicker, grasshopper sparrow, vesper sparrow, field sparrow, bobcat, and fisher. Species residing in the environmental study area that may reside at the project site are the marsh hawk, spruce grouse, and eastern bluebird. A variety of watch species live in Forest County and possibly in the environmental study area: bullfrog, ring-necked snake, smooth green snake, bull snake, red-bellied snake, merlin (as a migrant), and upland sandpiper.

Common loons have bred on Deep Hole and Rolling Stone Lakes and have been observed on Oak Lake. Black terns occur on Rice Lake and presumably nest there. A great blue heron rookery is located southwest of the environmental study area. Old fields and brushy areas in the environmental study area provide habitat for marsh hawks, eastern bluebirds, grasshopper sparrows, vesper sparrows, and field sparrows.

NOISE AND VIBRATIONS

Noise

Background noise levels at homes and recreational sites potentially impacted by construction and operation noise were monitored by Exxon during July and March in 1977 and 1983 (Figure 2-12). Seasonal monitoring was conducted to account for variations in noise levels caused by changes in foliage and local activities. Sound levels were recorded over a 16 minute to 21 minute period three times a day during daytime (7 AM to 6 PM), evening (6 PM to 10 PM), and nighttime (10 PM to 7 AM). During 1977, sites 1 through 6 were monitored for baseline conditions and in 1983 sites 7 through 10 were monitored.

During winter, natural sources of sound were wind, branches rustling, dogs barking, birds, voices, and water flowing over a small dam. Other noise sources included chain saws, snowmobiles, traffic, aircraft, and gunshots. During the summer, sources of sound were mainly from human activities associated with a picnic area and campground, voices, aircraft, traffic, or natural sounds such as wind, leaves, birds, and insects. At all locations, summer sound levels were higher than those reported during the winter mainly because of increased human activity. Daytime sound levels (L_d), nighttime sound levels (L_n) and day-night sound levels (L_{dn}) monitored at all locations in 1977 and 1983 for winter and summer are shown in Table 2-13.

Table 2-13
Daytime, Nighttime and Day-Night Equivalent Sound Levels (DBA)[1]

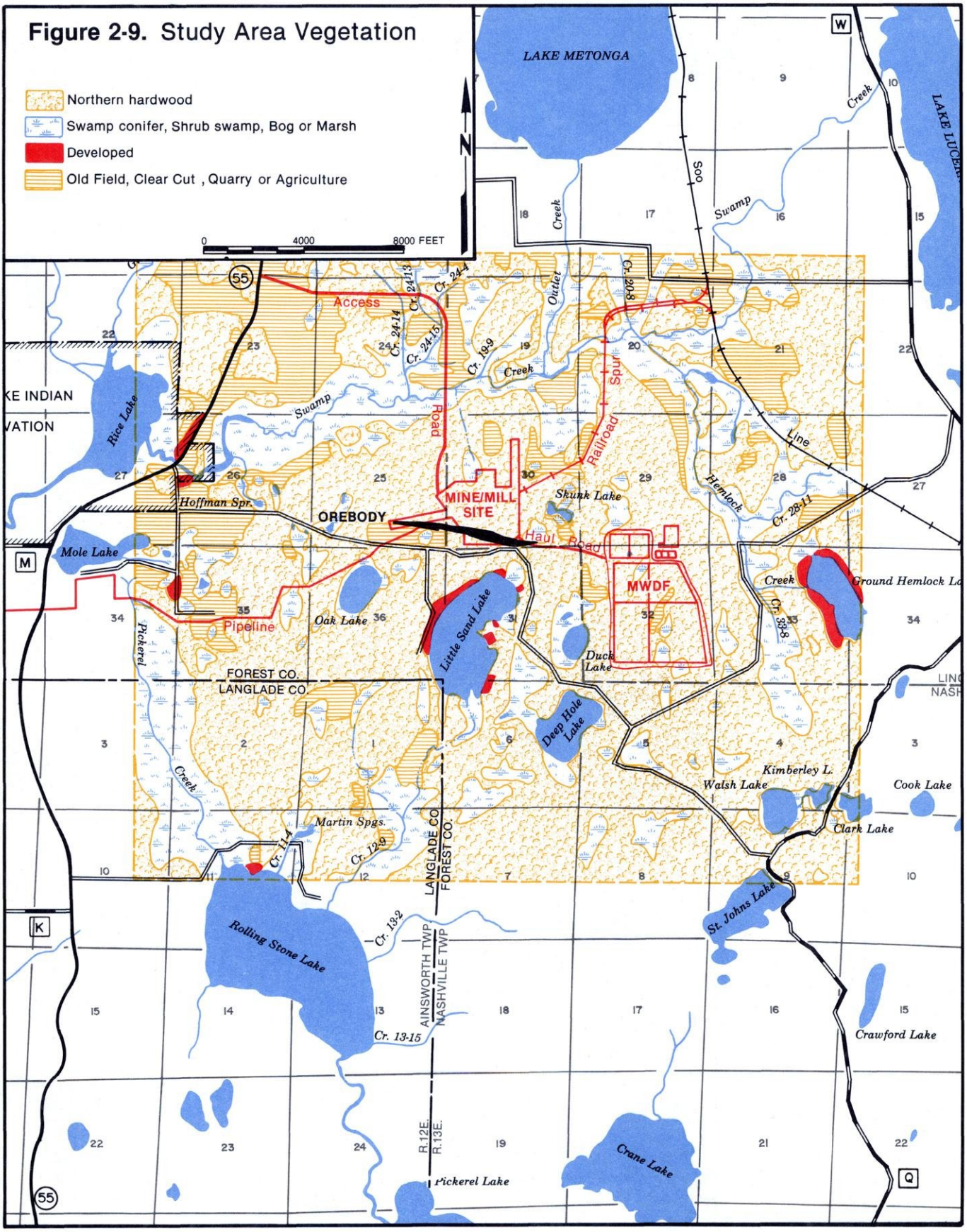
		Winter			Summer		
	Location	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}
1)	School[2]	43	30	42	47	43	50
2)	Community Center[2]	38	29	38	42	40	47
3)	Mihalko Residence[2]	39	24	38	44*	44	50*
4)	Residence 3712[2]	43*	35	44*	64	47	62
5)	Exxon Field Office[2]	42	38*	45	57*	27	55*
6)	Webb Residence[2]	42*	20	40*	38	39	45
7)	Lake Metonga[3]	45	42	49	48	41	49
8)	Rolling Stone Lake[3]	34	31	38	41	40	47
9)	Ground Hemlock Lake[3]	33	30	37	43	27	42
10)	St. John's Lake[3]	33	31	38	39	28	39

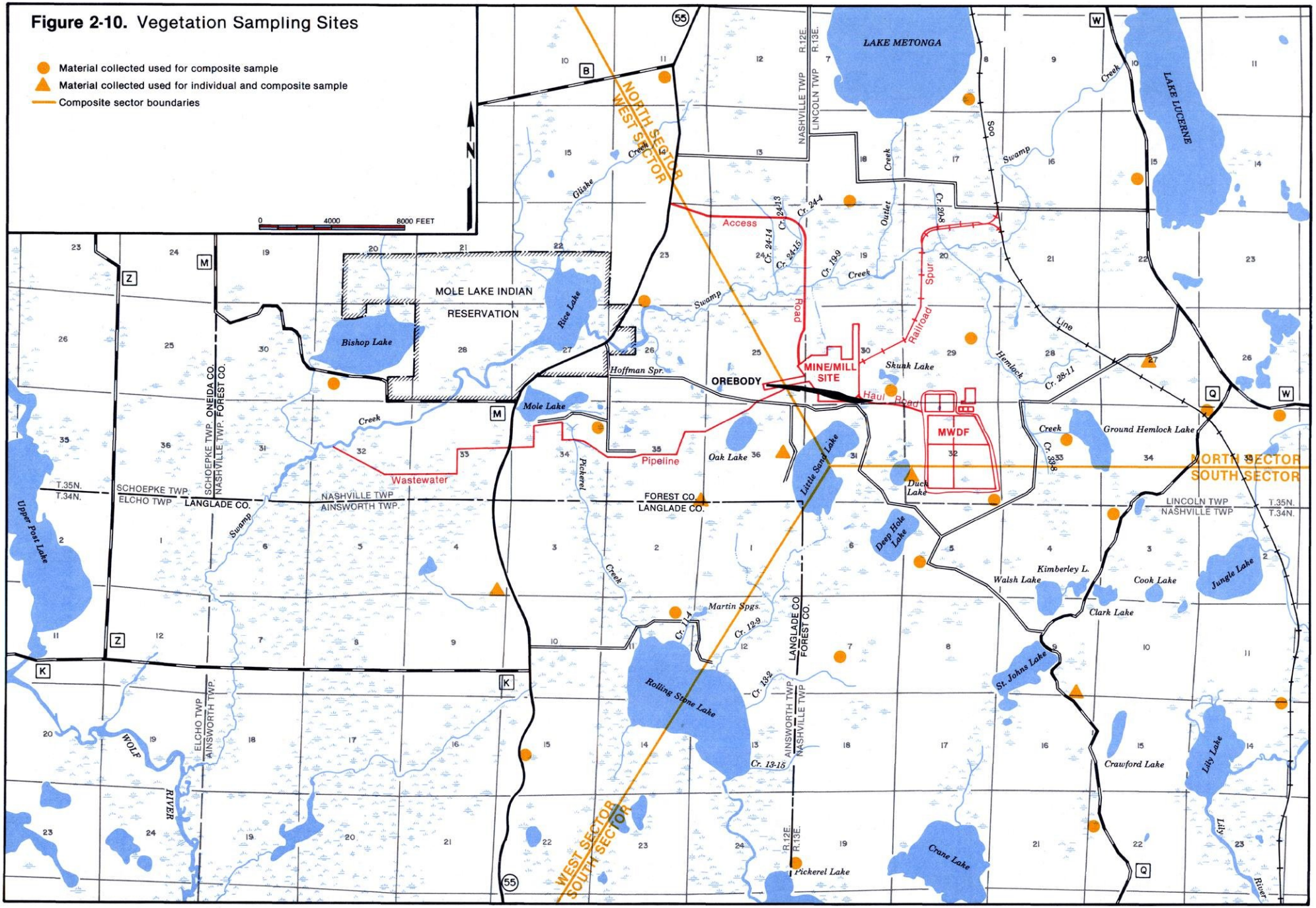
[1] DBA = decibels, A-weighted
[2] Monitored in 1977
[3] Monitored in 1983
* Values were adjusted to reduce the contribution from short duration, high sound pressure level sources.

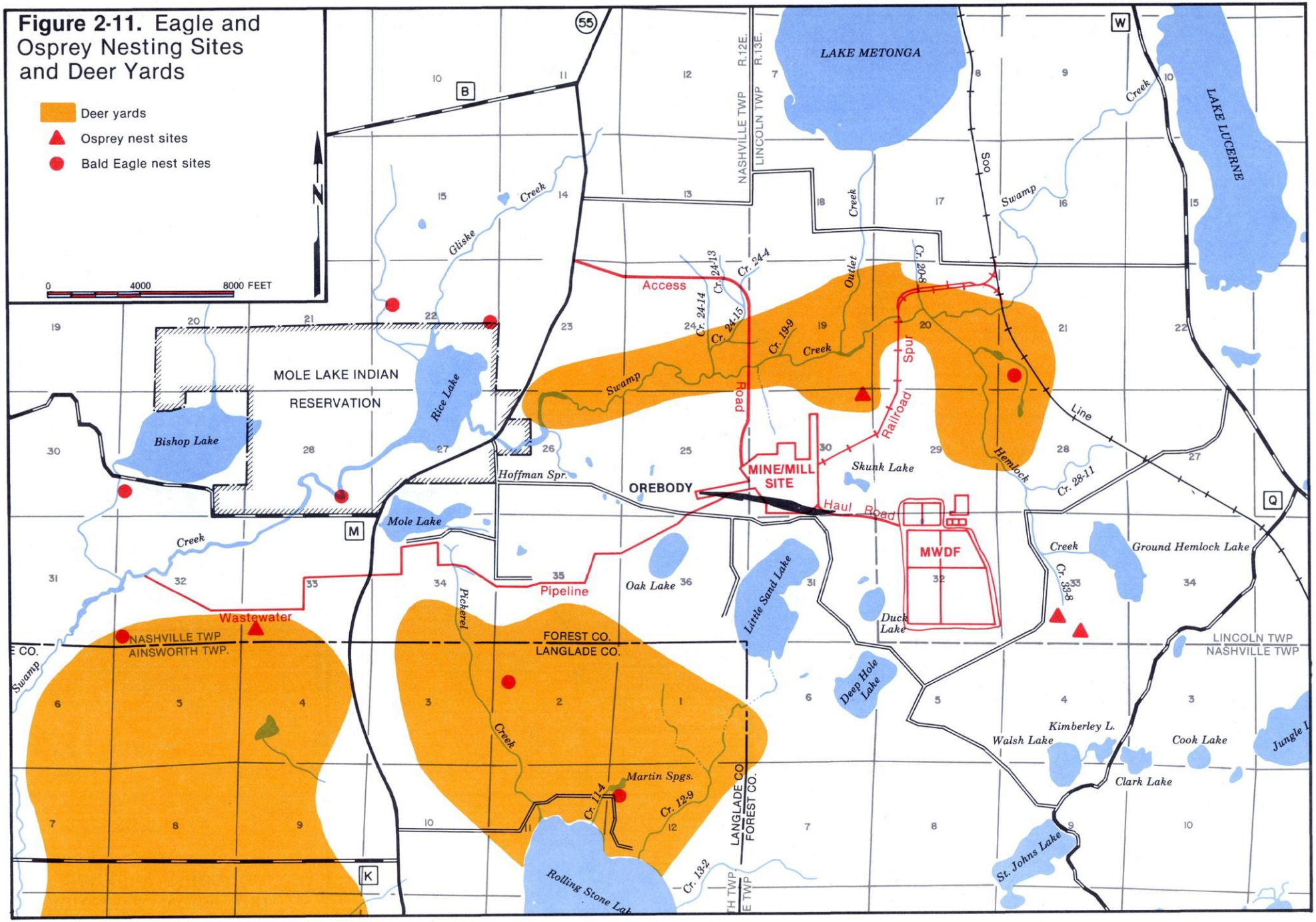
In addition, noise levels at three residences labeled A, B, and C were estimated for each of the three locations by using measured values from other locations where land use was similar. The estimated sound levels at the three sites are presented in Table 2-14.

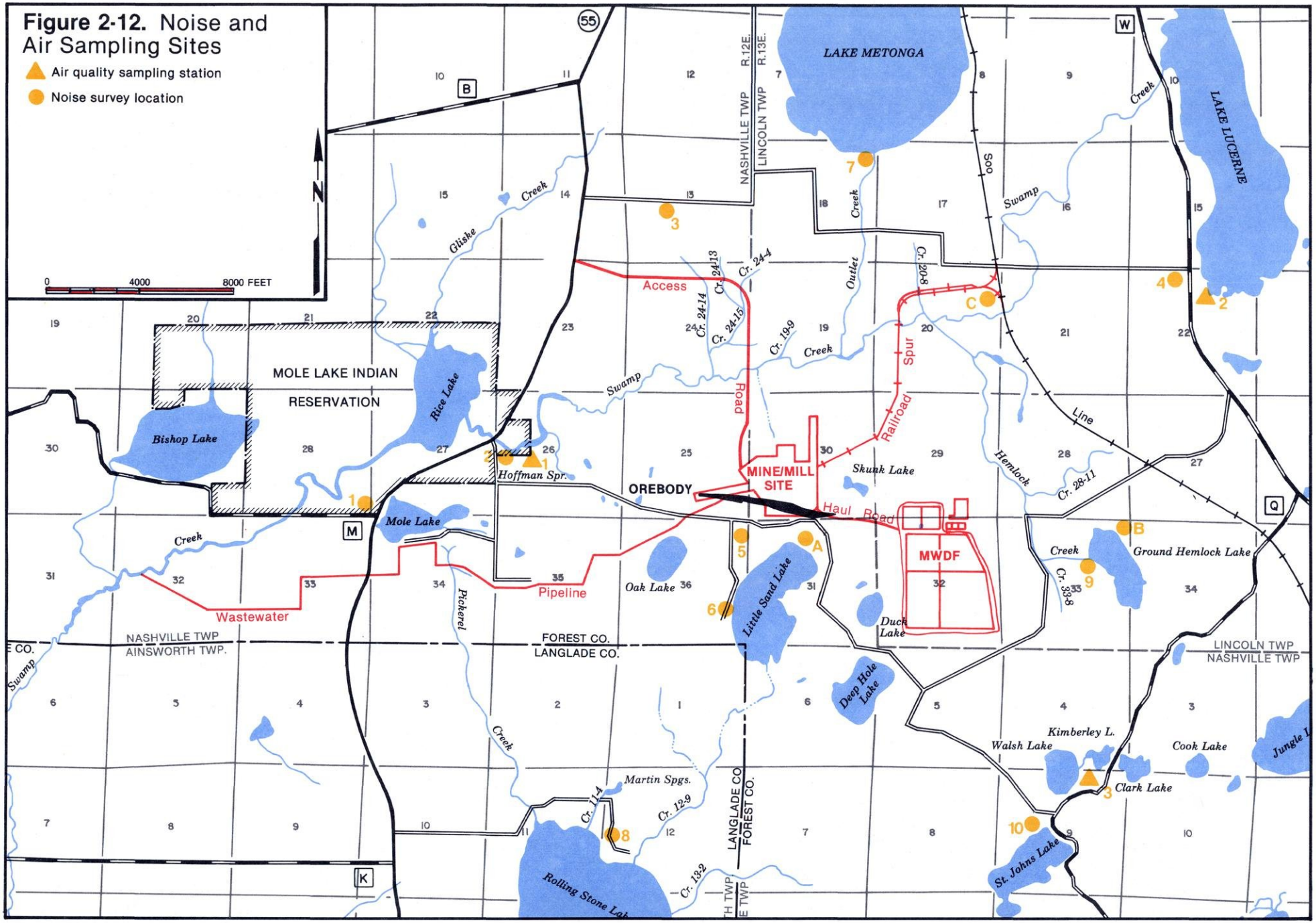
Table 2-14
Summary of Equivalent Sound Levels (DBA)
at Three Additional Baseline Locations

		Winter			Summer		
	Location	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}
A)	North Shore, Little Sand Lake	42	20	40	38	39	45
B)	East Shore, Ground Hemlock Lake	33	30	37	43	27	42
C)	Keith Siding Road Just West of Soo Line Railroad	43	39	46	46	43	50


Figure 2-9. Study Area Vegetation
Northern hardwood
Swamp conifer, Shrub swamp, Bog or Marsh
Developed
Old Field, Clear Cut , Quarry or Agriculture
N
0
4000
8000 FEET
LAKE METONGA
Creek
Soo
Swamp
Creek
LAKE LUCE
W
Access
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Creek
Outlet
Cr. 20-8
Spur
Railroad
Road
Line
Hemlock
Cr. 28-11
Swamp
Rice Lake
KE INDIAN
VATION
Hoffman Spr.
MINE/MILL SITE
OREBODY
Skunk Lake
Haul Road
MWDF
Mole Lake
Pipeline
Oak Lake
Little Sand Lake
Duck Lake
Creek
Ground Hemlock La
Cr. 33-8
Pickerel
FOREST CO.
LANGLADE CO.
Deep Hole Lake
Kimberley L.
Walsh Lake
Cook Lake
Clark Lake
Creek
Martin Spgs.
Cr. 11-4
Cr. 12-9
LANGLADE CO.
FOREST CO.
Rolling Stone Lake
Cr. 13-2
AINSWORTH TWP
NASHVILLE TWP
St. Johns Lake
Crawford Lake
Cr. 13-15
R.12E.
R.13E.
Pickerel Lake
Crane Lake
M
K
Q
55
W


Figure 2-10. Vegetation Sampling Sites
Material collected used for composite sample
Material collected used for individual and composite sample
Composite sector boundaries
N
0 4000 8000 FEET
NORTH SECTOR
WEST SECTOR
WEST SECTOR
SOUTH SECTOR
NORTH SECTOR
SOUTH SECTOR
MOLE LAKE INDIAN RESERVATION
LAKE METONGA
LAKE LUCERNE
Bishop Lake
Rice Lake
Mole Lake
Oak Lake
Little Sand Lake
Deep Hole Lake
Duck Lake
Skunk Lake
Ground Hemlock Lake
Kimberley L.
Walsh Lake
Cook Lake
Jungle Lake
Clark Lake
St. Johns Lake
Crawford Lake
Lily Lake
Rolling Stone Lake
Crane Lake
Pickerel Lake
Upper Post Lake
Martin Spgs.
Hoffman Spr.
Access
Road
Railroad Spur
Haul Road
Pipeline
Wastewater
Outlet
Creek
Swamp
Line
Hemlock
Pickerel
Glüske
Soo
Lily River
Wolf River
OREBODY
MINE/MILL SITE
MWDF
Cr. 24-13
Cr. 24-14
Cr. 24-15
Cr. 24-4
Cr. 19-9
Cr. 20-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
Cr. 13-15
SCHOEPKE TWP.
ELCHO TWP
NASHVILLE TWP
AINSWORTH TWP.
LINCOLN TWP
ONEIDA CO.
FOREST CO.
LANGLADE CO.
T.35N.
T.34N.
R.12E.
R.13E.


Figure 2-11. Eagle and Osprey Nesting Sites and Deer Yards
Deer yards
Osprey nest sites
Bald Eagle nest sites
0
4000
8000 FEET
N
LAKE METONGA
LAKE LUCERNE
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Hoffman Spr.
Gliske Creek
Swamp
Creek
Access
Cr. 24-13
Cr. 24-14
Cr. 24-15
Cr. 24-4
Cr. 19-9
Cr. 20-8
Outlet
Soo
Line
Railroad Spur
Road
MINE/MILL SITE
OREBODY
Haul Road
Skunk Lake
Hemlock
Cr. 28-11
MWDF
Duck Lake
Ground Hemlock Lake
Cr. 33-8
Pipeline
Wastewater
Oak Lake
Little Sand Lake
Pickerel Creek
NASHVILLE TWP
AINSWORTH TWP.
FOREST CO.
LANGLADE CO.
Martin Spgs.
Cr. 11-4
Cr. 12-9
Cr. 13-2
Rolling Stone Lake
Deep Hole Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Jungle L
LINCOLN TWP
NASHVILLE TWP
B
M
K
Q
W
55


Figure 2-12. Noise and Air Sampling Sites
Air quality sampling station
Noise survey location
0 4000 8000 FEET
N
LAKE METONGA
LAKE LUCERNE
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Oak Lake
Little Sand Lake
Deep Hole Lake
Duck Lake
Skunk Lake
Ground Hemlock Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Rolling Stone Lake
Martin Spgs.
Hoffman Spr.
Gliske Creek
Swamp
Outlet Creek
Soo Line
Hemlock Creek
Pickerel Creek
Access Road
Railroad Spur
Haul Road
Pipeline
Wastewater
OREBODY
MINE/MILL SITE
MWDF
NASHVILLE TWP
LINCOLN TWP
AINSWORTH TWP.
FOREST CO.
LANGLADE CO.
R.12E.
R.13E.
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
55
B
M
K
W
Q

Location A, north shore of Little Sand Lake - Background sound levels are estimated to be similar to those recorded at Location 6 (the Webb residence on Little Sand Lake Road).

Location B, east shore of Ground Hemlock Lake - Sound levels are estimated to be similar to those recorded at Location 9 (the west shore of Ground Hemlock Lake).

Location C, residence west of the Soo Line near the intersection with Keith Siding Road - Background sound levels at this location are estimated to be similar to those recorded at Locations 3 (Mihalko residence on Airport Road) or 7 (the parking lot of Forest County Veterans Memorial Park on the south shore of Lake Metonga). With the exception of summer activities at the Forest County Veterans Memorial Park, sound sources at Location C should be similar to those at Locations 3 and 7. The Soo Line, about 1,265 feet from Location C, and Keith Siding Road, 800 feet from Location C, contribute to noise levels at location C.

Background sound levels are comparable to those found in a rural or quiet suburban neighborhood. The Environmental Protection Agency (EPA) recommends a day-night sound level (L_{dn}) of 65 DBA as a short-term goal and an L_{dn} of 55 DBA as the long-term goal. The long-term goal has been identified as a requisite for the protection of public health and welfare. Day-night sound levels at the 13 sites were at or below the EPA's short-term goal (65 DBA L_{dn}). All sites except the residence at Site 4 were at or below EPA's long-term goal (55 DBA L_{dn}).

Vibrations

The mine/mill site and adjacent private lands are sparsely populated and heavily wooded. The existing cottages or homes are found near Little Sand Lake, Oak Lake, Ground Hemlock Lake, and Rolling Stone Lake. Vibration sources near these lakes are currently limited to automobile and truck traffic on the roadways. Seismic vibrations generated by the traffic are generally not felt since traffic is light and infrequent.

Structural vibrations, produced by truck traffic on nearby roads, are influenced by the distance of the structure from traffic and the condition of the roads. The level of vibration produced by traffic is usually less than the lower limit of human response given the distance of residences from the roads. Generally, current vibration sources do not create vibrations that exceed the level of human response within approximately 100 to 200 feet of a roadway. For this reason, the area is considered relatively free from seismic vibrations.

METEOROLOGY

General Climate

The climate of the region is continental, modified slightly by Lake Michigan 80 miles east, and Lake Superior, 93 miles north. The region has moderately warm summers with prevailing westerly winds and long cold winters. Summer weather is generally mild; temperatures rarely exceed 95°F during the day while night temperatures range between 50°F to 60°F. Winter temperatures range from 0°F to 25°F and occasionally will fall below -30°F.

Site Meteorology

At the project site, the winds are predominately from the south and west. All other directions accounted for the remaining observed wind directions. Wind speed less than one mile per hour accounted for about 14% of the observations and usually occurred at night.

Temperature information was collected at the site and at Nicolet College, 28 miles west-northwest of the site in Rhinelander. Mean monthly temperatures at the site were 2.7°F colder than those observed at Nicolet College. The highest temperatures recorded were 95°F at Nicolet College in July, 1977 and 91°F at the site. The lowest temperatures were -21°F in March, 1978 at the site and -24°F at Nicolet College in December, 1977 and February, 1978. The highest and lowest recorded temperatures in the region are 104°F and -40°F, respectively.

The long-term (1908 to 1980) annual average precipitation is 30.6 inches. Precipitation is greatest during early summer and least during mid-winter with snowfall averaging between 40 and 60 inches yearly.

AIR QUALITY

Monitoring for total suspended particulates (TSP) and sulfur dioxide was conducted to determine background levels at the project site. Background concentrations for the other criteria pollutants not monitored at the project site were collected at other locations. Table 2-15 presents a summary of TSP concentrations measured at the project site. A total of 113 sulfur dioxide (SO_2) samples were collected between November, 1977 and November, 1978. The SO_2 levels in the samples were all below detection limits (25 ug/m^3). Table 2-16 provides a summary of background concentrations of the remaining criteria pollutants measured elsewhere in Wisconsin. Except for one DNR sample found to contain one percent fly ash and one percent tire fragments, the particulates were from normal background sources, e.g. rock and soil minerals, plant and insect parts, and sulfates and nitrates. Chemical analysis of particles for heavy metals was conducted and results are presented in Table 2-17. The location of the air samplers is shown in Figure 2-12.

Table 2-15
Total Suspended Particulate (TSP) Concentrations
At Stations 1, 2, and 3 (ug/m^3)
(April 1977 - December 1978)

Concentrations	Station 1	Station 2	Station 3
Highest 24-Hour	99	65	74
Second Highest 24-Hour	77	61	73
Annual Geometric Mean	16.6	15.9	17.1[1]

[1] 11 months only

Table 2-16
Background Concentrations of Criteria Pollutants[1]

Pollutant	Averaging Period	Monitoring Site	Concentration
O_3 (ozone)	1-hour	Manitowish Waters (Vilas County)(1982)	0.084 ppm
Pb (lead)	Quarterly	Site #1 (Crandon)(1977)	0.11 ug/m^3

[1] Background concentrations for carbon monoxide and nitrogen oxides are considered negligible.

Table 2-17
Trace Element Concentrations at Station 1[1]
(April 1977 - March 1978)

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

[1] All concentrations expressed as nanograms per cubic meter (ng/m^3). A nanogram is equal to one-billionth of a gram.

Point Sources

A point source is a discharge to the air from an exhaust stack. The point sources nearest the site are in the City of Crandon. A large point source elsewhere in Forest County is Conner Forest Industries, 11 miles northeast of the site in Laona. There are other large point sources within 30 miles of the project site. The emission quantities for these sources are shown in Table 2-18. Fugitive dust emission estimates are not available for these sources. There is no evidence of noncompliance with air pollution rules from these sources.

Table 2-18
Emissions of Existing Point Sources of Air Pollution (tons/year)[1,2]

Source Name and City	Particulate Matter	Sulfur Oxides	Nitrogen Oxides	Carbon Monoxide	Hydrocarbons
Forest County					
Conner Forest Industries (Laona)[3]	80.9	1.4	25.7	36.8	12.9
Langlade County					
Vulcan Corporation (Antigo)	3.5	0.4	7.1	10.1	11.0
Kraft, Inc. (Antigo)	0.1	0.03	3.9	1.0	0.1
Yawkey-Bissell Hardwood Flooring Company (White Lake)	91.0	0.7	13.0	18.6	6.5
Oneida County					
Rhinelander Paper Co.	124.4	4862.4	1837.9	200.9	1101.2
Daniels Packaging Co.	0.1	0.02	3.1	637.5	0.6

[1] Wisconsin DNR, 1986.
[2] Actual 1985 annual emissions as determined by the DNR.

Line Sources

Line sources are roads and highways. In the environmental study area most roads are paved but receive light use. Vehicles using the highway network produce small quantities of emissions. For example, State Highway 55 from County Road K to Lake Metonga has the highest traffic volume in the environmental study area. This section of highway is 9.3 miles long and has an average daily traffic of 805 vehicles. The annual emissions from this section of Highway 55 listed in Table 2-19 are based upon existing traffic volume and average emission factors for 1979.

Table 2-19
Line Source Emissions

Emissions	Quantity (tons/year)
Carbon monoxide	110.0
Hydrocarbons	18.4
Nitrogen oxides	11.7
Sulfur oxides	0.6
Particulate matter	1.5

Area Sources

Area sources are farm fields or construction sites. Area source emissions have not been quantified within the environmental study area but they are believed to be minimal due to the limited amount of agriculture and the sparse population.

Sensitive Receptors

Sensitive receptors of air pollution include schools, residences, and recreation areas. The nearest sensitive receptor, the Mole Lake School is 2.5 miles west of the site. Permanent residences are widely scattered throughout the environmental study area. Concentrations of temporary and permanent residences occur around Little Sand Lake, Rolling Stone Lake, and Ground Hemlock Lake and at the Mole Lake Indian Reservation. There are several public boat landings in the environmental study area.

Odors

No known odor sources are within the environmental study area. No odor complaints from residents within the environmental study area have been received by the DNR.

Metal Deposition

Table 2-20 summarizes existing heavy metal deposition rates from the literature for both rural and urban areas. The values include rates from the nearby Lake Superior and Lake Michigan basins.

Table 2-20
Annual Heavy Metal Deposition from Atmospheric Sources

Metal	Natural Atmospheric Loadings (mg./sq. m./yr.) and Sampling Location	
Zinc	6.0	(N. L. Michigan basin)
	10-60	(Sudbury, Ontario)
	16.0	(L. Michigan)
	32.0	(L. Superior)
Lead	2.0	(N. L. Michigan basin)
	5-30	(Sudbury,Ontario)
	8.0	(L. Superior)
	10.0	(L. Michigan)
Arsenic	0.8-5.5	(Great Britain)
Manganese	3.0	(N. L. Michigan basin)
Copper	0.76	(N. L. Michigan basin)
	4.3	(L. Michigan)
	4.5	(L. Superior)
	50-300	(Sudbury, Ontario)
Cadmium	0.055	(N. L. Michigan basin)
	0.5	(L. Michigan)
	0.7	(L. Superior)
Chromium	0.8	(Sweden)
	2.2	(W. Germany)
	2.1-8.8	(Great Britain)

HUMAN (SOCIOECONOMIC) ENVIRONMENT

HISTORY OF THE LOCAL STUDY AREA

Fur traders were among the earliest non-native American resident settlers of the Local Study Area (Forest, Langlade and Oneida Counties), arriving in the 1850's. The financial panic of 1857 and the Civil War (1861-1865), however, slowed the exploration and settlement of northern Wisconsin. Following the Civil War, federal subsidization of a military road from Green Bay to Ft. Wilkins in the Upper Peninsula brought settlers and money to the region. Between 1860 and 1890 the growth of the Wisconsin pine lumber industry increased dramatically. During the 1870's, loggers and sawmill operators moved into Pelican Rapids (Rhinelander) and Lily. During the 1890's Wisconsin became the nation's largest supplier of pine. The introduction of the railroads and portable sawmills into the pinery replaced log driving streams and ushered in a new wave of development. Once the pine had been cut, the hardwood and hemlock trees were exploited. Hardwood logging led to yet another wave of economic development in the local study area and encouraged the establishment of a wood products industry in the region.

After the pine and much of the hardwood had been harvested, farmers settled on low-priced cut-over lands. As a result, the population of Oneida, Langlade, and Forest Counties rose rapidly. The population of Oneida County jumped from 8,875 in 1900 to 13,996 in 1920, with Rhinelander accounting for about half of the total. In Langlade County, the population increased from 685 in 1880 to 12,553 in 1900 and by 1920 reached 21,471. The population of Forest County jumped from 1,396 in 1900 to 9,850 in 1920. Most farmers, however, did not prosper; after the end of World War I, agricultural prices declined and two decades of agricultural depression followed. In 1935, the Wisconsin Isolated Settlers Project relocated farmers from 9,948 acres in the Crandon area. Despite the failure of many farms during the 1920's and 1930's, agriculture continues to be an important source of employment in the local study area. Areas suitable for agriculture are concentrated in Langlade and Oneida Counties where dairy farming and potato growing predominate. Today, 70% of the seed potatoes grown in Wisconsin are cultivated in Langlade County.

After 1925, reforestation was encouraged as the basis of future land use policy. The Forest Crop Law (1927) and the granting of authority to restrictively zone the cut-over (1929) helped limit the influx of farmers into areas unsuited for agriculture. These laws also provided incentives for timber landowners not to abandon their properties. The federal government also helped the state promote and undertake reforestation projects, and in 1933 created the Nicolet National Forest. State forests were established during this period and state subsidies for improving county forests and recreation also were granted.

Pulpwood for papermaking increasingly utilized spruce and balsam until a scientific breakthrough in the late 1930's allowed poplar/aspen to be used for pulp. Poplar flourishes on the cut-over pine lands and remains a vital resource in the area. Poplar pulp assured the economic viability of reforestation from a commercial-industrial perspective.

Reforestation lead to increases in tourism as recreational opportunities expanded. Tourism became the economic backbone of the area during the 1920's and by 1930 tourism provided larger tax revenues than agriculture. Although growth was limited during World War II, the area attracted new waves of recreation enthusiasts during the 1950's. To date, the area has remained attractive for recreationists, cottage owners, and retired persons.

Depopulation of the Local Study Area during the 1920's was reversed during the 1930's and the population reached new heights by 1940. Though the population of the three-county area continued to grow through the 1960's, the increase only amounted to 1,768 persons in total for an average rate of increase of 0.3% per year. A gradual decline in the number of working age people, however,

began in the 1960's. In addition, a sizeable reduction in the farm population, particularly in Forest County, also occurred. The number of manufacturing concerns located in the study area increased between 1940 and 1950. The existing pulp and other wood products industries also expanded. By 1960, about 22% of the working population of northern Wisconsin found employment in manufacturing. This increase, however, was offset by a decline in the rail industry which began in the 1950's. For example, the Chicago Northwestern laid off 400 employees in Antigo in 1951 as a result of competition from trucking. While industry remained in the study area during the 1960's, the region did not experience the economic growth that occurred elsewhere in the state during the decade.

DEFINITION OF THE LOCAL STUDY AREA

An impact area is usually defined as the geographic area in which significant impacts are likely to occur. The impact area, however, also should be defined as the governmental entities which are likely to experience significant impacts (Figure 2-13). The impact area for the proposed mine/mill includes the geographic area bounded by Langlade, Forest, and Oneida Counties, but it does not include every political entity within those boundaries. The primary level of analysis was given to the Townships of Nashville, Lincoln, Crandon and Elcho, and the City of Crandon, the two Native American tribes, the Rhinelander area (Rhinelander and the adjacent Townships of Pelican, Crescent, Newbold, and Pine Lake) and the Antigo area (City and Township of Antigo). The study area also includes the four school districts (Rhinelander, Antigo, Elcho, and Crandon). Although other municipalities would be impacted to varying degrees by the project, the impacts would not be unmanageable or markedly stress the existing character of the area. For this reason the remaining townships in these three counties were excluded from the local study area.

Examples of significant, discernible socioeconomic impacts include the following: higher rates of employment and higher levels of personal income due to growth in job opportunities for local residents; visible changes in a community's appearance due to changes in the character or value of the housing stock; new business opportunities as a result of increased demand for retail goods; changes in the property tax base or in payments received from a governmental impact assistance program, e.g., the Mining Investment and Local Impact Fund Board (MIB); and the need for new revenues for a jurisdiction because of project-related activities leading to increased tax or fee burden per household.

To arrive at a manageable definition of a local study area, five questions are asked with particular reference to the proposed mine/mill:

- Where would inmigrants work?
- Where would inmigrants live?
- How would shopping patterns change?
- What governmental entities could tax the project or receive MIB payments?
- Where would social contacts foster change?

Where Would Inmigrants Work?

Inmigrants directly employed by Exxon would work at the mine/mill, while inmigrants employed in secondary jobs would work mostly in the major trade centers, with smaller portions going to the less developed retail centers.

Where Would Inmigrants Live?

A number of factors influence where people live: commuting time to work; the availability of shopping service and entertainment centers; the quality of schools and housing availability. Commuting times to the project site are easily measured and provide a convenient indicator of inmigrant settlement patterns. A simplifying assumption was made that larger communities tend to attract more inmigrants than smaller ones because they offer more urban amenities.

In regard to commuting time to work, construction workers tolerate longer commuting times than operations workers. Studies have shown that construction workers tend to live within 73 miles or 1.4 hours of the job site, while operations workers tend to live within 40 miles or 0.8 hours. Workers who live farther away than these distances tend to move closer to the project site. These inmigrants tend to settle within 30 miles of the project or in major population centers within an hour's drive of the project site. Construction commuters could come from Iron River and Iron Mountain in Michigan's upper peninsula, and from Tomahawk, Merrill and Wausau. Certain locations may be more attractive than others because of their locations relative to the project and the amenities offered. Inmigrants who choose to live in settlements within a 30 minute commute of the project site could reside in the city of Crandon or the townships of Nashville, Lincoln, Crandon, and Elcho. Inmigrants settling within a one hour drive of the project would settle in the cities of Rhinelander and Antigo or the Townships of Crescent, Newbold, Pelican and Pine Lake in Oneida County or in the Township of Antigo in Langlade County. The Townships of Ainsworth, Schoepke, Monico, and Laona were candidates for inclusion in the study area, but did not appear to offer sufficient housing close enough to the project site to attract population. Although development is occurring south and west of Antigo in the towns of Rolling and Ackley, these areas are too distant from the mine site for significant numbers of inmigrants to settle.

The Rhinelander and Antigo areas are the major population centers in the local study area. The Rhinelander area has a population of around 17,800 including the city and the surrounding townships. The Antigo area has a population of around 11,000 including the city of Antigo and the adjacent townships of Ackley and Antigo. Because of their aggregate sizes, these two areas are likely to attract inmigrants.

How Would Shopping Patterns Change?

Shopping patterns determine the distribution of one of the project's positive impacts--increased retail sales stemming from higher levels of personal income. These increases in income may be attributable to direct employment by the project or secondary employment associated with project-related growth. Rhinelander and Antigo are the major trade centers in the area and account for 35% and 25%, respectively, of total retail sales in Langlade, Forest, and Oneida counties.

Wausau and Green Bay are within two-hour drives of the project and support significantly larger retail sectors than Rhinelander or Antigo. Their distances from the project site, however, would discourage casual shopping trips. Purchases made by the project-related population outside the study area would be minor in comparison to total retail volume in Rhinelander and Antigo.

What Government Entities Can Tax the Project or Receive MIB Payments?

Increases in local government revenues would be an impact of the project. These increases would occur when local governments tax the project or when the Mining Impact Board makes payments to local entities from net proceeds tax revenues. The following local government entities could levy property taxes on the proposed Crandon Project: Townships of Lincoln and Nashville, Crandon School District, Forest County, and Nicolet VTAE District. In addition, mandatory payments from the net proceeds funds are provided for the Mole Lake Chippewa Community and the Forest County Potawatomi Community.

Where Would Social Contacts Foster Change?

The primary social changes would occur to residents living close to the project, including the Sokaogan Chippewa and Forest County Potawatomi. Due to their proximity to the project site, frequent contact between members of these communities and the inmigrant population would be likely, and therefore, these two Native American communities were included in the study area.

In addition, interests of retirees and tourists or seasonal residents may conflict with some interests of newcomers. Some portion of the retirees may resist change in their communities. Seasonal residents may experience some competition with inmigrants for housing. Road congestion near the project site at shift changes may be disruptive to any residents using these roads. The potential for social contact also is great in the places where inmigrants live and shop.

POPULATION

The three counties of Forest, Langlade, and Oneida in aggregate lost population between 1950 and 1960 and experienced only moderate growth during the 1960s. During the 1970s, the development of retirement communities and year-round homes for recreation enthusiasts led to an increase in population in the local study area, particularly in the Rhinelander area and Oneida County. Between 1970 and 1984, the total three-county area population grew by 22 percent, exceeding the 8 percent growth evidenced in the state as a whole. The inmigration of large numbers of retired persons are apparent in the increase in numbers and percentage of persons aged 65 and older between the 1970 and 1980 census years. In 1970 this age group constituted almost 14 percent of the three-county population; by 1980 the proportion increased to almost 16 percent.

Forest County - The population decline in Forest County during the 1950s was reversed by a 23 percent growth in population between 1970 and 1984.

Langlade County - Langlade County lost population between 1950 (21,975 persons) and 1960 (19,916 persons) and has exhibited minimal growth since 1960. The county's population totalled 19,220 in 1970, 19,978 in 1980, and was estimated at 20,614 in 1984.

Oneida County - During the area's population decline in the 1950s, the only study area jurisdictions to show population increases were the city of Rhinelander and the townships which surround it. While these townships, Crescent, Pelican, Pine Lake, and Newbold, have exhibited a growth in population through 1984, Rhinelander's population has declined since 1960 from 8,790 to 7,985 in 1984. Oneida County as a whole had an average annual growth rate of about 2.5 percent between 1970 and 1980, and by 1984 the population estimate was 32,764. Table 2-21 illustrates the relative and absolute change in population in the three-county area between 1970 and 1984.

Table 2-21
Local Study Area Population 1970-1984

	1970	1980	% Change 1970-80	1984 WDA Prelim.	% Change 1980-84
Forest County	7,691	9,044	+18	9,465	+5
Crandon (city)	1,582	1,969	+25	2,093	+6
Crandon (township)	406	569	+40	632	+11
Lincoln (township)	350	577	+65	617	+7
Nashville (township)	519	703	+36	716	+2
Langlade County	19,200	19,978	+4	20,614	+3
Antigo (city)	9,005	8,653	-4	8,890	+3
Antigo (township)	1,692	1,661	+2	1,744	+5
Elcho (township)	885	1,078	+22	1,076	-
Oneida County	24,427	31,216	+28	32,764	+5
Rhinelander (city)	8,218	7,873	-4	7,985	+1
Crescent (township)	1,441	1,702	+18	1,837	+8
Newbold (township)	1,234	2,171	+76	2,428	+12
Pine Lake (township)	1,853	2,656	+43	2,806	+6
Pelican (township)	2,576	3,387	+32	3,391	-
3 County Total	51,338	60,238	+17	62,843	+4
State of Wisconsin	4,417,821	4,705,642	+7	4,774,000	+2

Source: U.S. Bureau of the Census and Wisconsin Department of Administration.

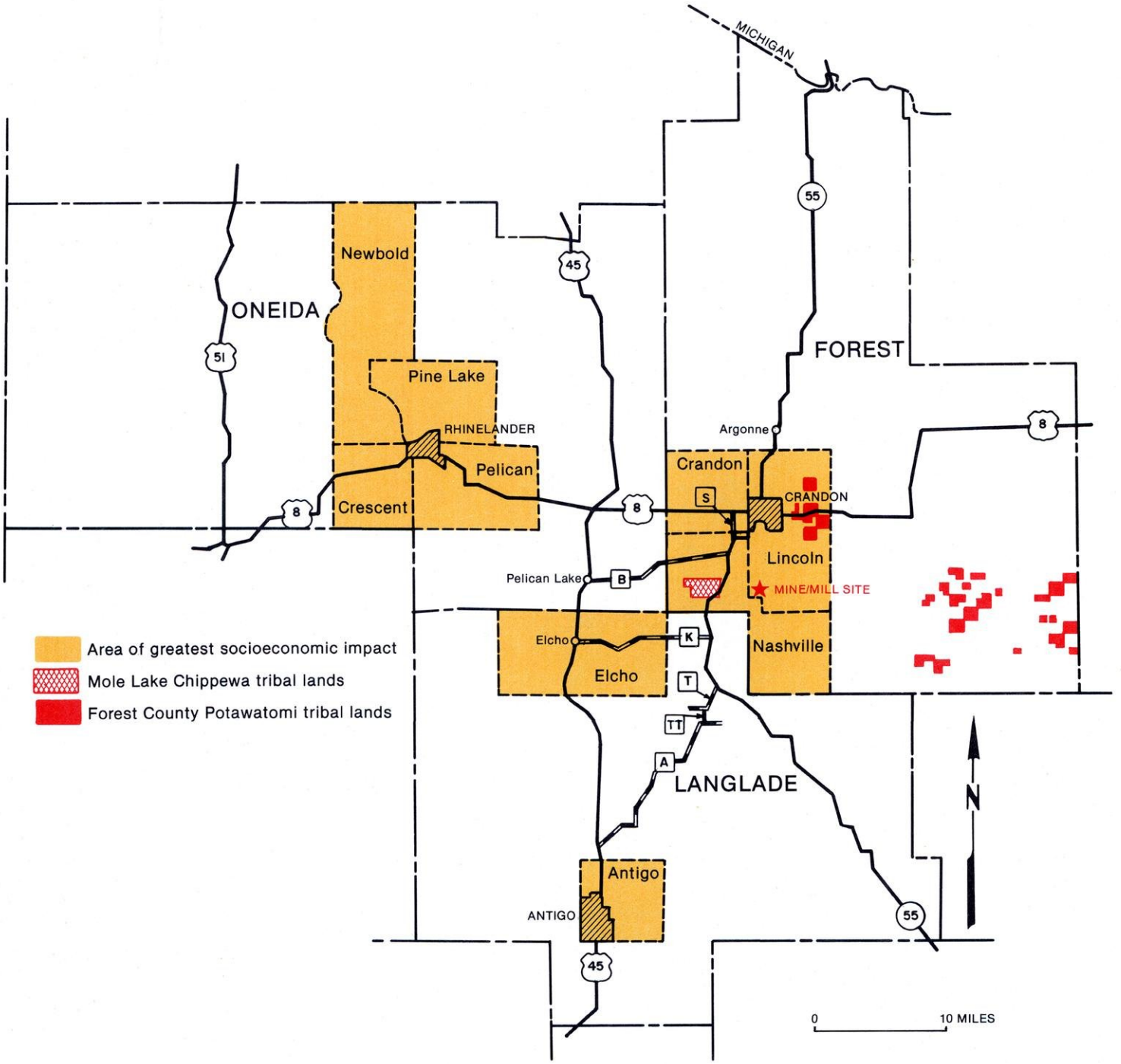


Figure 2-13. Socioeconomic Study Area

ECONOMIC BASE

The study area is less industrialized and less affluent than Wisconsin as a whole. Per capita personal income in all three counties is lower than statewide per capita income while unemployment rates are all higher. Overall, forestry and wood products manufacturing dominate the local study area economy, particularly in Forest and Oneida counties. Agriculture is important primarily in Langlade County. The recreation and tourism industry also is substantial and stimulates activity in retail trade and services. These are low wage industries and partially explain the low income levels in the local study area. Forest County is the least economically diverse of the three counties. It has the smallest population, lowest total income and earnings, and the lowest per capita income of the local study area.

Due to a relatively large agricultural base, Langlade County is the most economically balanced county of the local study area. Although manufacturing is the most important economic sector, retail trade, farming, services, and government also are important. Antigo, the Langlade county seat, serves as the county's industrial and trade center and accounts for about three-fourths of the county's total retail and service sale. Antigo also is the location of the county's major employers. Per capita personal income is higher in Langlade County than in Forest County. Both, however, were below the per capita income level in Oneida County and below state and U.S. levels.

Oneida County is the most populous and most economically developed of the three counties. The county surpasses both Forest and Langlade counties in total earnings, average weekly wages, and employment.

Personal Income - Table 2-22 shows total and per capita personal income by place of residence for the three counties. Personal per capita income is substantially lower in the local study area then the statewide and United States average per capita income.

Table 2-22
Local Study Area Personal Income, 1970, 1980, 1982[1]

	Forest County	Langlade County	Oneida County
Per Capita Personal Income ($ thousands/year)			
1970	$2,200	$2,700	$3,180
1980	5,460	6,970	7,920
1982	6,370	8,440	9,190
% of Average Statewide Per Capita Income			
1970	58	72	84
1980	58	75	85
1982	59	79	86
% of Average U.S. Per Capita Income			
1970	56	69	81
1980	57	73	83
1982	57	76	83
Total Personal Income by Place of Residence ($ millions/year)			
1970	$16.88	$ 52.11	$ 78.18
1980	49.74	140.09	249.05
1982	58.21	169.34	290.13

[1] Figures reported in then current dollars.

Source: U.S. Department of Commerce, Bureau of Economic Analysis. 1984 Regional Economic Information System, Personal Income by Source, Washington, D.C.

Table 2-23 displays retail sales data for the three study area counties. Excess retail sales capacity exists, particularly in the trade centers of Antigo and Rhinelander.

Table 2-23
Local Study Area Retail Sales, 1982[1]
(In Millions of 1982 Dollars)

	Total Retail Sales	Sales for Dominant Classes of Stores[2]		
			Total	As % of Total Retail Sales
Forest County	18	Food	4.4	24
		Automobile	3.0	16
		Eating and drinking	2.5	14
Langlade County	82	Food	23.6	29
		Automobile	14.3	18
		Eating and drinking	7.6	9
Oneida County	171	Food	36.8	22
		Automobile	25.6	15
		Eating and drinking	18.2	11

[1] Retail sales are receipts of retail establishments, including repairs or similar services. Receipts of service establishments are not included.
[2] Does not include all categories of retail sales so % of retail sale does not equal 100%.

Source: Sales and Marketing Management, "1983 Survey of Buying Power," 1983.

Earnings by Industry - Manufacturing was the single largest economic sector in 1982 for the three-county area, accounting for 21 percent of total earnings (Table 2-24). Retail trade, services, and government were next in importance, each contributing approximately 14 to 18 percent of total earnings for the three-county area. The combined share of services and retail trade (32 percent) reflects the importance of tourism to the economy.

There are differences in distribution of earnings by major industry among the three counties. In Forest County, government and manufacturing dominate. Next in importance are services and retail trade. In Langlade County, farming ranked first in total earning followed by manufacturing, retail trade, services, and government. In Oneida County, manufacturing had the greatest share of total earnings, followed closely by services, government, and retail trade.

Table 2-24
Local Study Area Earnings by Industry (1982)[1]
($ million)

County	1982	Percentage[1] of Total
Forest County		
Government	7.1	22
Manufacturing	6.5	20
Services	4.1	13
Retail trade	2.4	7
Transportation, communication, and utilities	2.0	7
Farming[2]	1.8	7
Langlade County		
Farming[2]	21.5	21
Manufacturing	20.7	20
Retail trade	14.1	14
Services	13.2	13
Government	13.0	13
Wholesale trade	7.5	7

Table 2-24 (continued)
Local Study Area Earnings by Industry (1982)[1]
($ million)

County	1982	Percentage[1] of Total
Oneida County		
Manufacturing	39.6	22
Services	39.5	22
Government	30.1	17
Retail trade	27.6	15
Transportation, communication, and utilities	11.4	6
Construction	10.1	6
Three-County Area		
Manufacturing	66.7	21
Services	56.8	18
Government	50.3	16
Retail trade	44.0	14
Farming[2]	27.9	9
Transportation, communication, and utilities	20.0	6
Wholesale trade	15.6	5
Construction	15.3	5

[1] Does not include all sources of earning so % will not total 100%.
[2] Includes logging.

Source: U.S. Department of Commerce, Bureau of Economic Analysis, 1984 Regional Economic Information System, Earnings by Industry, Washington, D.C.

Unemployment Rates - Unemployment rates for the local study area are typically higher than for Wisconsin. The difference is particularly great for Forest County, where the unemployment rate has been close to double the state average for each year from 1982 to 1985 as shown in Table 2-25.

Table 2-25
Unemployment Rates, 1982-1985

	1982	1983	1984	1985
U.S.	9.7	9.6	7.5	--
Wisconsin	10.7	10.4	7.6	7.2
Forest County	20.5	18.5	14.2	12.8
Langlade County	9.6	10.1	8.2	7.8
Oneida County	11.2	10.4	9.2	8.2

Sources: U.S. Department of Labor, Bureau of Labor Statistics, 1984. Wisconsin Department of Industry, Labor and Human Relations, Labor Market Information 1984.

Average Weekly Wages - In 1984, the lowest average weekly wage for covered employment (see following section) in the three county area ($192) was in Forest County, followed by Langlade County ($235) and Oneida County ($264) (Table 2-26). The industrial categories with the highest wages in Forest County were finance, insurance and real estate ($265), wholesale trade ($262), and transportation, communication and utilities ($256). In Langlade County, the average weekly wage for construction was highest ($305), followed by wholesale trade ($283) and manufacturing ($274). In Oneida County, location of Exxon's Crandon Project Offices, sand and gravel mining, with an average weekly wage of $870, showed the highest wage among industrial categories, followed by manufacturing ($400), transportation, communication, and utilities ($322) and wholesale trade ($317). In all three counties, retail trade and services commanded among the lowest average weekly wage rate.

Total Covered Employment - Statistics on total covered employment by quarter illustrate both the dominance of Oneida County as the major employment base for the three county area and the seasonal nature of employment in each county (Table 2-26). Covered employment includes only those employees of employers who are subject to the Wisconsin Unemployment Compensation Law.

Table 2-26
1984 First Quarter Average Covered Employment

Industry	Forest County		Langlade County		Oneida County	
	Covered Employment	Average Weekly Wage	Covered Employment	Average Weekly Wage	Covered Employment	Average Weekly Wage
All industries	1,860	$190	5,440	$240	9,890	$260
All government	580	200	920	270	1,700	280
Agriculture, forestry and fishing[1]	--	--	170	200	160	180
Mining	0	--	0	--	20	870
Construction	20	110	140	310	310	240
Manufacturing	540	210	1,260	270	1,600	400
Transportation, communication and utilities	130	260	280	260	470	320
Wholesale trade	40	260	350	280	280	320
Retail trade	230	120	1,240	180	2,370	160
Finance, insurance, and real estate	50	270	160	260	400	340
Services	280	170	930	200	2,570	250

[1] Information on logging withheld for confidentiality.

Source: Wisconsin Department of Industry, Labor and Human Relations.

HOUSING

Consumer preferences within the local study area have created residential patterns characterized as medium to low density, with recent growth concentrated in the townships surrounding Rhinelander. This concentration of growth in communities surrounding historical population centers, combined with the slow growth or population declines in these centers, illustrates the increasingly dispersed nature of housing development in the local study area. Table 2-27 shows the total supply of housing units existing in the local study area at the time of the 1980 census. A housing unit is defined as the residence of one household, e.g., a house, an apartment, or a mobile home. In addition to total housing stock, the table subtracts second homes which are not considered year-round residences. Finally, the vacancy rate for each community is estimated by comparing occupied units with the year-round housing units available in the local study area. Table 2-27 also shows the relative condition of the occupied housing stock at the time of the 1980 census. Housing is determined to be "substandard" if one of the following conditions is met:

1. An owner-occupied unit is valued at less than $15,500;

2. A renter-occupied unit lacks some or all plumbing facilities; or

3. A renter-occupied unit with all plumbing facilities has a rent below the median rent for units lacking some or all facilities.

Table 2-28 provides an inventory of existing and potential residential land within the local study area, indicating a substantial capacity to accommodate growth within the primary population centers. A parcel is designated as "improved" if the assessor's office shows taxable improvements in the parcel's valuation.

Table 2-27
Housing Supply in the Local Study Area, 1980

	Total Units	Year-round Units	Occupied Units	Vacancy Rate %	Substandard Units	Percent Substandard
City of Crandon	869	811	694	14	198	29
Crandon Township	302	183	163	11	25	15
Lincoln Township	708	253	187	26	27	14
Nashville Township	1,025	610	257	58	41	16
TOTAL Forest County	6,229	3,652	2,792	24	631	23
City of Antigo	3,498	3,495	3,344	4	881	26
Antigo Township	540	540	520	4	62	12
Elcho Township	1,313	496	433	13	90	21
TOTAL Langlade County	9,595	7,528	6,901	8	1,519	22
City of Rhinelander	3,184	3,182	3,020	5	735	24
Crescent Township	895	645	556	14	47	9
Newbold Township	1,774	1,076	734	32	65	9
Pelican Township	1,766	1,390	1,209	13	153	13
Pine Lake Township	1,262	964	901	7	75	8
TOTAL Oneida County	17,669	10,812	8,718	19	1,304	15
TOTAL, Local Study Area	33,493	21,992	18,411	16	3,454	19

Source: 1980 Census of Population and Housing, Wisconsin.

Table 2-28
Residential Parcels Within the Local Study Area, 1984

	Total Residential Parcels	Improved Parcels	Vacant Parcels	Percentage Improved
City of Crandon	1,300	673	627	52
Crandon Township	365	253	102	72
Lincoln Township	948	604	344	64
Nashville Township	1,313	826	487	63
City of Antigo	3,091	2,777	314	90
Elcho Township	1,422	1,109	313	78
City of Rhinelander	2,925	2,470	455	85
Crescent Township	1,104	803	301	73
Newbold Township	2,433	1,618	815	67
Pelican Township	1,737	1,197	540	69
Pine Lake Township	1,492	1,084	408	73

Source: Assessors' offices--Forest, Langlade, and Oneida counties.

Government Structure and Public Finance

Mining Impact Fund - The State of Wisconsin established the Mining Investment and Local Impact Fund to: ".... assure that monies will be available to such municipalities for long and short term costs associated with social, educational, environmental and economic impacts of metalliferous mineral mining." (Section 70.37(1), Wisconsin Statutes)

The 11-member Mining Impact Board (MIB) manages funds generated by Wisconsin's net proceeds tax on mines and distributes them to local governments to mitigate metallic mining impacts. The legislature has provided $2.758 million in loans to meet front-end costs in areas anticipating mining development. Loan repayment was planned to begin in 1988.

The funds are distributed to local communities both through legislative authorization (Section 70.395, Wisconsin Statutes) and through discretionary grants by the board. The direct payments are made to localities where mining is occurring or is proposed. Discretionary payments also can be made to communities in the area surrounding those localities. In 1983, the board began annual permit period payments of $100,000 (indexed to a measure of the gross national product) to Lincoln and Nashville Townships and the Forest County Potawatomi and the Sokaogan Chippewa tribes. These payments will continue through 1986 during the mine permitting process. Following initiation of mine construction, construction period payments would be made to the same four municipalities. These could continue for up to three years after concentrate production begins and would be paid by the applicant to the MIB. The construction period payments would be $100,000 annually (indexed). In addition, during the construction period, Forest County is eligible to receive reimbursement for mining-related costs for three years. The amount they are eligible to receive each year is a maximum of $300,000 reduced by the amount of property taxes paid by Exxon to the county.

Following the construction period payments, "first dollar" payments of $100,000 per year (indexed) would be made to the same two towns and two Indian tribes and to Forest County. In addition, Forest County is eligible to receive 20 percent of the net proceeds tax collected or $250,000, whichever is less. The first dollar payments and the additional sum to Forest County are dependent upon sufficient net proceeds tax revenue from the mine, and thus, unlike the permit period and construction period payments, are not guaranteed.

Many of the discretionary funding allocations have been to Local Impact Boards which serve throughout the three-county area. Local Impact Boards serve as the focal point for local residents concerned about mining impacts. The boards also have been active in local planning efforts aimed at adapting to mine-related development.

Public Costs to Municipalities - Existing standards for public services in the local study area can be measured on a per capita basis. The purpose for measuring standards in this manner is to use them in developing estimates of increased public costs due to the expected population increase. Using prevailing standards has the effect of including deferred maintenance, outdated equipment, and understaffing, where such conditions may exist, as part of the prevailing standards for each jurisdiction since these conditions are "built into" the derived per capita cost factors. Table 2-29 identifies the existing public cost standards. Included are costs for general government, water supply and wastewater treatment (where appropriate), fire and police protection, library (where appropriate), recreation, street and roads, and solid waste disposal.

Table 2-29
Public Service Costs Per Capita (1982 Dollars)

	Costs Per Capita
Crandon (city)	$ 300
Crandon (township)	120
Lincoln (township)	330
Nashville (township)	290
Crandon School District (per pupil)	2,270
Forest County	520
Antigo (city)	560
Antigo (township)	110
Elcho (township)	170
Antigo School District (per pupil)	2,740
Elcho School District (per pupil)	2,820
Langlade County	390

Table 2-29 (continued)
Public Service Costs Per Capita (1982 Dollars)

	Costs Per Capita
Rhinelander (city)	550
Crescent (township)	100
Newbold (township)	110
Pelican (township)	70
Pine Lake (township)	100
Rhinelander School District (per pupil)	2,890
Oneida County	320

Source: From Denver Research Institute, 1986.

Net Proceeds Tax - There is a net proceeds occupational tax on metalliferous mineral extraction (s. 70.37, Wisconsin Statutes). This tax is a graduated mine profits tax to compensate the state and local municipalities for the loss of irreplaceable minerals. The tax rates vary from 3% on amounts up to $5 million to 15% on amounts exceeding $25 million. Sixty percent of the net proceeds tax is deposited in the Mining Investment and Local Impact Fund to mitigate the negative impacts of mining. The remainder is deposited in the Badger Fund, a dedicated trust fund. Interest from the Badger Fund is used for recreation and education in Wisconsin. The Legislature did not designate how principal in the Badger Fund would be used..

Property Taxes - A number of different jurisdictions in the local study area provide services to their residents and have the authority to levy property taxes to pay for those services. The jurisdictions include towns, cities, villages, counties and school districts. Thus, a resident in the local study area pays taxes to a city, village or township, plus the county, school district, and vocational-technical district, as well as the State of Wisconsin. The general property tax is the largest single locally raised revenue source of local governments.

The property tax levied by a local government is based on the difference between the actual costs of the service minus any state and federal funds or user fees provided to the non-tax revenues local unit of government. Property taxes are based on the assessed value of each property within a taxing jurisdiction. The parcel owner is liable for the same percentage of a jurisdiction's tax levy as the parcel's percentage of the total property value in their jurisdiction. For example, if a parcel's value is equal to 3 percent of the total property value in the municipality, 2 percent of the school district total value and 1 percent of the county total value, then the parcel's owner must pay 3 percent of the total municipal tax levy, 2 percent of the total school tax levy, and 1 percent of the total county tax levy. The assessed value of a property is determined by a local tax assessor except for manufacturing property, which is assessed annually by the Wisconsin Department of Revenue.

For residents (land owners) in the project area, about 60% of their taxes are paid to the school district, 20% is allocated to the county, and 12% to the local municipality. Table 2-30 shows how local residents' taxes from three townships are allocated to the five taxing jurisdictions. Since the school district levey is the largest of the tax bill components, any change in it would have the greatest impact on tax bills.

Table 2-30
Allocation of Property Taxes to Taxing Jurisdictions, 1984 Tax Year

	Nashville Township %	Lincoln Township %	Elcho Township %
School District	59	62	58
County	19	20	22
Township	12	8	11
VTAE	9	9	7
Other	1	1	2
	100	100	100

Source: From Township, Village and City Taxes - 1984, Department of Revenue.

State equalization aids help offset local property taxes. These equalizing aids consist of payments to municipalities, counties, and school districts. The equalizing aids are primarily affected by a local jurisdictions' spending, revenues, and property values within the jurisdiction and its student enrollment (in the case of school districts) in comparison to other jurisdictions in the state. In addition, other payments from state and federal sources contribute to revenues of local governments. Table 2-31 shows the major sources and relative amounts of revenues for local municipalities, and indicates that property taxes make up from 14% of all revenues for Lincoln Township to 28% of the total revenues for Nashville Township. Local municipalities are dependent upon revenues from a variety of state sources.

Table 2-31
Revenue Sources for Local Municipalities[1]
by Category and Percent of Total

	Total Revenues	Health & Social Service Aids		Transp. Aids		Property Tax		State Shared Revenue	
Lincoln Township	$247	$81	33%	$65	26%	$35	14%	$19	8%
Nashville Township	$406	$105	34%	$37	12%	$87	28%	$21	7%
Forest County	$3823	$845	22%	$203	5%	$753	20%	$161	4%

[1] In thousands of 1984 dollars. From Resources Provided and Expended, Department of Revenue 1986.

PUBLIC FACILITIES AND SERVICES

The following section contains descriptions of the major facilities and services provided by the local study area municipalities. Included are sections on human services, school districts, the transportation system, municipal water and wastewater treatment systems, utilities, and solid waste disposal sites.

Human Services

The Wisconsin Department of Health and Social Services is responsible for planning, policy development, standard setting, funding and monitoring of most of the community programs in the local study area. The department has jurisdiction in the areas of mental health, alcohol and drug abuse, developmental disabilities, social services, youth services, day care, senior services and vocational rehabilitation. Only Job Services and domestic violence programs are not within the purview of the Department of Health and Social Services. Job Services is a division of the Department of Industry, Labor and Human Relations. Domestic violence programs are organized under the Governor's Domestic Abuse Council.

Most community-based human services programs are organized on a county basis. Many human services are statutorily mandated county responsibilities. Table 2-32 summarizes the role of Forest, Langlade, and Oneida counties in the delivery of community-based human services.

Table 2-32
Human Services Delivery in the Local Study Area

	Statutorily Required County Involvement	Not Statutorily Required, but Tradition of Strong County Involvement	State/Federal Program--Little or No County Involvement	Private Sector Program--Little or No County Involvement
Mental health	X			
Alcohol and drug abuse	X			
Developmental disabilities	X			
Domestic violence				X-some state support

Table 2-32 (continued)
Human Services Delivery in the Local Study Area

	Statutorily Required County Involvement	Not Statutorily Required, but Tradition of Strong County Involvement	State/Federal Program--Little or No County Involvement	Private Sector Program--Little or No County Involvement
Social Services	X			
Youth services	X			
Day care				X-state licensed
Senior services		X		
Vocational Rehabilitation			X	
Job Services			X	
Health manpower				X
Emergency medical services		X		
Hospitals				X-state licensed some federal and state subsidization
Nursing homes				X-state licensed some federal and state subsidization
Public health services		X		
School Health		X		

Mental Health - Mental health services in Oneida and Forest counties are provided by the Human Services Board of Forest, Oneida, and Vilas Counties (s. 51.42 Wis. Statutes) both directly and on a contractual basis. There are several private providers in the local study area as well. Northwoods Guidance Center has their main office in Rhinelander with a satellite office in Crandon. The Crandon office is staffed one day a week. The Northwoods facility, built three years ago, is adequate for current needs. The current average client load is approximately 950 clients per year with about 55 new clients seen per month. In Langlade County, community based mental health services are provided by the Human Services Board of Langlade, Lincoln, and Marathon Counties (s. 51.42 Wis. Statutes). Mental health services include outpatient counseling at the Langlade Health Care Center in Antigo. There is typically a waiting list at all clinic offices.

Alcohol and Drug Abuse - Alcohol and drug abuse services in Forest and Oneida counties are provided by the Lakeland Council on Alcoholism and Other Drug Abuse and the Human Services Board of Forest, Oneida and Vilas Counties. The Lakeland Council provides outpatient counseling services to substance abusers and their families, crisis intervention services, information and referral services, and prevention services including a very active education program in the public schools. Satellite offices are located in Rhinelander, and Crandon. The office in Rhinelander is staffed full-time. The Crandon office is staffed two days a week, although counseling is only available one day a week. The Human Services Board of Langlade, Lincoln and Marathon Counties provides alcohol and drug abuse services at the Langlade Health Care Center in Antigo.

Health Services (Forest County) - Health Staff - The situation in Forest County is typical of many rural areas where it is difficult to attract and retain health care professionals. According to standards of the Wisconsin North Central Area Health Planning Association, the county is underserved by primary care physicians (e.g., family medicine, general practice, internal medicine, pediatric, and obstetrics/gynecology practitioners), registered nurses, licensed practical nurses, dentists, and optometrists. The federal government has also designated seven townships in Forest County as federal shortage areas for primary care

physicians. The entire county has been designated as a federal shortage area for psychiatrists. A federal shortage area is one in which health manpower does not meet minimum federal standards for personnel per population for classes of health manpower covered by federal legislation. The health manpower supply for Forest County is summarized in Table 2-33.

Table 2-33
Forest County Health Staff

	Active[1]	FTE[1]	Standard[2]	Ratio to 1984 Population
Physicians	3	3	--	1:3,155
Primary care physicians	3	3	1:2,000	1:3,155
Registered nurses	19	15.1	1:215-310	1:627
Licensed practical nurses	8	6.9	1:380	1:1,372
Dentists	2	2	1:1,500	1:4,733
Optometrists	1	0.5	1:7,150	1:18,930

[1] Wisconsin Department of Health and Social Services, Division of Health, Center for Health Statistics, 1982 Maternal Child Health Profiles. FTE full-time equivalent.
[2] Wisconsin North Central Area Health Planning Association, Annual Implementation Plan, 1982.

Emergency Medical Services - In the project area, emergency medical services are provided in Crandon and the Township of Nashville. The Crandon Area Rescue Squad, Inc., provides ambulance service to the area of Forest County surrounding Crandon, including the townships of Crandon, Lincoln, and Nashville. The ambulances are fully equipped. Emergency Medical Services, Township of Nashville, maintains two ambulances at the fire station in the Township of Nashville. There are seven emergency medical technicians, four first responders, and two registered nurses.

Hospitals - No hospitals are located in Forest County. St. Mary's Hospital in Rhinelander and Langlade Memorial Hospital in Antigo are the closest hospitals providing primary acute inpatient care (the least specialized level). Secondary care is available at the Wausau Hospital Center. Tertiary care (the most specialized level) is available in Marshfield, 140 miles from Crandon. Serious illnesses and accidents frequently require secondary or tertiary hospital care.

Health Services (Oneida County) - Health Staff - Oneida County has adequate numbers of primary care physicians. There also is an adequate supply of optometrists and registered nurses. The number of dentists and licensed practical nurses, however, is below standard. The county has no resident psychiatrists and is currently designated as a federal shortage area. Most of the health care professionals in the county are located in Rhinelander. The health staff supply for Oneida County is summarized in Table 2-34.

Table 2-34
Oneida County Health Staff

	Active[1]	FTE[1]	Standard[2]	Ratio to 1984 Population
Physicians	56	52.9	--	1:619
Primary care physicians	27	24.9	1:2,000	1:1,316
Registered nurses	261	218.5	1:215-310	1:150
Licensed practical nurses	64	51.7	1:380	1:634
Dentists	20	17.1	1:1,150	1:1,916
Optometrists	5	5	1:7,150	1:6,552

[1] Wisconsin Department of Health and Social Services. FTE = full-time equivalent.
[2] Wisconsin North Central Area Health Planning Association, Annual Implementation Plan, 1982.

Emergency Medical Services - Emergency medical services in the county are supplied by St. Mary's Hospital in Rhinelander and Howard Young Medical Center in Woodruff.

Hospitals - St. Mary's Hospital in Rhinelander is a 133-bed primary care facility. St. Mary's is jointly managed with Sacred Heart Hospital in Tomahawk (20 miles from Rhinelander) in Lincoln County. Sacred Heart has an 11-bed psychiatric ward and a 28-day alcohol and drug abuse unit licensed for 15 beds. St. Mary's had a 50 percent occupancy rate in 1984. Citizens from Oneida County must travel out of the county to receive secondary and tertiary hospital care.

Health Services (Langlade County) - Health Staff - There are an adequate number of primary care physicians in Langlade County and there are two medical clinics in Antigo. The number of registered nurses, licensed practical nurses, and dentists is below standard in Langlade County. The health staff supply for the county is summarized in Table 2-35.

Table 2-35
Langlade County Health Staff

	Active[1]	FTE[1]	Standard[2]	Ratio to 1984 Population
Physicians	13	1.3	--	1:1,586
Primary care physicians	11	11	1:2,000	1:1,874
Registered nurses	70	51.5	1:215-310	1:400
Licensed practical nurses	64	13.3	1:215-310	1:1,550
Dentists	10	8.9	1:1,150	1:2,316
Optometrists	4	4	1:7,150	1:5,154

[1] Wisconsin Department of Health and Social Services, Division of Health, Center for Health Statistics, 1982 Maternal Child Health Profiles. FTE = full-time equivalent.
[2] Wisconsin North Central Area Health Planning Association, Annual Implementation Plan, 1982.

Emergency Medical Services - Emergency medical services are provided county-wide in Langlade County by the county subsidized Crawford Ambulance Service. There are four emergency medical units located in Antigo, Elcho, White Lake, and Pickerel. The Antigo unit has two ambulances and 23 emergency medical technicians. The Elcho unit has one first-response van and 14 emergency medical technicians. Funding is from the county and fees for service. The ratio of emergency medical technicians to population in the city and township of Antigo and in Elcho are within state standards of adequacy.

Hospitals - Langlade Memorial Hospital is an 80-bed primary care facility located in Antigo. There are no psychiatric or alcohol and drug rehabilitation beds. The hospital had a 48 percent occupancy rate in 1983.

Social Services (Oneida County) - The Oneida County Department of Social Services provides two main divisions of services: social services and income maintenance.

The income maintenance section of the department administers public assistance programs such as AFDC (Aid to Families with Dependent Children), medical assistance, food stamps, and general relief. Social services include a variety of youth and adult programs. The Oneida County Department of Social Services serves the whole county.

In 1983 there were 1,469 new applications for service. This represented a 40 percent increase from 1982. During 1983, significant increases in case loads were experienced in the areas of juvenile drug abuse, guardianships and protective placements, sexual abuse cases, day care requests, supportive home care requests, and family and financial counseling requests. The income maintenance section of the agency also experienced substantial increases in every program administered. These trends continued in 1984.

Social Services (Forest County) - The Forest County Department of Social Services offers social services and income maintenance programs for the entire county, including the two Native American communities. There are ten full-time equivalent staff, including the director, two social workers, and three income maintenance workers. The department has Native American clients in several programs, including AFDC, protective services and juvenile problems (about 50 percent of the clients in this category are Native Americans), and some medical assistance and food stamps.

Standards (0.5 social workers per 1,000 population) suggests the department needs should have at least two more social workers. Only very basic needs in the county are being met because of this shortage. Program needs include an intensive home care program to prevent expensive institutionalization.

Social Services (Langlade County) - The Langlade County Department of Social Services provides social services and income maintenance programs for the entire county. The department has 15.5 FTE employees, including four social workers and four income maintenance workers. Participation in the income maintenance programs has remained at a high level because of high unemployment. Total expenditures in 1983 were $6.8 million.

School Districts

All four districts in the local study area (Antigo, Crandon, Elcho, and Rhinelander) have had generally declining enrollment from peak mid-1970's figures. The age of school buildings and equipment is a major concern common to all the districts. The problem is most acute in the two largest districts, Antigo and Rhinelander, where bond issues for new school construction have failed repeatedly. Table 2-36 shows 1984-85 enrollment and capacity.

Antigo School District - The 1984-85 enrollment of 3,087 was down nearly 30 percent from the 1975-76 peak of 4,215. The pupil/teacher ratio of 15.7 and pupil/staff ratio of 13.7 were very close to the state average of 16 and 13.9 respectively. The average per pupil cost of $3,580 (1983-1984) was within 1 percent of the state average. Although enrollment in the lower grades has stabilized, total enrollment is expected to drop even further.

Crandon School District - 1984-1985 enrollment in the Crandon School District was 986 students, down from over 1,100 ten years ago. The pupil/teacher ratio of 18.8 and pupil/staff ratio of 15.8 are significantly above the state average, and as a result, the average cost per student of $3,070 (1983-1984) was 15 percent below the statewide average of $3,621. The enrollment figures for each school within the district are below capacities, and additional students could be absorbed at each of the schools. The Crandon junior/senior high school requires structural and wiring repairs.

Elcho School District - The Elcho School District's enrollment has declined from a peak of 613 students in 1973-1974 to 485 students in 1984-1985. The pupil/teacher ratio of 13.9 and pupil/staff ratio of 12.6 are significantly lower than the state averages, and the average cost per pupil (1983-1984) of $3,780 was 4 percent greater than the state average. The decline in the size of entering classes has begun to level off and enrollment is expected to remain stable through the year 2000. Although the Elcho District does not face the immediate need for new facilities, deferred maintenance and equipment needs may pose problems in the future. Because of its relatively large tax base, the district currently receives minimum state school aid.

Rhinelander School District - The age of school facilities and the recent failure of bond issues for school construction are prominent issues in the Rhinelander School District. Bond issues for construction of a new kindergarten through 6th grade (K-6) school in Pelican and an addition to West School (K-6) failed to win approval in 1984 and 1985. Enrollment has been declining in the district to the present level of 3,326. The pupil/teacher ratio of 16.8 and pupil/staff ratio of 14.6 are slightly higher than the state averages, while the average cost per pupil of $3,510 was three percent lower than the state average for 1983-1984. West School is currently at capacity and Pelican School may need to be replaced. The school board has developed a plan for renting additional space to ease the situation at West School.

Table 2-36
Public School Capacity and Enrollment (1984-85 School Year)

School	Capacity	Enrollment
	Elementary	
Rhinelander		
West	260	216
Pelican	230	167
Central	205	202
Crescent	165	133
Curran	205	89
Newbold	205	167
Pine Lake	345	311
South Park	205	132
Woodboro	123	83
Crandon		
Argonne	130	110
Crandon	375	323
Mole Lake	120	98
Antigo		
Crestwood	200	146
East	200	169
Lily	75	55
North	285	235
Pleasant	200	153
River Grove	225	201
Spring Valley	200	162
West	325	290
	Junior High	
Rhinelander - J. W. Jr. High	700	500
Antigo - Antigo Jr. High	625	531
	Senior High	
Rhinelander Senior High School	1,700	1,297
Crandon Junior/Senior High School	520	450
Elcho School (K-12)	525	485
Antigo Senior High School	960	961

Transportation Systems

The transportation system in the local study area depends largely on private automobiles, buses and school buses, trucks, and a highway net provided by the state, the counties, and (to some extent) the towns. The Soo Line is the dominant railroad, but carries only freight, no passengers. Rhinelander has the major airport in the local study area.

Roadways - The major state system highways are U.S. 8 connecting Rhinelander, Crandon, and Laona, U.S. 45 between Antigo and Three Lakes, and State Highway 55 connecting Argonne, Crandon, and south to the county line (Figure 2-13). These roads, while not usually lane separated, are all carrying less than their design capacity according to the Wisconsin Department of Transportation (DOT) planners. Peak traffic volume, measured in daily or hourly seasonally adjusted peak traffic, is below design standards for all roadways. DOT, however, reports the highest accident rate in the local study area to exist on State Highway 55 between Crandon and the Langlade County line. Improvements are scheduled for U.S. 45, and long-range planning for improvements on State Highway 55 has been announced. There is some congestion on these routes within the cities, particularly during the summer tourist season. A particular hazard exists for the heavy pedestrian traffic on State Highway 55 in the vicinity of Mole Lake.

The Department of Transportation (DOT) has developed a highway deficiency rating called the Critical Accident Ratio (CAR). The CAR compares a particular highway segment with the statewide average to measure its relative hazardous rating.

The CAR for a particular highway segment is calculated from the average daily traffic (ADT) and the number of accidents on that segment. Accidents are expressed as accidents per 100 million vehicle-miles over a three year period. By comparing the CAR number with a statewide average, a ratio is obtained. DOT evaluates any highway with a CAR greater than 1 as abnormally high.

State Trunk Highway 55 south of Crandon has two segments with abnormally high CAR's. One segment is a 9.3 mile segment between County Trunk Highway M and the northern boundary of the Menominee Reservation. This segment has an ADT of 408 and has experienced 22 accidents over a three year period. The accident rate per 100 million miles is 530, and the CAR is 1.18. The second segment is 8.35 miles between the southern boundary of Forest County and Crandon. This segment has an ADT of 950. In comparison, the rural statewide average is 233 accidents per 100 million miles. The accident rate per 100 million vehicle miles is 533, and the CAR is 1.38. The other segments along STH 55 in Langlade and Menominee Counties have a CAR which varies between .3 and .7.

The county roads vary greatly in adequacy and deferred road maintenance is a problem on some roads. Forest County Highway M, and the stretch of County Highway S between State Highway 55 and U.S. 8 are narrow with little or no shoulder. On the other hand, Langlade County Highway A is excellent. Langlade County Highway K (from State Highway 55 to Elcho) is adequate for present traffic.

Forest County is unable to maintain adequate snow removal and road maintenance. The highway department is judged to be understaffed and in need of updated equipment and facilities. The county resurfaces an average of 3-4 miles (4%) of its roadways annually. Four of the county's seven graders (with an estimated effective life of 15 years) are over 25 years old.

Railroads - The Soo Line provides rail service to Forest and Langlade Counties with the segment between Argonne (Forest County) and Fond du Lac (Fond du Lac County) of particular interest. The line carries north-south through traffic between Sault Ste. Marie, Michigan and Chicago. The line also transports raw wood products from northern Wisconsin and the upper peninsula of Michigan to the Green Bay and Fox River Valley pulp and paper manufacturers. The total amount of freight moved over the line is approximately 2.5 million tons per mile per year southbound and 1.5 million tons per mile per year northbound. This is considered a low to moderate amount of freight traffic. This traffic is profitable and consistent with much of the Soo Line system. Most traffic along the line (one train per day in each direction) is in transit between other points, but some local traffic does begin and end in Forest and Langlade Counties.

Recent levels of local rail traffic are generally less than one hundred carloads per year of outbound raw wood and inbound liquified propane gas. Local traffic from Crandon, Freeman, Lily, Hollister, and White Lake cannot financially support rail service on the line without the revenue contributed by through traffic moving from the upper Fox River Valley and Chicago to Sault Ste. Marie. The line through Forest and Langlade Counties is in good condition, but the rail is among the lightest in use.

Air Travel - The Rhinelander-Oneida County Airport can handle jet aircraft and has some landing aids. Republic Airlines served the airport until 1984. Subsequently, service has been provided by Republic Express and Air Wisconsin.

Community Water Supplies

The four community water supply facilities in the local study area are summarized in Table 2-37. All other homes in the local study area are served by individual wells.

City of Crandon - The water supply system is generally confined to city limits. Future review of the storage capacity may be necessary in order to maintain an adequate quantity of water in storage.

City of Antigo - The water supply system presently accommodates the existing demand. Unsafe bacteriological samples and volatile organic compounds have been detected in several wells. An engineering study to plan for an adequate quantity of good quality water into the future should be prepared.

Elcho Sanitary District No. 1 - The boundaries of the district's water supply system are unknown but the system has sufficient capacity to accommodate existing demand. A second well was recently constructed to improve system reliability.

City of Rhinelander - The water supply system presently accommodates existing residential demand. Unsafe bacteriological samples periodically collected at two wells along with a volatile organic compound at one of these same wells are cause for concern. An engineering study to examine groundwater quality and quantity, source capacity, elevated storage capacity, and the distribution system should be considered.

Table 2-37
Community Water Supplies

Location	No. of Wells (Depth in feet)	Water Quality	Ground Storage (gallons)	Elevated Storage (gallons)	Distribution (mains, flows, pressures)	Consumption gallons/ capita/day	Average Daily Production (gallons)
City of Crandon	4 (80-90)	high manganese in wells #2 and #3, high iron in well #2	75,000	55,000	adequate	79.7	157,000
City of Antigo[1]	7 (55-62)	Bacteriological contamination in wells #8 and #12 has been detected, V.O.C.s[2] have been found in well #9	-	350,000	adequate	82.5	714,000
Elcho Sanitary District No. 1	2 (155)	High iron in well #1	100,000	190,000	adequate	65.6	37,000
City of Rhinelander	5 (68-90)	Bacteriological contamination in wells #4 and #5 has been detected, V.O.C.'s have been found in well #5	-	500,000	adequate, replacement of 4 inch piping should be considered	297	2,338,000

[1] City of Antigo owns a Lime Softening Water Treatment Plant with a 500,000 gallon clear well.
[2] V.O.C. means volatile organic compounds.

Municipal Wastewater Treatment
Characteristics of the four municipal wastewater treatment facilities in the local study area are summarized in Table 2-38. Homes in the remainder of the local study area are served by individual septic systems.

City of Antigo - Average flow in 1983 at the Antigo sewage plant was 1.44 million gallons per day. The plant generally performs well and could tolerate the additional loadings of a population increase up to 6,500 people.

City of Crandon - The Crandon facility had a 1983 average flow of 150,000 gallons per day and operated well within permit limitations. Some decrease in the seepage cell infiltration capacity, however, has occurred since the start-up. The longevity of aerated lagoons discharging to seepage cells is not well understood, but if the system is capable of operating at design capacity, an additional 1,000 to 2,000 residential users could be accommodated.

Elcho Sanitary District No. 1 - This plant is operating very close to design capacity with a 1983 average flow of 58,000 gallons per day. The lagoons as well as the collection system appear to be subject to considerable clearwater infiltration. Under existing conditions the Elcho sewage treatment plant's capacity to accommodate increased loading is questionable.

Rhinelander - The Rhinelander sewage treatment plant had a 1983 average flow of 1.53 million gallons per day and is currently operating below design capacity. A modest increase in Rhinelander's population could be accommodated but if a population increase over 2,500 people occurs, treatment plant modifications would be necessary.

Table 2-38
Municipal Wastewater Facilities

Location	Treatment Type	Year Constructed	Design Capacity	Average Daily Flow
City of Antigo	Two-stage activated sludge with rapid sand filtration	1979	2.47 mgd[1]	1.44 mgd
City of Crandon	Aerated lagoons discharging into seepage cells	1981	260,000 gpd[2]	150,000 gpd
Elcho Sanitary District No. 1	Two stabilization lagoons-fill and draw discharge	1969	60,000 gpd	58,000 gpd
Rhinelander	Microscreen followed by Biological Contacters	1977	1.9 mgd	1.53 mgd

[1] mgd = million gallons per day
[2] gpd = gallons per day

Utilities

Electric Utility - The electric transmission line to serve the mine would originate at the Venus substation, located near Monico, Wisconsin (Figure 2-14). Three existing 115 kV transmission lines currently connect at the Venus substation. The Venus substation is the closest 115 kV source to the project site with a straight line distance of 12 miles. The next nearest line with a voltage of 115 kV or larger is over 50 miles to the south and over 35 miles to the east. No lines 115 kV or greater are found in Wisconsin to the north of the project site.

The Venus substation is part of a multiple looped 115 kV transmission network serving Vilas, Oneida, Lincoln, Langlade, Forest Counties, and adjacent areas. The primary electrical source for this network is the Weston Power Plant south of Wausau. This network is tied to other utility facilities by transmission lines heading west, south and southeast of the Wausau area.

A new 345 kV transmission line into Venus is planned to operate initially at 115 kV. This line would connect the Venus Substation with the Black Brook Switching Station and would be operational no earlier than 1989.

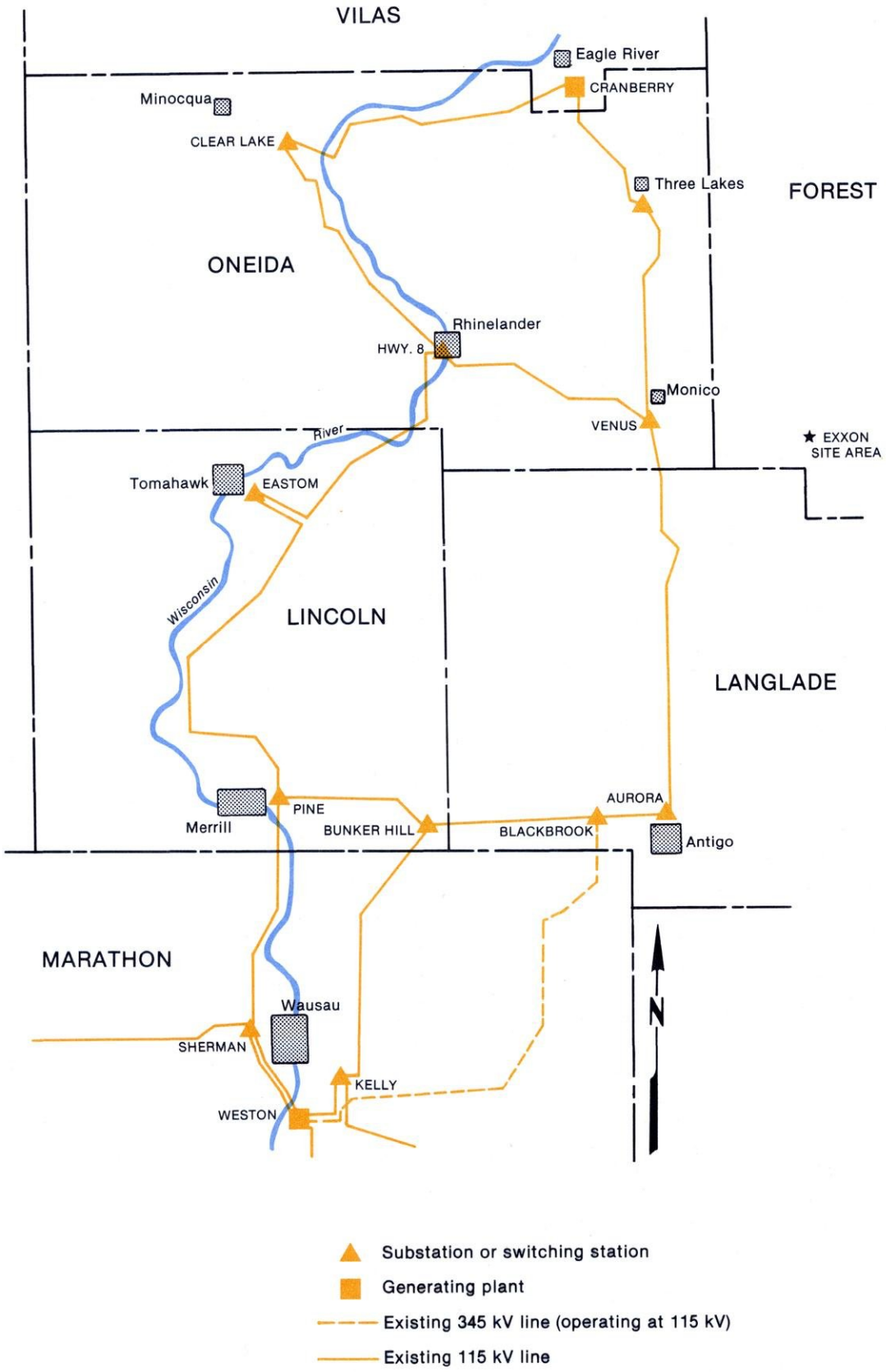


Figure 2-14 Utility Network

Gas Utility - Natural gas service is available in only scattered portions of Forest, Oneida, and Langlade Counties. While the City of Crandon and some surrounding areas have gas service, the project site currently does not. Two pipeline systems provide natural gas to the region. The first pipeline runs from Rhinelander to Wabeno, passing north of Crandon. This pipeline system owned by ANR Pipeline Company would provide the natural gas for the proposed gas line to the mine. The second system is a large (30 inch diameter) pipeline which runs northward out of the Green Bay area into the Upper Peninsula of Michigan. This pipeline is about 30 miles east of the project site.

Solid Waste Disposal

Presently there are 11 landfills serving communities in the local study area (excluding the Rhinelander Paper Co. sludge disposal area). Only three of these sites are modern "approved" landfills. All facilities (i.e., landfills) with plans of operation approved under the provisions of NR 180 and Chapter 144 of the Wisconsin Statutes after May 21, 1978, are classified as approved facilities. Facilities approved between May 21, 1975 and May 21, 1978 which have had their plan of operations re-reviewed and approved by the Department also are classified as approved facilities. All other facilities are classified as non-approved.

Approved facilities have specified capacities, incorporate long-term care and closure funding and have been engineered to protect the environment. The provisions of NR 180.13(10) govern the operations of all licensed facilities (landfills) in the State of Wisconsin. Non-approved landfills "grandfathered" into the program have not been engineered to protect the environment like modern landfills.

All of the landfills indicated in Table 3-49 receive municipal refuse on a regular basis. These landfills could receive additional refuse as a result of the increased population.

SOCIOCULTURAL ENVIRONMENT

Sociocultural Characteristics

Two different sociocultural groups exist in the local study area. One is the white majority, making up more than 98 percent of the population. The other significant group is the Native Americans consisting of the Forest County Potawatomi, with lands scattered east of Crandon, and the Sokaogan band of Chippewa, with tribal government at Mole Lake. The Native American populations are discussed in more detail in separate sections.

The white majority shares general values but is not homogeneous in tradition, demographic characteristics, occupation, nor community self-perception. The Antigo area of Langlade County is an extension of Midwestern farm country. The decline in agricultural activities has been countered by the entry of metalworking manufacturing, but more industrial diversification is desired. The cultural values in the area have been influenced by North European immigrants who took readily to farming and dairying.

Langlade County north of Antigo, all of Forest County, and most of Oneida County is North Woods country. The economy has been based on logging and some wood products manufacturing. Recreation is and has been an important amenity. Recreation took on increased economic value as automobile-borne tourism resulted in small retail and service businesses developing after World War I. The independent traits of the loggers and related trades was reinforced by several thousand Kentucky families moving north from rural Kentucky because of railroad and timber company land promotions between 1890 and World War I.

Archeological Features

Beloit College researchers inventoried 3,760 acres of the project site and identified artifacts at 14 sites. Stone tool manufacturing debris, a 19th century logging sleigh, and historic bottles and cans were discovered at 11 of the archeological sites. None of these sites qualified for the National Register of Historic Places (NRHP). The remaining three locations contained insignificant standing structures.

Great Lakes Archeological Research Center, Inc. inventoried 1,079 acres of the project site and identified artifacts at 12 sites. Only two prehistoric sites east of Oak Lake are considered eligible for the NRHP.

Aesthetics

The environmental study area contains visual amenities common to northern Wisconsin. The lakes, streams, forest, and rolling terrain contribute to the scenic diversity of the environmental study area. These features plus the low population density make the area particularly well adapted to the existing forestry/recreation land use pattern. The landscape in the environmental study area is primarily second growth forest with scattered agricultural clearings. The topography is gently rolling with prominent hills and ridges near Nashville, between Lake Metonga and Lake Lucerne, and west of Oak Lake and Hemlock Creek. Sugarbush Hill, northeast of the environmental study area, is four miles east of Crandon. A lookout tower on Sugarbush Hill provides a view of the environmental study area. Forested uplands and wetlands are the predominant landscape views.

There are no state or federally designated scenic areas such as state parks, Wisconsin scientific areas, or national natural landmarks within the environmental study area. A state historical roadside marker is in the Mole Lake Indian community.

Most views along the county and state highways and town roads in the environmental study area consist of forest land, but are occasionally interrupted by open land, agricultural land, and shoreline residences. Scenic vistas are frequent along the shoreline roads of Lake Metonga and Lake Lucerne. Views from gravel roads at the project site are limited by the hardwood forest.

A buffer strip of hardwood trees obscures the evidence of mineral exploration activities but partial views of the site are available along Sand Lake Road. The areas cleared for exploration activities have been graded, seeded, mulched, and the slash removed.

Recreation and Water Use

Significant public access is available to Swamp Creek (below Rice Lake) and the Wolf River (below its confluence with Swamp Creek). The access areas consist of county forest lands and the Upper Wolf River Fishery Area. Access to the Wolf River also is available at private camp grounds and scouting camps.

Use of Swamp Creek below Rice Lake is light and consists of an occasional fisherman, hunter, or trapper. In comparison, recreational activities in the Upper Wolf River Fishery Area is high. Rafting, canoeing, and kayaking levels exceed all other recreational activities in the Wolf River Fishery Area. DNR staff estimate these three activities total about 41,000 user-years, with rafting being the most frequent activity. The majority of the rafters rent from local firms with as many as three out of four rafters from out-of-state. Small watercraft use on the Wolf River is very high on summer weekends and occurs most frequently south of Lily (Table 2-39). Canoeing and small motorized boat use of the Wolf River north of Lily also occurs but to a much smaller degree.

Fishing is the secondary use, with site seeing, picnicking, camping and hunting as the other frequent recreational activities. During the primary use period roughly 600 to 700 per day visitations occurred in the Fishery Area during 1976.

Table 2-39
Rubber Raft Use on the Wolf River, Lily to Markton, Summer, 1976

	Rafts per Hour		People per Hour
	Normal	Maximum	Normal
Average Weekday	21	34	36
Average Weekend Day	30	50	63-76

In contrast to recreational activities by all users, local residents consider rafting and canoeing only their third most frequent use of the river. According to an informal survey of local residence at a town meeting (Table 2-40), 12% considered canoeing and rafting their primary use of the Wolf River and 29% considered this to be their secondary use.

Table 2-40
Informal Survey of Use of Wolf River by About 80 Local Residents in 1976

Primary Use	%	Secondary Use	%
Fishing	56	Aesthetic	34
Aesthetic	16	Rafting & Canoeing	29
Rafting & Canoeing	12	Fishing	27
"General Recreation" (Unspecified)	11	Swimming	5
Nonrecreational (Economic: Raft Rental, Bait trapping)	5	Camping	2-1/2
		Hunting	2-1/2

Fishing has been the traditional recreational use of the Wolf River because of its reputation for large trout. Only in recent times has fishing been surpassed by rafting and canoeing as the primary recreational activity. Total number of user hours was estimated to be 9,900 in 1972 and 13,000 user hours in 1976. Fishing is the major use of the river only among local residents. Swimming, horseback riding, picnicking, and other activities occur but use levels have not been quantified.

Although not well defined, general aesthetic enjoyment of the Wolf River is probably one of the major recreational uses of the river. This includes passive activity such as sight seeing, wildlife observation, photography, short walks, appreciation of scenery and nature, and pleasure driving.

Some wild rice beds also occur on the Wolf River and Swamp Creek below the proposed discharge. The amount of wild rice harvested by local residents has not been quantified.

No water diversions exist for agriculture, industry or drinking water purposes on Swamp Creek or the Wolf River in Langlade County below its confluence with Swamp Creek.

NATIVE AMERICAN COMMUNITIES

Sociocultural Profile

The traditional cultures of the Native Americans did not encourage a highly structured society for a large population. Annual migrations based on seasonal activities included families working within a radius of about 100 miles of the village during the summer. During the winter, the villages tended to break up into family units.

Since only bits and pieces of the traditional cultures remain, the present Native American ways consist of products of both traditional values and of several hundred years of contact with western society. Many reservation residents have spent years aways from the reservation and have lived in large cities. Many residents have found white culture inherently dissatisfying and any activity which might thrust white culture into their lives would not be welcome. Thus, despite the adoption of many elements of white culture, the attitudes of Native Americans differ significantly from those of contemporary whites.

To the Potawatomi, the earth, air, water, plants, and animals all are believed to have spiritual qualities. The Potawatomi believe people should have great respect for these resources and not abuse or pollute them. Burial grounds, sacred to the Potawatomi, are in the process of being mapped. Some elders believe mining at the Crandon project site may disturb burial grounds on aboriginal lands ceded to the United States by treaty. Potawatomi elders are concerned their unique cultural heritage might be lost if large-scale developments, such as the proposed Crandon project, occur in Forest County.

The Sokaogan view the land with a religious respect. They have a deep and enduring love for the land bounded by the reservation and also the adjoining forests and lakes. The land is viewed as a source of life, as the repository of the bones of their ancestors, and the womb of generations yet unborn. Nowhere is the Sakaogan devotion to the land more evident than in their beliefs attached to Rice Lake. Rice Lake and the bounty of the lakes harvest lie at the heart of their identity as a people. Considerable religious ceremony is associated with the lake and the growth and harvesting of the wild rice. The rice and the lake are the major links between themselves, Mother Earth, their ancestors and future generations. Accounts of their history during the period when they did not have a reservation have been passed from one generation to another. History has intensified their commitment to their homeland and reinforced the deep feelings of belonging to a particular area. In general, relations between Native Americans and whites in northern Wisconsin and in the local study area have historically been strained. These tensions are due to such factors as competition for resources (land, natural resources, and revenues), misunderstanding of the tribes rights to self-government, and lack of appreciation for the culture and life style of Native American people. As a specific example, the Voigt Decision to recognize the continued existence of treaty rights by the Chippewa in Wisconsin to hunt, fish, and gather in their aboriginal territories has created tension. There also have been problems with law enforcement, social discrimination, education, and economic integration.

The Native Americans continue to rely on natural resources for part of their subsistence. On tribal lands, the Potawatomi and Chippewa have unlimited hunting and fishing rights. Over thirty percent of the Potawatomi families and eighty-six percent of the Chippewa families rely somewhat to a great deal on hunting and fishing for food. Gardening, ricing, and picking wild plants are used somewhat to a great deal in the subsistence of twenty-six percent of the Potawatomi families and over ninety percent of the Chippewa families. In addition, the use of wild plants for medicinal purposes continues to this day.

The Forest County Potawatomi
Tribal Reservation and History - Forest County Potawatomi tribal lands consist of scattered holdings totaling 11,786 acres in Blackwell, Lincoln, and Wabeno townships within southeastern Forest County (Figure 2-13). The Potawatomi lands were once a mature hardwood forest which was subsequently logged, and now consists of second-growth forest vegetation. There are also scattered lakes on the tribal lands. The land is suitable for timber production but not for agriculture.

Tribal lands are sparsely developed and houses and trailers are scattered widely. There are two main concentrations of residences: those located in the Stone Lake area (now called Lake Lucerne) near Crandon in Lincoln Township, and those located in Wabeno Township. The two communities are about 20 miles apart. The greater proportion of residences are located in the Stone Lake area as is the tribal hall which contains tribal government offices.

During the period of white colonization and establishment of reservations, some of the Wisconsin Potawatomi fled north to the heavily forested areas of Wisconsin rather than be moved west. There they became nomads, occupying public lands or territories cut-over by lumber companies. In an attempt to settle the tribe in 1914, scattered, cut-over land holdings were purchased for the tribe by the U.S. government. The policy of purchasing isolated lands was intended to stimulate assimilation. At that time each person over 18 was allotted 40 acres in staggered sections; however, title to the land was held in trust for the tribe. Although it was intended that the Potawatomi become farmers, the land was unsuitable for this type of development. Cutting timber and tribal employment have been the main sources of employment since the reservation was established.

According to the traditions the Potawatomi, Chippewa, and Ottawa tribes, all were originally one people who spoke the Algonquian language. This tradition also says that long before historic contact, the Potawatomi, Chippewa, and Ottawa kept a perpetual fire.The name Potawatomi means "People of the place of the fire."

Population - Most of the information in the following sections is based on a household and a mail survey of Potawatomi tribal members conducted in December 1984 by Denver Research Institute (DRI). Membership in the Forest County Potawatomi tribe consists of all persons of one-fourth degree or more Potawatomi Indian blood born to any member of the community, those whose names were on the 1934 census of Wisconsin Potawatomi, and who were residing on tribal lands as of 1937 and their descendants, and all those persons enrolled as members of the Forest County Potawatomi tribe under the 1937 constitution prior to 1982, the effective date of the latest constitution. Table 2-41 presents information on enrolled members and population living on and adjacent to tribal lands.

Table 2-41
Number of Enrolled Members Living on or Adjacent to Forest County Potawatomi Tribal Lands

Year	Total Enrolled Members	Members Living Adjacent to Tribal Lands	Members Living on Tribal Lands
1980	600	51	265
1982	NA	144	255
1984	683	133	333

Source: U.S. Department of Interior, Bureau of Indian Affairs. Report of the Labor Force, 1980, 1982, 1984. Personal communication, Ms. Noskoviak, Bureau of Indian Affairs, Ashland, Wisconsin, 3/19/85.

Age, Sex, and Education Characteristics - The age and sex distribution of this population is shown in Table 2-42. The population is about 52% male and 48% female. The Forest County Potawatomi population has a higher percentage of persons aged 20 and under than either the total American Indian population or the white population. The Forest County Potawatomi school-aged population, ages five through 18, enumerated by the DRI household survey was 146 persons. Seventy were male and seventy-six were female. Of these, 114, or 78%, were listed as students.

Indian mothers tend to have children at earlier ages, thus increasing the growth potential of the population. Between 1978 and 1982 12% of the births within townships where the Potawatomi reside were to Indian mothers although the Potawatomi are only 4% of the population. The years of school completed by those surveyed who were 25 years of age or older is compared to that of American Indians and the total U.S. population in Table 2-43. The Forest County Potawatomi have fewer high school graduates and college graduates than both of the other groups.

Table 2-42
Household Survey: Age and Sex Distribution of the Resident Population

Age	Male	Female	Total
Under 10	57	50	107
10-19	43	50	93
20-29	37	39	76
30-39	28	20	48
40-49	18	13	31
50-59	14	14	28
60-69	8	2	10
70-79	2	3	5
Over 80	0	0	0
Total	207	191	398

Source: Potawatomi Household Survey, December 1984

Table 2-43
Years of School Completed by Persons 25 and Over (By Percent)

Years of School	Forest County Potawatomi	American Indians and Alaska Natives, 1980	Total U.S. Population, 1980
8 years or less	23	22	18
1 to 3 years high school	41	17	15
4 years high school/GED	23	40	35
1 to 3 years college	12	14	16
4+ years college	1	7	16

Source: Potawatomi Household Survey, December 1984. U.S. Bureau of the Census.

Migration - Substantial migration occurs within the Forest County Potawatomi community. Ninety-five survey respondents gave migration histories. Eighty-five of these (89%) have lived off the reservation. About one-third lived in Forest, Langlade, or Oneida counties, another third lived in rural areas outside the local study area, and one-third lived in cities of over 50,000. The majority who have lived off tribal lands lived in Wisconsin or adjacent states. The average length of time that was spent living off the reservation was about seven years. Most returned to the Forest County Potawatomi community because they liked the reservation environment or they wanted to return to their homeland. Personal reasons, such as health, family responsibilities or retirement, were the next most common reasons given.

Employment - The DRI Potawatomi survey obtained information on 178 persons aged 16 and above who are in the labor force. Fifty-seven were employed and 121 (68%) were unemployed. Of those unemployed, 79% reported they wanted to work. The occupations of the 57 individuals who were employed are shown in Table 2-44.

Table 2-44
Occupations of Employed Potawatomi

Occupation	Forest County Potawatomi
Managerial & Professional	10
Technical, Sales, and Administrative Support	17
Service	10
Farm, Forestry, Fishing	7
Precision Production, Craft and Repair	8
Operators and Laborers	5

Source: Potawatomi Household Survey, 1984.

The tribal government is the major source of employment. The most frequently occurring occupational classifications are management related, administrative support (clerical), and service (community health representative). The higher rates of employment in forestry and agriculture reflect the significance of timber harvesting as a part of the Forest County economic base. The low percentage of jobs in manufacturing, however, indicates the Potawatomi are not integrated into the workforce at local sawmills and wood product plants.

One-fourth of the currently employed Potawatomi worked less than 35 hours a week and three-fourths worked over 35 hours or full-time. A little over one-third had jobs of limited duration. About four percent had seasonal jobs, such as timber harvesting, and the remaining had no foreseeable termination point for their job. The significant number of persons with limited term jobs is indicative of the temporary nature of many government programs and grants the tribal economy is dependent upon.

Information on job skills, vocational training, and trade licensing/certification was given to 174 respondents to the households survey (Table 2-45). Most people have job skills categorized as operators and laborers. Predominant occupations within this category were machine operators (9), welders (8), truck drivers (12), and heavy equipment operators (14).

Table 2-45
Potawatomi Job Skills, Vocational Training, Trade Licensure/ Certification by Occupational Category

Occupational Category	Job Skills	Vocational Training	Trades Licensed/ Certified
	No.	No.	No.
Managerial and Professional	7	7	3
Technical, Sales & Administrative Support	67	22	3
Service	23	15	8
Farm, Forestry, Fishing	25	7	2
Precision Production, Craft and Repair	44	36	9
Operatives and Laborers	95	26	13

Source: Potawatomi Household Survey, December 1984.

Seventy-five individuals (43%) had vocational training in one or more occupations. Predominant types of training were in the areas of precision production (11 auto mechanics); technical, sales, and administrative support occupations (10 office/secretarial); and operators and laborers (7 welders). Thirty-one people were licensed or certified in one or more trades. Forty people have belonged to a union at some time and one-fourth of unions listed were for skilled trades.

Many of the Potawatomi are interested in mining-related jobs as indicated by the Potawatomi household survey. The number of Potawatomi's interested in obtaining employment in the various project-related job categories is as follows: construction, 33; transportation, 31; millwork, 31; administration, 30; maintenance, 27; underground, 7.

Income - Household cash income is shown in Table 2-46. A large portion of the income came from governmental aid sources such as Aid to Families with Dependent Children (AFDC), Relief of Needy Indian Persons (RNIP), Social Security, pensions, disability payments, and unemployment compensation. After AFDC, wages were the second most common form of family income. The poverty level for a family of four in 1979 was $7,412. At least one-third and possibly as many as one-half of the Potawatomi families are below the poverty level.

Table 2-46
Potawatomi Family Cash Income

Amount	Number of Families	Percent
Under $3,000	11	13
$3,000-5,999	21	24
$6,000-8,999	23	26
$9,000-11,999	18	21
$12,000-14,999	5	6
$15,000-17,999	3	3
$18,000-20,999	2	2
$21,000-23,999	2	2
$24,000-26,999	2	2
$27,000+	1	1

Source: DRI Potawatomi Household Survey, December 1984.

Reservation Businesses and Tribal Economic Development Activities - Several tribal enterprises have been initiated in the recent past. Profits from the enterprises are used to support employment of tribal members and to provide capital for other economic development activities.

Cigarette Sales - The Forest County Potawatomi sell discount cigarettes to the general public. Since 1982, Native American tribes in Wisconsin have been able to receive a rebate on taxes for cigarettes, thus making it possible to sell cigarettes at discounted prices. Cigarettes are marketed both at the tribal hall near Crandon and in Wabeno. The business has a volume of about $100,000 per year and employs three persons full-time.

Bingo - The tribe started a bingo operation in 1983. Bingo is a self-sustaining business and employs one full-time person. Bingo operation revenues average about $300 per week.

Forest County Potawatomis Excavating and Construction Company - In 1982, the Forest County Potawatomi received a land claims settlement. Twenty percent or $194,000, was set aside for tribal economic development. With a portion of this money, excavation equipment was purchased in 1984. This enterprise is in the initial stages of organization.

Logging and Firewood Sales - This is a seasonal business activity conducted on tribal lands.

Housing - There are currently 77 homes on tribal lands, of which 76 were enumerated by the Potawatomi household survey. In all, the survey obtained data on 92 residences on and adjacent to tribal lands. Thirty-eight percent of the residences were single family units, 60% were mobile homes, and 2% were classified as apartments. The average number of rooms per residence was 5.3 with an average of 4.1 persons per household. By comparison, the average number of persons per household in 1980 was 2.7 in the U.S. and 2.8 in Wisconsin. Of the Potawatomi houses surveyed, 17% were occupied by two or more families. Directors of the various housing programs state that overcrowding and the poor state of repair are the most serious housing problems for the Forest County Potawatomi.

Structure and Function of Tribal Government - The constitution and by-laws of the Forest County Potawatomi community were first approved by the Secretary of the Interior in 1937, while the current constitution was adopted in 1982. The governing body of the Forest County Potawatomi is the General Council, composed of all qualified voters of the community. Qualified voters are enrolled members of the community 18 years of age or older. A six-member Executive Council, elected by the General Council is responsible for conducting the day-to-day affairs of the tribe.

Committees are an important aspect of tribal government. The Executive Council appoints members to various tribal committees and members serve on a volunteer basis except for expense reimbursements. The Mining Impact Board has been a particularly active and important committee during the environmental assessment and permit application process for the proposed Crandon project. The elected tribal chairman also serves as the tribal administrator and as a member of the Executive Council.

Tribal Finance - The major source of revenues for the Forest County Potawatomi are federal and state grant programs and money generated through tribal enterprises. By far the most important source is federal and state funds. In 1984, the tribe received about $1 million in revenues from all sources. These funds were expended to provide health, education and welfare, housing, and planning services to the community. The federal and state grants which provide the major portion of revenue for the Potawatomi tribal government are clearly not a secure or predictable revenue base. The Bureau of Indian Affairs and Indian Health Service funds for education and health are more secure. Even these funds, however, are subject to changes in Congressional appropriations.

The tribe received $100,000 annual permit period payments (1983-1986) from the Mining Investment and Local Impact Fund to plan and prepare for the Crandon project.

The Mole Lake Sokaogan Chippewa

The following discussion, with the exception of the brief Chippewa history, provides a profile of the current characteristics of the Mole Lake Sokaogan Chippewa. Several different data sources have been utilized. The most important were the Chippewa themselves. In March 1985, Denver Research Institute (DRI), the DNR socioeconomic consultant, conducted interviews with 21 officials and employees of the tribal government to obtain information on the tribe. To supplement these interviews, a questionnaire was administered to all willing adult tribal members residing on the reservation. Bureau of Indian Affairs and other reports also were used to provide data on the tribe.

The Mole Lake Chippewa Reservation consists of nearly 1700 contiguous acres located in the Township of Nashville, Forest County. The eastern edge of the reservation lies two miles west of the proposed mine/mill site. A dominant physical feature of the reservation is Rice Lake, a shallow 208 acre lake located entirely within the eastern third of the reservation. Swamp Creek, the largest tributary of Rice Lake, runs north of the orebody and enters the reservation from the east. Rice Lake is considered one of the best wild rice producing lakes in Wisconsin, and is a vital part of the economic and social life of the reservation residents. Bishop Lake lies on the southwestern border of the reservation.

State Highway 55 crosses through the eastern portion of the reservation and connects Crandon, eight miles to the north, with Lily, ten miles to the south. County Trunk Highway M runs west along the southern boundary of the reservation linking Highway 55 with Jennings and Pelican Lake. The majority of homes on the reservation are scattered on either side of Highway 55, with a few residences lying along interior reservation roads.

History - The Chippewa, also known as the Ojibwa, trace their origin to a group of Algonquian - speaking Indians who originally lived along the Atlantic coast near the mouth of the St. Lawrence River but later migrated to the shores of Lake Huron. Depending on the season, the Chippewa lived in villages numbering between 30 and 300 people. Their culture was based primarily on hunting. In the winter, families dispersed in order to use the hunt to greatest advantage. They regrouped to collect maple sap and greens in the spring, berries and wild rice in the summer, and nuts and tubers in the fall.

The first direct contact the Chippewa had with whites occurred about 1610 when French fur traders entered the Upper Great Lakes. The compatible relationship between the Chippewa and the French was based on traders supplying the Indians with manufactured products in exchange for furs. The fur trade, however, was disrupted during the French and Indian War of 1755-1763. Following the revival of the fur trade, the Chippewa migrated into Wisconsin and prospered by trading with the British until the beaver were trapped out by the 1820's.

During the early 1800's the Chippewa steadily lost their sovereignty and territory in lower Michigan, Wisconsin, northern Illinois and Minnesota through a series of treaties (1819, 1826, and 1837) with the United States. In 1842, the Chippewa ceded the southern Lake Superior shore in Wisconsin and Michigan. With the ceding of additional lands in 1854, the Chippewa only controlled territory at Keweenaw and Ontanagon in Michigan, Fond du Lac and Grand Portage in Minnesota, and Bad River, Lac Court Oreilles and Red Cliff in Wisconsin. By the 1870's the Chippewa entered the reservation era. Federal policies attempted to change the Chippewa's hunting and gathering culture to a farming, Christian culture through education and control. Today the Chippewa constitute the third largest North American Indian people, numbering 50,000 in Canada and 30,000 in the United States.

The Mole Lake Chippewa constitute one of the older resident communities in the Crandon area. By 1837 the Pelican Lake "Suk-a-Aug-un-ing" had settlements at Post Lake, Pickerel Lake, and "Metawanja" Lake, and Rice Lake in the Upper Wolf River. The Sokaogan Chippewa are believed to have numbered 200 individuals in 1848. They are the "People of the Post in the Lake," both to themselves and to other Indian tribes. In 1855, Sokaogan Chief Me-ge-zee, also called "The Eagle," complained to federal officials that his band had no right of location on any reservation. Though the Sokaogan steadfastly held to the claim that a reservation was promised, the government never established one. For over 80 years, the Sokaogans continued to occupy their traditional territory but their identity as a separate band was ignored by the United States. Four generations later, under terms of thc Indian Reorganization Act (1934), the United States established the reservation at Mole Lake. Membership in the Sokaogan Chippewa band is now determined by direct blood relationship to anyone on the 1937 tribal roll.

Population - Total membership of the Mole Lake Sokaogan Chippewa is 1,093. Currently 271 tribal members reside on the reservation and another 72 individuals live within a 50 mile radius of the reservation (Table 2-47). About 750 members live elsewhere. This figure does not include 30 babies born to tribal members living on or adjacent to the reservation during the years 1983-84 for whom

application for membership is pending. The number of tribal members and residents on the reservation in 1977 was 193, an increase of 40% in seven years. Tribal authorities report 62 families live on the reservation and 33 families live adjacent to the reservation. Family size is 4.4 persons/family for reservation residents and 2.2 persons/family for adjacent residents.

Table 2-47
Ages of Sokaogan Tribal Members Living on or Adjacent to the Mole Lake Reservation in 1984

Age	Males	Females	Total
Under 16	46	74	120
16-24	39	36	75
25-34	31	25	56
35-44	25	11	36
45-64	27	19	46
65 and over	6	4	10
TOTAL	174	169	343

Education - Children from the Mole Lake Reservation attend public schools in the Crandon School District. Pupils in kindergarten through sixth grade attend Mole Lake Elementary School. Children in grades 7-12 attend Crandon Schools. A total of 77 children were enrolled in grades kindergarten through 12 in 1984. Six children attended Flandreau Indian School in Flandreau, South Dakota where they believe a better education is possible. An additional ten tribal members were enrolled in either trade school or college on at least a part-time basis. The Crandon School District receives aid from the federal government for each Indian child living on the reservation who attends the district's schools. Additional federal funding also is provided to the tribe for assisting students in higher education and for the employment of a home-school coordinator.

There is considerable dissatisfaction among tribal members with their children's educational experiences at the Crandon schools, especially the high school. They report a noticeable reduction of interest and performance as soon as the students transfer from Mole Lake Elementary School to Crandon. The drop out rate for tribal children is disproportionately high and the graduation rate is low.

Employment and Income - A potential labor force of 160 individuals live on or adjacent to the reservation. The survey of reservation residents shows 39% of the adults lack either a high school diploma or General Equivalency Degree (GED). Another 10% report having a GED, 27% possess a high school diploma, and 15% report they have attended college. Table 2-48 contains information on tribal education attainment.

Table 2-48
Educational Attainment of Chippewa Labor Force (1985)

Years of Education	Number of Tribal Members
1-6	1
7-8	10
Some high school	28
GED	10
High school diploma	27
Some college	15
B.A. Degree	2

Source: DRI Survey

Thirty-one percent of those surveyed have had some occupational training while 69% have had no training. The survey further showed only one individual with training was licensed or certified in an occupation. Occupations reported in the survey include secretary, teacher's aide, truck driver, welder, mechanic, television and radio tower repair, and cook. Table 2-49 provides survey-based data on the work/skill experiences of the Mole Lake Reservation labor force based on the COACT report from 1980.

Table 2-49
Skills and Work Experience of Labor Force

Work Experience	Percent
Mining	1
Heavy equipment operation	13
Mechanical	10
Carpentry	10
Welding	4
Electrical	2
Electronics	2
Administration	8
Plumbing	3
Sheet metal	2
Painting	1
Forestry	25
Health	7
Food preparation	4
Education	3
Accounting and bookkeeping	4
Clerical	5
Minor experience and housewives	40

The majority of the reservation residents with jobs are employed in tribal government and tribal-sponsored enterprises. Tribal government is the largest employer, providing full or part-time work for more than a dozen persons. Published information on the family income of tribal members is not available. Family income, however, is quite low because of the high rates of unemployment on the reservation and because of the seasonal nature of the few available jobs. Only 17% of the families surveyed received income from wages and salary. Approximately 48% reported receiving Relief for Needy Indian People (RNIP) funds while 26% received AFDC. About nine percent reported receiving Social Security benefits with four percent collecting disability payments.

Tribal Economic Development - The Sokaogan Chippewa are engaged in a number of enterprises intended to provide employment to members and to make the tribe self-sufficient.

Bluegrass Festival - The Bluegrass Festival is one of the most successful tribal activities. For the past nine summers, the tribe has sponsored a music festival featuring bluegrass music groups. In 1984, the event drew from 30,000-45,000 patrons from across the U.S. and Canada. Among other purposes, the profits have been used as seed money to start other tribal enterprises, for the establishment of an emergency medical fund, and for purchase of land for the reservation.

Bingo - The Sokaogan Chippewa operate a bingo operation which provides employment for about a dozen tribal members. Bingo profits are used as seed money for other tribal endeavors.

Wild Rice - The care and harvesting of wild rice from Rice Lake is a highly important religious, social, and economic activity to the Sokaogan Chippewa. Wild rice constitutes an important part of the Sokaogan diet. In addition, part of the wild rice production is sold. In 1984, freshly harvested wild rice sold for approximately $1.10 per pound at Mole Lake. Depending upon natural conditions, total wild rice harvests can vary from an insignificant amount to many thousands of pounds of unprocessed rice.

Grocery Store - The tribe owns and operates the Mole Lake Grocery Store. The store creates jobs, provides a convenience for tribal members, represents an effort by the tribe to provide for members needs, and to keep resources on the reservation.

Other Enterprises - The tribe owns a 51% interest in Sokaogan Limited, a construction company, and plans to secure their first contracts in the Spring of 1985. In addition, the Mole Hole (a tavern located on Highway 55 across from tribal headquarters), a gas station, the Arrowhead Cafe, and the Arrowhead Indian Development Corporation are private enterprises located on the reservation with at least partial ownership by tribal members.

Sources of Tribal Revenues and Expenditures - In addition to the economic sources listed above, the Sokaogan Chippewa receive funds from a variety of governmental sources to operate tribal government and provide essential services for members. The Bureau of Indian Affairs (BIA) provides a Core Management Grant, which pays for an accountant, a bookkeeper trainee, and a secretary. The BIA also provides funds for the tribal judicial program and a secretary for the tribal enrollment program. Under the Johnson O'Malley program, the BIA funds grants for higher education and a home-school coordinator. In 1984 the tribe also received funds from the Indian Heath Service for health management, two community health representatives, a community health nurse, and for the operation of an alcohol and drug counseling program. The tribe also has grants to improve the housing on the reservation. Overhead is taken from each contract for the operation of tribal offices and for salaries of the tribal chairman and secretary. The food commodities and distribution program is available for qualified tribal members, as are funds from AFDC and RNIP, a program sponsored by the State of Wisconsin.

Sokaogan Chippewa Health - Frequency data on the incidence of disease among the Sokaogan Chippewa is not available. Alcohol abuse and alcoholism are probably the most serious health problems among the Sokaogan. Problems connected with alcohol are thought to affect 50% or more of the adult population and many young people. Health officials report depression to be the most common form of mental illness among the Sokaogan.

Health care is available to all Sokaogan in need. Maternal, child health, and well baby programs are available on the reservation. A community health nurse is available for screening health problems with serious cases referred to local physicians. Payment of health care costs is through Medicare, AFDC, RNIP, and other aid programs.

Community Services and Facilities - Tribal government is a focal point of life on the Mole Lake Reservation. The tribal government is the main distributor of services to tribal members but Sokaogan tribal members may obtain needed services off the reservation if they wish. The government also functions as a clearinghouse for the distribution of funds and services intended for the tribe as a whole. This includes most of the jobs reservation residents hold, as well as welfare payments, housing, medical care, and food commodities distribution. Tribal government also functions as the major advocate for tribal member welfare, protection of reservation lands, and Sokaogan tribal rights and privileges.

Mole Lake Reservation Housing - The Bureau of Indian Affairs (1985) reports that there are 64 homes located on the Mole Lake Reservation. The U.S. Department of Housing and Urban Development (HUD) provided funds for 34 modern homes on the reservation located along Highway 55, north of the tribal offices. The homes are rented to tribal members at a price commensurate with the occupants' income. In addition, there are 30 privately owned homes on the reservation; 15 are trailer homes and 15 are of conventional construction. All are of generally lower quality than the HUD homes. The tribe has secured funding from HUD for the construction of an additional 40 modern homes. There

presently is considerable unmet demand for housing on the reservation. Tribal authorities receive several calls a week from members as far away as Chicago, Milwaukee, and Los Angeles requesting housing of any kind.

Reservation Traffic - Automobile and truck traffic on Highway 55 is a continuous hazard to the residents of the Mole Lake Chippewa Reservation. Four pedestrians have been struck and killed along the roadway between the Arrowhead Cafe and Mole Lake Elementary School since 1962. Three others have been seriously injured. In 1966, a sidewalk was constructed from the trading post north to the bridge over Swamp Creek. An adjacent sidewalk is utilized by a large number of pedestrians when the weather is good. During the winter, however, snow piles make the sidewalk generally impassable.

Mole Lake Chippewa Reservation Land Use - All land within the Mole Lake Chippewa Reservation boundary is tribally owned. Rice Lake and the adjoining wetlands are the dominant physical features on the reservation. Upland brush and low-grade timber land cover the remainder of the reservation. In addition to the wild rice produced each year, the waters of Rice Lake provide fish and waterfowl. The Sokaogan fish and hunt on the lake, and collect numerous plant foods and herbs from the reservation's wetlands and forests. They also hunt, fish, and collect plant foods from lands adjoining the reservation. A prime collecting area, especially good for wild raspberries and medicinal herbs is found in the area south of Swamp Creek to the east of the reservation.

Government Structure - The Mole Lake Chippewa Reservation was established in 1939 by proclamation of the Assistant Secretary of the Interior. The tribe is governed by a chairman, vice-chairman, secretary, and treasurer, each of whom serves a two-year term. Two councilmen are elected for terms of one year. The two councilmen, together with the elected officials, serve as the tribal council. Between 175 and 220 members vote in a typical tribal election. Any tribal member 18 years old is eligible to vote. A number of permanent committees serve the tribal council. There are permanent committees on health, education, housing, forestry, treaty rights, mining impact (Exxon project), Bluegrass Festival, and nuclear waste. The relatively small tribal population and complex government results in a wide participatory democracy, with a large proportion of members directly involved in tribal government.

Forest County provides law enforcement services for the reservation. Since Forest County does not keep separate statistics for the reservation, crime rates are not available. Tribal authorities report no murders or suicides in recent years.

CHAPTER THREE
ENVIRONMENTAL IMPACTS OF THE PROPOSED PROJECT

IMPACTS TO THE BIOLOGICAL AND PHYSICAL ENVIRONMENT

IMPACTS ON TOPOGRAPHY

Construction - Grading would create a gentle, uniform slope of two percent at the mine/mill site. The lowest elevation would be at drainage basin #2 (1,624 feet above MSL) while the highest elevation would be at the drumlin summit (1,677 feet above MSL) in the southwestern part of the site. The summit of the drumlin would be preserved. Surface water drainage patterns at the site would remain the same except runoff would be routed through drainage basins #1 and #2 before release.

At the mine waste disposal facility (MWDF), the highest elevation (1,732 feet above MSL) during construction, as well as operation, would be on the crests of the tailings ponds embankments. The lowest elevation (1,625 feet above MSL) would be on the exterior southwest corner of tailings pond T1. Extensive earth work would be required to construct the banks from the soils excavated from the interior of the ponds. The bottom of the tailings ponds would slope to a maximum depth of 1,633 feet above MSL.

The access road, railroad spur, haul road, and water discharge corridors would enter the mine/mill site from the northwest, northeast, southeast, and southwest, respectively. The construction of uniform grades and bases for the railroad spur, access road, and haul road would modify the topography. The corridors would be level but short, steep side slopes would occur at cut-and-fill areas.

Operations - Topographic impacts at the mine/mill site would be minimal and would be related to landscaping and erosion control activities. The impacts on topography at the MWDF during operations would consist of the sequential construction, filling, closure, and reclamation of the four tailings ponds. Along corridors, the impacts on topography would be small, consisting of landscaping or erosion control activities.

Closure - During mine/mill site reclamation the area would be regraded to approximate the pre-existing landscape. Surface facilities would be dismantled and demolition materials would be moved into low areas and covered, or removed from the site. Final elevations after reclamation would be between 1,624 and 1,677 feet above MSL. The original drainage pattern would be re-established and disturbed areas would be revegetated with native herbaceous species.

The MWDF would have the most obvious and permanent impact on topography. Maximum relief at the MWDF following closure would be about 130 feet, with final elevations commonly 20 feet to 60 feet higher than the pre-existing elevations. The final cover would have a slope of two percent while embankments would have side slopes of 33%. The reclaim pond would be graded smooth with a gentle two percent slope toward Duck Lake. The finished grades and elevations at the MWDF are detailed on Figure 1-18. The landscape would change from undulating hills and swales to a mesa-like feature bounded by natural and engineered slopes.

The final cover and surface drainage swales would be contoured to route runoff toward surrounding wetlands and drainageways but the original drainage patterns would not be completely re-established. The final topography would be consistent with the proposed final use of re-establishing native forest communities.

Corridor grading would be minimized to preserve usefulness for wildlife and recreation, but the access road and railroad spur bridges crossing Swamp Creek would be removed if not needed. The impacts on topography caused by the cut-and-fill construction of the corridors would endure by design.

The major long-term impact would be the alteration of 380 acres of mineral and organic soils by the tailings ponds and landfill. Topsoil and silty subsoil stockpiled during construction would be spread over the site during landscaping or reclamation activities. The net effect would be the permanent loss of 49 acres of wetland soils and a gain of 49 acres of mineral soils.

Subtle changes in soil characteristics caused by mixing and compacting during grading activities would result in long-term but minor impacts. These changes should have minimal impact on revegetation efforts and the re-establishment of surface water drainage patterns.

Soil erosion is the greatest potential short-term impact. The most significant of the potential impacts are reduced soil fertility (due to loss of organic matter and clay particles) and coverage of adjacent soils. The keys to minimizing soil erosion impacts would be rapid implementation of the erosion control practices, proper maintenance of the practices, and active oversight/enforcement of reclamation rules by DNR staff. Undoubtedly, some erosion would occur, but if the erosion control plan were implemented as proposed the impacts should be minimal, especially to lakes and streams.

MWDF and Adjacent Facilities - Since the tailings ponds would be sequentially constructed, operated, and closed, reclamation activities would occur in phases. For example tailings pond T1 would have been reclaimed for about 20 years upon closure of pond T4. Moreover, the number and location of the discharge points from the sedimentation ponds would change over time (see Fig. 1-16). As the vegetation on the reclaimed MWDF progresses through successive ecologic stages, a reduction in the rate of soil erosion could be expected. A litter layer of leaves and fallen branches under the forest cover or a dense sod created by an herbaceous community would limit erosional losses, especially of the fine silts and clays. If a good plant cover is developed, long-term (approximately 500-years) soil loss is calculated to be approximately 2.5 inches. This amount represents about 4% of the five foot thick reclamation soil cover.

Impacts off-site should be minimal because the water control berms, diversions, silt fences, and sedimentation ponds would be installed before construction begins on the ponds. Furthermore, none of the discharge points would release directly to a lake or stream. All flows either would enter a wetland directly or travel overland some distance before reaching a wetland. Thus, the greatest potential impacts would be to wetlands by sedimentation and nutrient enrichment from the silts and clays in the discharge.

The amount of soil erosion and consequent runoff contamination obviously would depend on the timing and quantity of rain as well as the stage of construction, operation and closure of the tailings ponds. To minimize the impacts, the erosion control structures would be designed to accommodate a 100-year, 24-hour storm event as required by section NR 182, Wisconsin Administrative Code. To the extent that the sedimentation ponds detain runoff, permit seepage out the bottom, and settle out the fine soil particles, adverse impacts could be limited. Impacts on lakes and streams, even if an outright failure of a sedimentation pond occurred, should not be significant because of wetland and overland filtering of the discharge.

About 115 acres would be disturbed over the life of the project at the construction support area, reclaim ponds, and soil borrow area sites, except for about 4 acres of wetland permanently removed. These three sites would be reclaimed at project completion and should eventually support vegetation comparable to pre-project conditions.

Mine/Mill Facilities and Corridors - Another 205 acres of soils would be impacted at the mine/mill site and along the access road, railroad spur, and haul road/pipeline corridors. The greatest disturbance would occur during construction when the topsoil would be stripped off and stockpiled. Approximately 7 acres of wetlands, 11 acres of farmland or old field, and 187 acres of wooded or cut-over areas would be affected by these facilities. During construction, the mine/mill site would be brought to grade and revegetated. During final reclamation, demolition waste and broken foundations would be buried under at least 18 inches of soil. These buried foundations should not cause drainage or revegetation problems.

Wetland soils disturbed along the electric power, discharge water, mitigation pipelines, access and natural gas corridors would total about 23 acres. Clearing activities and pipeline burial would mix surface organic soils with deeper mineral subsoils during construction. Revegetation by wetland species should be rapid. The natural gas pipeline construction would temporarily disturb wetland soils at Swamp, Drake, and Rocky Siding Creeks as well as several other areas. Soils would not be further disturbed for the duration of the project along the natural gas pipeline and water discharge pipeline. However, the wastewater discharge structure at Swamp Creek and the surface water mitigation discharge structures would be removed during final reclamation resulting in temporary soil disturbance.

About 110 acres of mineral forest soils and 23 acres of open land and agricultural land would be temporarily disturbed by power line and pipeline installation. The natural gas pipeline would follow existing road rights-of-way and would be within the access road corridor as it enters the mine/mill site.

Discharge from mine/mill site drainage basins #1, #2, and #3 would not directly enter a lake or stream. Discharge from basin #1 would flow overland and through a small wetland before entering Little Sand Lake. Runoff collected in basins #2 and #3 would be pumped to the reclaim ponds during the operations phase. During construction, however, discharge from basin #2 would drain to the north through a large wetland before entering Swamp Creek. Similar to the MWDF, potential impacts would be greatest to wetlands along the drainage ways.

The linear access and utility corridors, likewise, would probably have a greater impact on wetlands compared to surface waters. The most direct impacts would be at stream crossings. The construction erosion control measures at the stream crossings, if implemented and maintained as proposed, should minimize impacts to aquatic species and habitat.

GEOLOGICAL IMPACTS

Construction and Operation - Certain unavoidable and irreversible impacts to bedrock would result from the removal of ore and waste rock during mine construction and operation. During the life of the mine, approximately 67.4 million tons of ore and seven million tons of waste rock would be generated. Approximately 0.4 million tons of waste rock would remain above ground as riprap in the MWDF and reclaim ponds. The remainder of the waste rock and the coarse fraction of the tailings (30.3 million tons) would be used for backfilling. Approximately 90% of the potentially minable ore would be removed by the mining operations, thus depleting known reserves of metallic resources in the project area although there are additional tonnages at depth. The remaining 10% of the potentially minable ore would be left in place as rib pillars between stopes, in the ore crown pillar, or at the margins of the orebody. Fracturing of adjacent rock also could occur during ore and waste rock blasting and removal.

Rock or backfill failure during mining would be unlikely because of the competency (strength) of the bedrock. In addition, the proposed mining methods, stoping sequence and dimensions, as well as backfill properties and placement procedures, would minimize the potential for rock failure. If a backfilled stope did fail, backfill would mix with and dilute the ore grade of the adjacent, active stope block. Failures of backfilled stopes should not occur if proper backfill mixing and placement procedures were followed and if blasting were conducted according to the appropriate specifications. If failure did occur, however, the main impact would be economic in nature and not related to worker safety or environmental concerns.

Closure - Upon termination of mining, only the horizontal drifts and vertical shafts outside the orebody would not be backfilled. These areas represent about 10% of the total underground openings. These small openings should not be vulnerable to failure since they would be distributed around the orebody, and would be separated by a considerable thickness of stable bedrock. The backfilled orebody and shafts would be stable, and not subject to failure or subsequent surface subsidence. The mining method employed, specifically the placement of backfill, use of rib pillars between stopes, and the preservation of a crown pillar (65 feet in thickness) would provide structural stability to the mined out area.

Impacts of the Mine/Mill on Groundwater

Several facilities at the mine/mill site (e.g., fuel storage areas, reagent storage, and preproduction ore storage pad) would be potential sources of groundwater contamination. During operation, however, the area would experience a substantial groundwater drawdown which would diminish the likelihood of groundwater contamination. Contaminants seeping from these facilities into the drawdown-induced unsaturated zone could contaminate groundwater once mine pumping ceases. In order to prevent this occurrence, the facilities with the greatest potential to contaminate groundwater would have liner systems, or concrete floors and curbing. In addition, these facilities would have operating procedures such that remedial action could be taken if a spill or leak occurred. If significant deviations in groundwater quality were predicted to occur at the mine/mill compliance boundary (see Fig. 1-22), Exxon would be required to intervene in accordance with an approved contingency plan.

Impacts to Groundwater from the Orebody

Both premining and post-mining groundwater flow in bedrock were computer modeled. The modeling results indicate premining groundwater flows are less than eight gallons per minute through the total volume of the weathered orebody. Post-mining flows are predicted to be no greater than 25 gallons per minute. These flows are expected to be confined to mine openings above the 310 foot mining level and in the crown pillar. Post-mining impacts on glacial aquifer water quality from the mined-out orebody would be small.

Impacts to Groundwater from the Mine Waste Disposal Facility

Tailings pond leachate percolating through the unsaturated sediments would move vertically downward to the glacial aquifer. This leachate would continue to move primarily downward even in the saturated upper till. Once the saturated outwash was reached, however, the high hydraulic conductivity of the outwash would direct the leachate in a primarily horizontal direction. A small amount of water, though, would continue to move downward through the outwash and eventually flow into the lower till and bedrock. The substantially lower conductivity coupled with the occasional upward flows of groundwater from the bedrock and lower till could inhibit the movement of MWDF contaminants below that of the outwash layer.

Contaminant transport modeling by D'Appolonia (Exxon's consultant) indicates the groundwater standards at the compliance boundary could be exceeded if the final cover fails to perform as expected. Steady state simulations, utilizing a worst case MWDF leakage rate of 0.067 inches per year, predicted sulfate concentrations at the compliance boundary of 45 parts per million (USGS/DNR model) to 800 parts per million (D'Appolonia model) in the glacial till. These modeling differences are probably due to the different hydrogeological conditions found at the respective USGS-DNR and the D'Appolonia model cross-section locations, and also that the D'Appolonia cross-section traverses a larger area covered by the MWDF. It would take approximately 500 to 2000 years before the 250 parts per million sulfate standard could be potentially exceeded under the D'Appolonia modeling. It is likely that elevated manganese concentrations may be associated with areas of high sulfate concentration. USGS/DNR worst case transient analysis of potential seepage during mine operation produced a maximum compliance boundary sulfate concentration of 200 mg/l after 50 years of operation (30 years of seepage). The highest contaminant concentrations were found in the lower till or in the bedrock. These units, however, are not likely to be developed as groundwater resources. A high-capacity well developed in the leachate plume of the outwash would draw in some sulfates. The concentration, however, would remain low due to dilution occurring within the highly conductive outwash. Additional details about the contaminant transport computer modeling are found on pages 126-130.

Though the MWDF cap and enhanced marginal recharge zones would markedly change the local groundwater flow paths, the water table elevation should not be appreciably changed.

MWDF Seepage - The volume of seepage would increase during the operation phase and would peak shortly after closure of tailings cell T4. Thus, impacts on groundwater quality would progressively increase as greater amounts of leachate were generated from the sequential operation and closure of the four cells. Total MWDF seepage would range from about 2.5 to 10.2 gallons per minute during the first 50 years of the project (base seepage area of 82 acres). After 50 years, a steady state leachate

generation should be reached. If the infiltration control system, particularly the geomembrane, works as designed, no leachate would be generated after the cells had been capped and the tailings had dewatered. Figure 3-1 shows the predicted maximum and minimum seepage from an individual tailings cell. The potential long-term effects on groundwater also were evaluated assuming a partially deteriorated geomembrane (some infiltration through the cap). The long-term seepage under this worst case scenario predicted a rate of 0.93 gallons per minute (0.067 in/yr over 270 acres).

MWDF Leachate Characteristics - Table 3-1 provides the predicted tailings ponds leachate quality prior to and after attenuation by the soil liner and underlying soils. The major leachate components are sulfate, calcium, magnesium, and iron. Attenuation processes within the liner and underlying glacial soils would reduce the concentration of many toxic metals in the leachate.

Table 3-1
Predicted MWDF Leachate Chemistry[1]

Parameter	Initial Leachate Characteristics	After Attenuation
pH	7	7-8
Total dissolved solids (TDS)	3,000	3,000
Sulfate	2,000	2,000
Arsenic	0.50	0.03
Barium	0.03	0.1
Cadmium	0.50	<0.001
Chromium	0.06	0.001
Copper	0.10	<0.01
Iron	30.0	0.02
Lead	0.04	0.01
Manganese	20.0	<20.0
Mercury	0.01	<0.001
Selenium	0.10	<0.001
Silver	0.03	<0.001
Zinc	10.0	0.2
Calcium	500.0	500
Magnesium	250.0	250
Hardness	2,000	2,000

[1] pH in pH units; all others in mg/l (ppm)
Source: In part from Table A-4, Appendix 4.1A, EIR

The concentration of dissolved solids and metals in the leachate would change over time as the tailings slurry water was flushed from the tailings. If the final cover remained intact, any percolating water would probably not contain sufficient dissolved oxygen to decompose the pyrite in the tailings. Without oxygen, pyrite decomposes slowly, if at all, and thus is unlikely to contribute dissolved constituents. Water transport without corresponding oxygen transport would only displace slurry water trapped in the pores of the tailings. Under the worst case infiltration scenario (0.067 in/yr), about 3600 years would be required before the tailings pore water would be replaced by clean percolating water.

Other wastes disposed with the tailings would contribute relatively small amounts of dissolved constituents to the pore water, even if pyrite decomposition did not occur. Wastewater sludge from the treatment plant and reclaim ponds would contribute leachate constituents very similar to those of the tailings themselves. The sludges would provide a small amount of neutralizing capacity to the waste mass, but it would be of minor importance. The physical and mineralogical properties of the tailings would be a more important source of pH control.

Storage of salt cake (sodium sulfate, a by-product of the reverse osmosis water treatment process) in the MWDF is proposed until a determination of commercial marketability would be made. If stored within a bermed portion of tailings cell T-1, sodium sulfate would absorb water (hydrate) from excess available water if left uncovered. Following hydration it would begin to dissolve and contribute sodium and sulfate ions to the leachate. Approximately 2000 cubic yards of sodium sulfate would be produced annually.

The impacts of a leachate with a high sodium concentration on the permeability of the bentonite-modified soil liner cannot be accurately determined. No laboratory data are available, although soil science literature indicates that sodium could replace other cations in the soils and possibly alter its permeability.

Acid Generation in the Tailings - The tailings, which would be disposed in the MWDF, have the potential to generate an acid solution during decomposition. Decomposition, or oxidation, of pyrites in the tailings could occur in the presence of oxygen, and would be greatly increased by the presence of a ubiquitous bacterium Thiobacillus ferrooxidans and related species. The design and operation of the MWDF, however, would limit acid formation in a number of ways. First, this bacterium thrives only in very acid environments and under aerobic conditions. The MWDF and associated waters are proposed to be kept neutral to slightly alkaline to meet the requirements of the flotation process water. Secondly, the influx of oxygen into the tailings mass should be very limited because the bulk of the tailings would be submerged or wet, and the gradation of the tailings should allow only slow movement of water into the waste mass. In addition, the limited oxygen present in the tailings and tailings pond decant water would be rapidly depleted due to thiosalt oxidation. Exposed tailings should become anoxic within a few inches of the surface and prevent pyrite oxidation and resultant acid generation. Leachate from pyritic minerals exposed on waste rock surfaces would contribute minimal acid potential. The presence of feldspar minerals in the tailings and addition of alkaline sludges to the MWDF would help buffer acid production. In summary, under expected operating conditions and after final MWDF reclamation, acid generation in the tailings mass is not expected to significantly lower the pH of the tailings. If for some reason acidic conditions developed, they could be controlled through addion of lime. The only way that acid leachates could be expected to be produced in significant quantities would be if the tailings mass were exposed to the atmosphere due to erosion of the capping material. Long-term care of the tailings mass would prevent significant exposure from erosion.

MWDF Leachate-Liner Compatibility - D'Appolonia simulated an MWDF leachate liquid to test whether the leachate would have any effect on the bentonite-amended soil liner. During these tests, the synthetic leachate was percolated through columns containing compacted bentonite and till. Some changes in the clay mineralogy were found, but no significant changes in permeability resulted. Only high concentrations of organic or acidic chemicals would cause significant deterioration of the bentonite-amended soil liners. Since, these types of chemicals are not expected in the MWDF leachate, liner deterioration should be minimal.

Leachate Attenuation - Leachate seeping through the bottom of the MWDF and percolating through the unsaturated and saturated glacial sediments and bentonite-amended liner would be attenuated (reduced in concentration) by several processes. These include dilution, dispersion, adsorption, cation exchange, precipitation, biological metabolism and neutralization. Through these processes acidity, and the concentration of toxic metals, such as lead, cadmium, mercury, copper, chromium, or silver, would be reduced to very low levels. In addition, the solubility of these metals would be controlled by the pH of the groundwater system. In the neutral conditions found and expected to be maintained in the groundwater, the solubility of most heavy metals is low. In contrast, calcium, magnesium, sodium, and potassium contained in the glacial soils would be released by these processes thus raising the groundwater hardness and maintaining the total dissolved solids (TDS) at a high level. Sulfate and other negatively charged ions in the leachate, however, would be largely unaffected by neutralization, adsorption or precipitation. Manganese would be normally attenuated by the soils but in the presence of high concentrations of sulfate a neutral complex can form which is largely unaffected by soil adsorption processes. As the sulfate concentration decreases, the manganese sulfate complex concentration also would decrease, and the manganese would be adsorbed by the soil. It is possible that leachate seepage may cause the manganese concentration in the groundwater to exceed the drinking water standard of 0.05 mg/l even where sulfate concentrations have been attenuated below the 250 mg/l drinking water standard. Attenuation of sulfate and the other anions would occur by dilution and dispersion as the leachate moved through the groundwater system. Thus, the negatively charged particles, sulfate in particular, are of greatest concern, with manganese being a potential concern where sulfate concentrations are high. Health-related contaminants are not expected to reach the groundwater in significant quantities.

Given the differences in attenuation, the various leachate constituents would move at different rates through the glacial soils and aquifer. The capacity to retard contaminant movement is defined by a

retardation factor (Rd). Rd is the ratio of the rate of groundwater movement compared to the rate of movement of a contaminant in the groundwater. Table 3-2 shows the Rd's for several of the anticipated leachate constituents. For example, copper with an Rd of approximately fourteen would move about fourteen times slower than the groundwater. In contrast, sulfate has an Rd=1 and would move at the same rate as groundwater.

Table 3-2
Representative Retardation Factors (Rd)
for Glacial Materials

Parameter	Outwash Rd[1]	Till Rd[1]
Filterable residue (TDS)	1	1
Sulfate	1	1
Arsenic	BD[2]	BD
Barium	BD	BD
Cadmium	>13	>14
Chromium	BD	BD
Copper	>13	14
Iron	BD	BD
Lead	BD	BD
Manganese	<7	<7
Mercury	>13	>14
Selenium	>13	>14
Silver	>7	>14
Zinc	BD	BD

[1] From projected tailing seepage pH of 9.
[2] Rd Values reported as "BD" represent soluble metal concentrations below detection limits.
> Means greater than.
< Means less than.

Impacts to the Groundwater from the Mine Refuse Disposal Facility (MRDF)
Groundwater Impacts - MRDF leachate would contribute a number of common ions to the groundwater. The MRDF would contribute more chloride, magnesium, BOD (biological oxygen demand), COD (chemical oxygen demand), and nitrate than the MWDF per unit of leachate, but much less sulfate. Attenuation mechanisms would reduce leachate concentration as it flowed through underlying soils. Toxic metals would be retained in the wastes, liner, or unsaturated subsoils. Only traces of the organics would remain in the leachate by the time it reached groundwater. Leachate reaching the saturated sediments would have a minor impact on groundwater quality. Compared to MWDF seepage of thousands of years, the MRDF seepage duration of 40-60 years would be very short. Subsequent dilution by natural recharge and mixing within the aquifer would reduce the overall impacts, and no groundwater standards are predicted to be violated at the compliance boundary (150 feet from the facility).

Leachate Generation - The proposed MRDF design (large area of side slope, high permeability drain layer, low permeability liner, and short flow distance to the leachate collection system) would result in high leachate collection efficiency. The design, however, would concentrate the leachate on the base grades (2% slopes), and thus may result in higher seepage if aggressive leachate pumping were not pursued.

Seepage through the base of the MRDF should be less than 10% of the precipitation falling on an operating cell. Since annual precipitation is about 30 inches, the resulting seepage would be about three inches per year (500 gallons per day). In comparison, natural infiltration is 6.5 inches per year or more, thus there would be substantial dilution of leachate by the surrounding recharge. Actual leachate production would depend on the permeability of the liner and the drain layers, precipitation gains, and evaporation losses. Thus, the volume of leachate could be several times larger or smaller than was estimated. Following placement of the final cover, the refuse should dewater quickly due to its high permeability and low moisture holding capacity. The volume of leachate collected should decrease rapidly after closure.

The plastic membrane cap would reduce leachate generation to near zero. A worst case scenario similar to that of the MWDF, where 10% of the membrane is destroyed, would produce about 0.067 inches of leachate per year.

Leachate Quality - Mill waste would include wood, refuse, paper and packaging materials. The resulting organics in leachates would be of only moderate strength with less odor potential than municipal waste leachate. Table 3-3 contains information on leachate chemistry from municipal landfills and a paper mill landfill. Leachate from the MRDF would be of similar quality prior to attenuation or dilution. The leachate should not have the quantity or types of organic constituents that have been found to degrade bentonite and result in higher liner permeability.

Table 3-3
Landfill Leachate Chemistry

	Range of Landfill Leachate Quality from 12 Wis. Sites	Range of Paper Mill Leachate Quality
Cations		
Calcium	200 - 2100	
Cadmium	ND - 0.07	<0.1
Cobalt	ND - 1.0	0.85
Copper	ND - 0.32	ND - 0.55
Iron^{+2}	2.1 - 1400	1 - 80
Lead	ND - 1.11	ND - 0.11
Mercury	ND - 0.001	<0.0005
Magnesium	120 - 780	--
Manganese	0.03 - 26	? - 4.5
Potassium	ND - 1375	? - 1500
Silver	ND - 0.024	<0.05
Sodium	12 - 1630	? - 640
Zinc	ND - 54	? - 3
Anions		
Arsenic	ND - 0.225	ND - 0.2
Chlorides	180 - 2651	40 - 250
Cyanide	ND - 0.25	<0.005
Phosphorus	0.3 - 117	? - 1.5
Sulfates	8.4 - 500	50 - 845
Others		
Hardness	1650 - 9380	600 - 1730
pH	5.4 - 7.2	6.5 - 8.0
TDS	2180 - 25,873	--
BOD	1101 - 29,200	2 - 380
COD	1120 - 50,450	40 - 910
Nitrogen (as NH_3)	26 - 557	1 - 100
Total Organic	427 - 5890	--

Values in mg/l except pH.

Impacts of Groundwater Drawdown

Construction Impacts - During development of the main production shaft and air exhaust shafts, water would enter the excavations from three sources: (1) precipitation; (2) groundwater seepage; and (3) utility water. All mine water removed from the shafts during construction would be pumped to reclaim pond cell A or the wastewater storage lagoons. An estimated 6.5 million gallons of inflow would be pumped out of the shafts during their construction. Inflow should be minor due to the following factors: (1) the freezewall construction method would minimize groundwater flow in the adjacent glacial soils; (2) grouting of inflows exceeding 15 gallons per minute would limit inflow; and (3) surface water runoff would be diverted away from all shaft excavations.

Mine inflow, however, would increase as the development drifts were excavated around the orebody. A maximum inflow of about 200 gallons per minute is predicted for the construction phase. Except for groundwater table declines of several feet in the mine area, the groundwater table Figure 3-2 (modeled) and Figure 2-4 (actual) would be expected to remain near preconstruction levels through the construction phase.

Operations - Mine inflow would not begin to increase appreciably until project year 5 and would not be fully developed until project years 6 or 7. The groundwater drawdown would continue to slowly expand until a steady state condition was reached later in the project. Modeling of steady state groundwater drawdown was chosen for project year 28. Figures 3-3 and 3-4 present the predicted water table decline at year 28 for the moderate recharge case. The greatest predicted groundwater drawdown (58 feet) would occur directly above the mine. The maximum predicted extent of the cone of depression is indicated by the outermost contour representing the one foot drawdown (Figure 3-3). The water table decline predicted for the other recharge cases (low and high recharge cases) are similar to those for the moderate recharge case.

The cone of depression shown in Figure 3-3 would be asymmetrical because the higher permeability and greater thickness of the outwash south of the mine would provide the greatest flow toward the mine. North of the mine, the aquifer thins and a greater proportion of the aquifer consists of low permeability glacial till. This low permeability till reduces the potential impacts of groundwater drawdown on Swamp Creek.

During mining, weathered rocks with relatively high permeabilities, especially during the massive ore phase, would be removed and replaced with cemented backfill. This backfill would have a lower permeability, hence inflow to the mine might be reduced. In addition, grouting of active water courses may reduce inflows. The net result of these activities should be to lower mine inflow. The reduction in mine inflows, however, is not predictable, so decreasing inflow was not evaluated during modeling.

Closure - After mine pumping ceases, the water table level would rebound to within a few meters at the mine in three years and would be within about 1 meter of preconstruction conditions within 6 years. Groundwater modeling indicates the water table would rebound to original levels within 30 years of mine closure.

The recovery of the groundwater table and the resulting resaturation of the glacial aquifer sediments would not be expected to alter groundwater quality. Seasonal variations in groundwater levels and quality occur naturally, but these seasonal fluctuations do not significantly change groundwater quality. While the magnitude of the water level changes due to mine pumping and recovery would be greater than natural seasonal fluctuations, the mine-related drawdown recovery should not produce a greater impact on water quality than the existing fluctuations.

Resaturation of soils beneath a reagent, fuel, concentrate or other spill or leak could release contaminants to the groundwater. However, removal of the contaminated soil in accordance with the spill prevention counter-measure and control plan would minimize to the extent possible such sources of contamination. Also, since the majority of the groundwater level recovery is predicted to occur within the first 6 years, monitoring during the remaining long-term care period should identify any potential contamination problems. If necessary the Department could continue monitoring beyond the long-term care period.

Impacts on Water Wells

A water well inventory conducted by Exxon identified 27 privately owned water wells which would be replaced or deepened to mitigate the groundwater drawdown impacts on these wells. These wells are northwest of or around Little Sand Lake (Fig. 1-19). If other water wells were affected they would be replaced or deepened as appropriate. Section 144.855, Wisconsin Statutes, provides relief for private water wells impacted by mining activities. Beyond the area of greatest drawdown, however, negligible impacts should occur to water wells.

The closest public utility water wells are 2 miles west (Mole Lake community) and 8 miles north (City of Crandon). No impacts would be expected from the predicted groundwater drawdown on either water supply.

The water table decline and resulting changes in groundwater flow would not be expected to significantly affect the water quality of the area wells. The lowering of the water table would provide increased unsaturated soils for purification of water percolating from local contamination sources. In addition, any potential contamination from the mine/mill, but not the MWDF, would flow toward the mine.

Analysis of Groundwater Impacts by Computer Modeling

NOTE: The following provides a technical discussion of the modeling assumptions and conditions used during analysis of the groundwater impacts. The models were used to determine the range of potential impacts and to guide the development of mitigation strategies. While the models lack the detailed reality of the groundwater system, they are one of the best ways to approximate the behavior of the aquifer.

Groundwater Drawdown Modeling - The model described in EIR Appendix 4.1A was used to predict the extent of the groundwater drawdown and changes in groundwater flow direction. To estimate the range of impacts, the computer model was first calibrated to produce a groundwater contour map which closely resembled existing conditions (Figure 3-2). Second, three recharge rates (recharge is the amount of water from precipitation or lake and wetland seepage entering the groundwater aquifer) were assumed: (1) 6 inches/year, a low recharge rate; (2) 8.5 inches/year, a moderate recharge rate; and (3) 11 inches/year, a high recharge rate. The recharge rate is important because it would effect the amount of water flowing into the mine and the extent and duration of the drawdown. Steady state mine inflow rates established by Thomas A. Prickett and Associates (Exxon's consultant) based upon the low, moderate, and high recharge rates were 933 gallons per minute (gpm), 1,270 gpm, and 1,590 gpm, respectively. Subsequent modeling indicated lake seepage could increase mine inflow rates by about 200 gpm.

Contaminant Transport in the Groundwater System - The various computer modeling exercises tended to confirm one another and provided a reasonable method of evaluating potential contaminant movement from the MWDF. The United States Geological Survey (USGS) and DNR used a two dimensional, cross-sectional, groundwater flow model crossing from west of Rice Lake to east of Hemlock Creek. This cross section included the orebody and MWDF. Bedrock hydrogeology was included in the model. A subset of the model was utilized to model contaminant transport from the MWDF. The USGS/DNR modeling provided a check on D'Appolonia's (Exxon's consultant) modeling and allowed for inspection of alternate model inputs/assumptions. D'Appolonia prepared a horizontal (areal) two dimensional model, a two dimensional vertical profile (cross-sectional) model and a vertical one dimensional model. The one dimensional model was used as input to the two dimensional vertical model.

Horizontal (Areal) Modeling - The horizontal (areal) simulations by D'Appolonia provide an indication of contaminant (sulfate) movement in the plan view. A constant MWDF leachate seepage of .067 inches/year was used to simulate the contaminant source. A seepage rate of .067 inches/year is equivalent to 0.93 gallons/minute total seepage from the MWDF if it were closed as proposed but steady state seepage were occurring due to deterioration of the capping membrane. The seepage is based on the worst case assumption in which approximately 10% of the capping membrane had been destroyed. The results, as shown in Figure 3-5, indicate most of the contaminant transport would be to the northeast toward Hemlock Creek. A small amount would move southwest and discharge into the wetland northeast of Rolling Stone Lake (headwaters of Creek 12-9). The contaminant concentrations provided by D'Appolonia give only an approximation of the sulfate concentrations in the aquifer. In reality, the sulfate concentrations would be distributed unevenly within the thickness of the aquifer. The sulfate concentrations indicated as varying from 10 to 80 parts per million could be anywhere from 5 to 10 times lesser or greater at any given vertical location in the aquifer. The concentration would depend on the type of glacial material and contaminant plume thickness. The vertical profile modeling (see following discussion) indicates the highest sulfate concentrations would be found deeper in the aquifer.

Vertical Model Application - The D'Appolonia and DNR/USGS vertical models are generally similar but differ in a number of details. Both modeling efforts resulted in similar contaminant distributions but different contaminant concentrations and rates of contaminant movement. The rate of contaminant movement in the D'Appolonia simulations was less than in the USGS/DNR simulations. This was due to D'Appolonia's assumption of slow contaminate movement in the unsaturated soils below the MWDF. A slow rate of movement through the unsaturated zone would delay contaminant arrival at the water table. The lack of field data concerning unsaturated fluid and contaminant movements, however, precludes accurate quantification of contaminant travel times in the unsaturated zone. Calculations by the Department indicate contaminants may reach the water table in about 20 to 100 years. D'Appolonia modeling indicated about 600 years would be required before the sulfate concentration reached 2000 parts per million at the water table beneath the

MWDF. The USGS/DNR modeling conservatively assumed contaminants seeping from the MWDF immediately entered the water table and began flowing with the groundwater. This assumption allows for rapid contaminant movement due to channelized leachate flow within the unsaturated zone beneath the MWDF. Both models utilized a range of dispersivities to vary the extent of contaminant movement and concentration through time. Dispersivity (dispersion) describes the spreading (decrease in concentration) of contaminants as they move through the aquifer. The range of dispersivities utilized in the modeling included values appropriate for the scale and type of aquifer materials found at the MWDF site. A range of values must be used since no existing contaminant plume exists at the MWDF area to which the models could be calibrated. An extreme set of values using a very low longitudinal dispersivity coupled with a very high longitudinal to transverse dispersivity ratio was not modeled because the model grid was not fine enough to allow very small longitudinal dispersivity values. It is more likely a medium to large longitudinal dispersivity would be associated with the site hydrogeological conditions, which include high values for hydraulic conductivity and long flow distances.

It should be noted the cross-section through which the USGS/DNR vertical model is constructed does not intersect the MWDF as is presently proposed by Exxon. The modeling was conducted for a larger, earlier MWDF design which extended northward to the model cross-section. The model results are still valuable in providing a general indication of potential contaminant movements in the MWDF area.

D'Appolonia Profile Model Results - Sulfate was the major concern in the modeling analysis. Sulfate ions are very mobile in groundwater and have a secondary drinking water standard of 250 parts per million. People drinking water containing sulfate in concentrations of several times the 250 parts per million standard have shown no adverse effect, but people unaccustomed to drinking such water would likely develop diarrhea. Manganese, which forms a complex ion with sulfate potentially could be found in concentrations greater than the secondary drinking water standard of 0.05 mg/l. The background concentrations of manganese in the glacial aquifer average 0.42 mg/l or about eight times the secondary drinking water standard. The levels of manganese which could potentially be generated at the compliance boundary through MWDF seepage are not of health concern but would cause staining of plumbing fixtures and impart a cloudy or grayish to dark color to drinking water. The other constituents comprise a much smaller percentage of the leachate, and would either be attenuated or diluted by the underlying soils and groundwater movement. Because of this, these constituents would not become distributed within the aquifer or become detrimental to public health or welfare.

Both steady-state and transient simulations were used to evaluate MWDF groundwater impacts. A steady state simulation is one in which the model input parameters (e.g., conductivities, leachate quality and quantity, and aquifer thickness) are held constant and the contaminant plume is allowed to develop. The steady state simulations thus represent long-term equilibrium conditions expected within the aquifer. In contrast, a transient simulation allows model input parameters to be varied through time and contaminant plume configurations and concentrations to be inspected after any length of time desired. A transient simulation shows the development of the contaminant plume as leachate reaches the aquifer and moves down and through the saturated sediments over time.

The steady-state simulations indicate contaminant plumes would move downward and to the east toward Hemlock Creek. Figures 3-6 and 3-7, provide representative ranges of potential contaminant concentration distributions for the various dispersivity values. Most worst case simulations indicate sulfate concentrations at the compliance boundary (1,200 feet away from the MWDF) would be less than 250 parts per million (the secondary drinking water standard). The Wisconsin mine waste disposal regulations specify contaminants cannot exceed federal drinking water standards at the compliance boundary. Simulation utilizing a small longitudinal dispersivity value indicates sulfate concentrations exceeding 600 parts per million would develop in the till above the bedrock at the compliance boundary. The simulation utilizing a very large dispersivity ratio shows an even higher value of 800 parts per million in the till layer at the compliance boundary. Localized recharge from the cap (percolation from the MWDF perimeter) tend to force the contaminants down into the till layer and bedrock beneath the outwash thus increasing concentrations until steady-state values were reached. Figure 3-8 shows changes in sulfate concentration over time at three locations. The concentrations decrease with distance from the MWDF. None of the simulations using .067 inches/year seepage rates allow sulfate concentrations to exceed 250 parts per million in the highly conductive outwash with the exception of the highest dispersivity ratio simulation of 1000/1, where sulfate concentration reached about 300 mg/l.

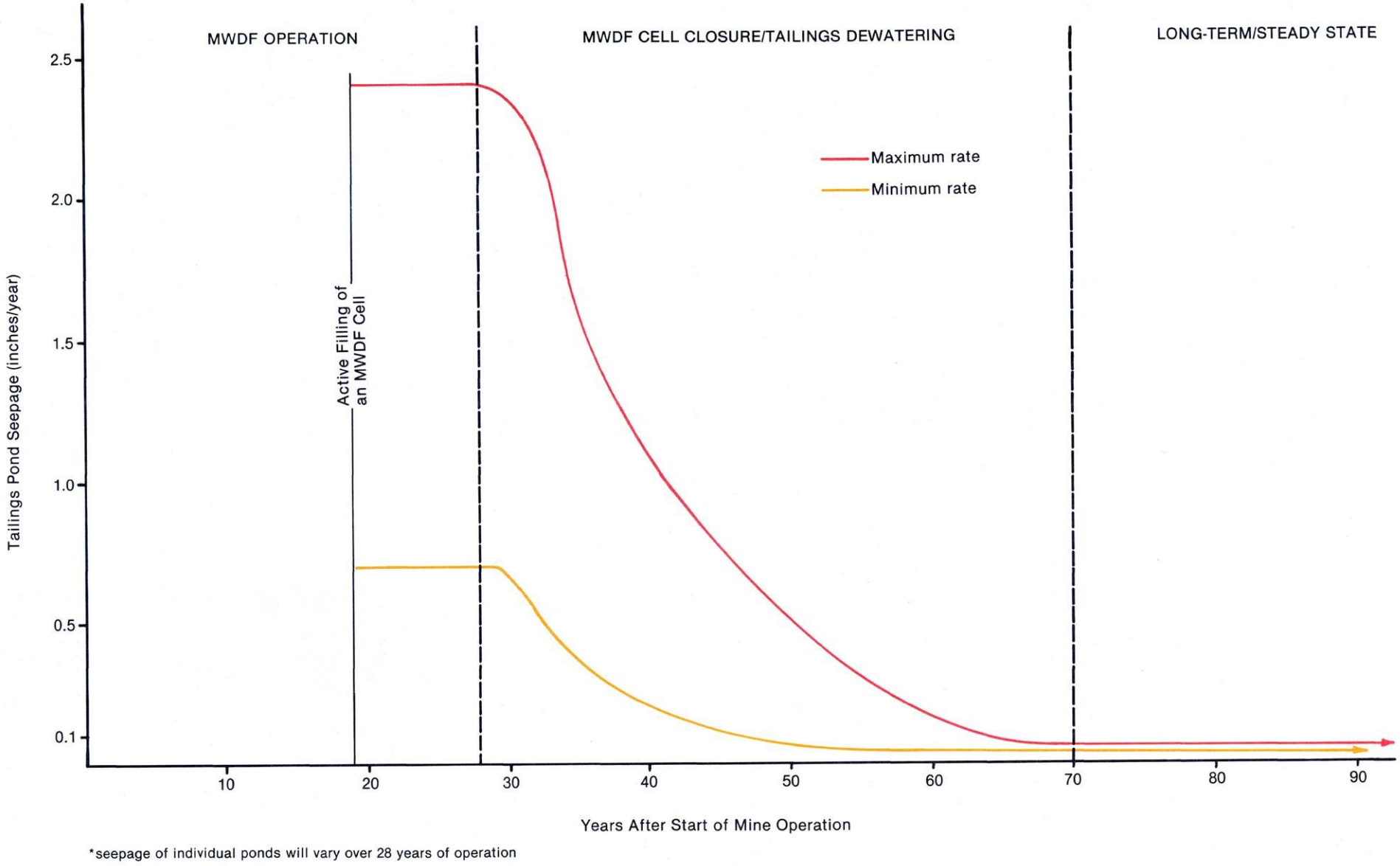
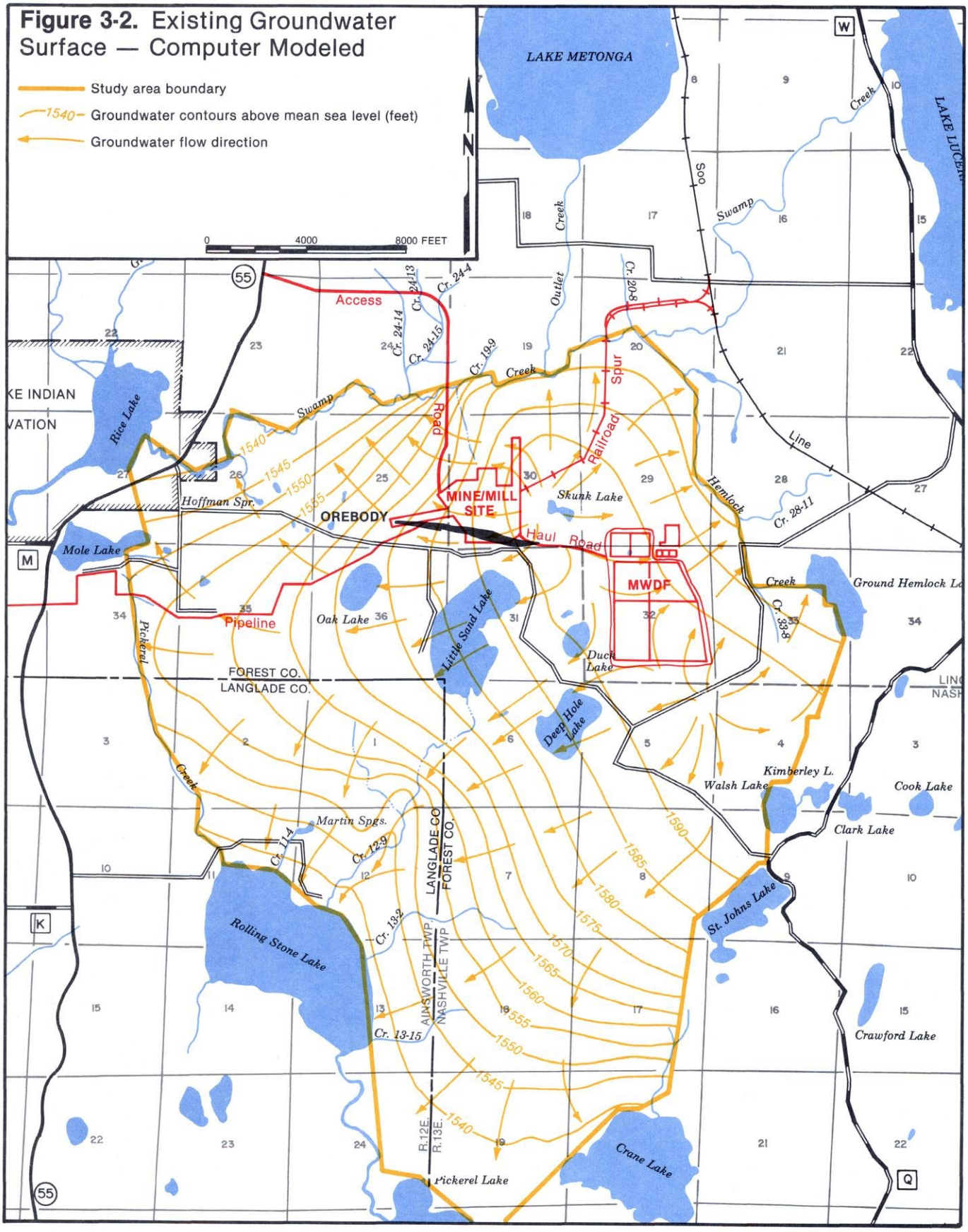
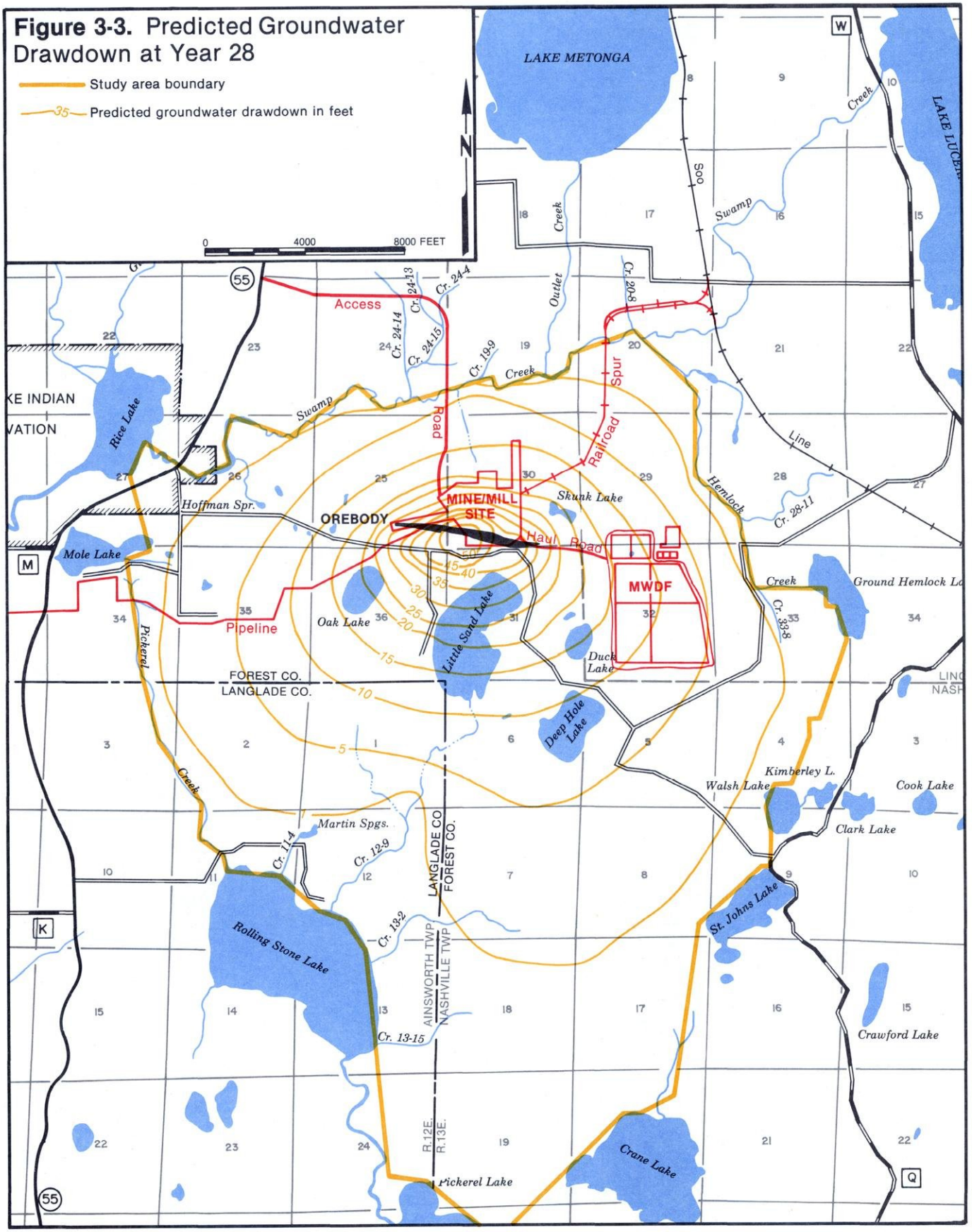
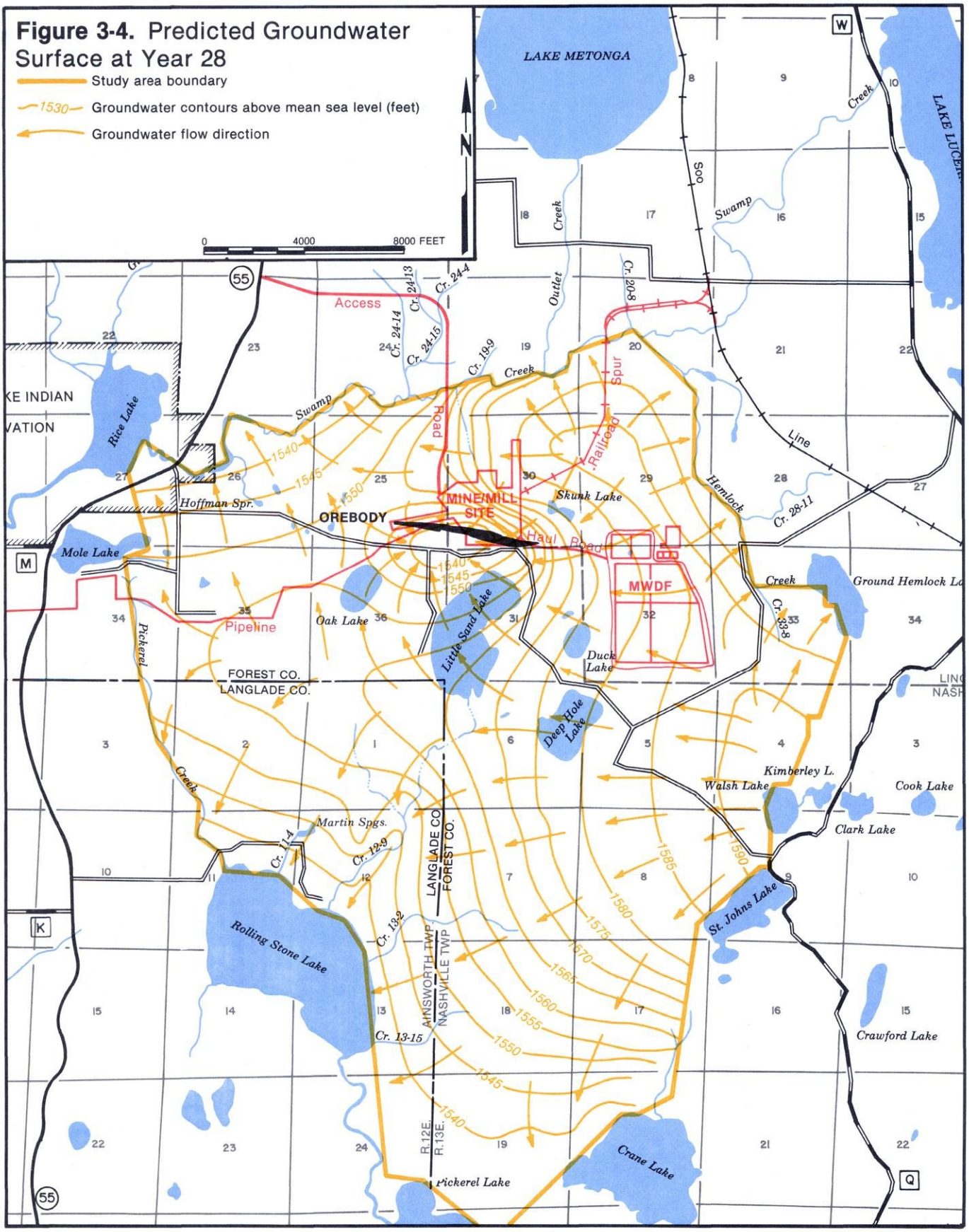
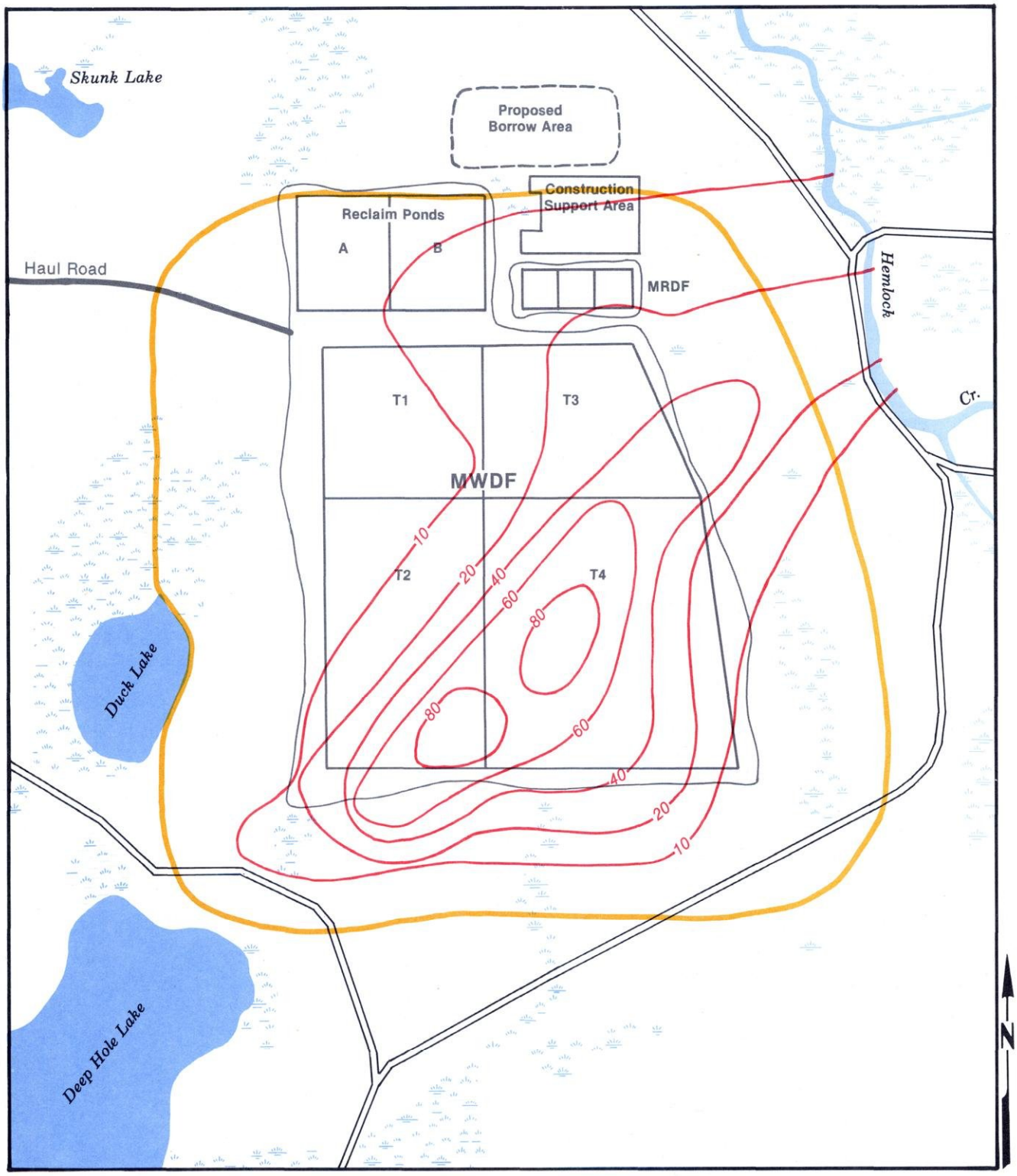


Figure 3-1. Predicted MWDF Maximum and Minimum Seepage Rates


Figure 3-2. Existing Groundwater Surface — Computer Modeled
Study area boundary
1540 Groundwater contours above mean sea level (feet)
Groundwater flow direction
0 4000 8000 FEET
N
LAKE METONGA
Access
MINE/MILL SITE
OREBODY
Haul Road
MWDF
Pipeline
Rice Lake
Mole Lake
Hoffman Spr.
Oak Lake
Little Sand Lake
Duck Lake
Skunk Lake
Deep Hole Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Crawford Lake
Crane Lake
Rolling Stone Lake
Martin Spgs.
Pickerel Lake
Ground Hemlock Lake
FOREST CO.
LANGLADE CO.
AINSWORTH TWP
NASHVILLE TWP
R.12E.
R.13E.
Cr. 24-4
Cr. 24-13
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
Cr. 13-15
Outlet Creek
Swamp
Soo Line
Railroad Spur
Hemlock Creek
Pickerel Creek
1540
1545
1550
1555
1560
1565
1570
1575
1580
1585
1590

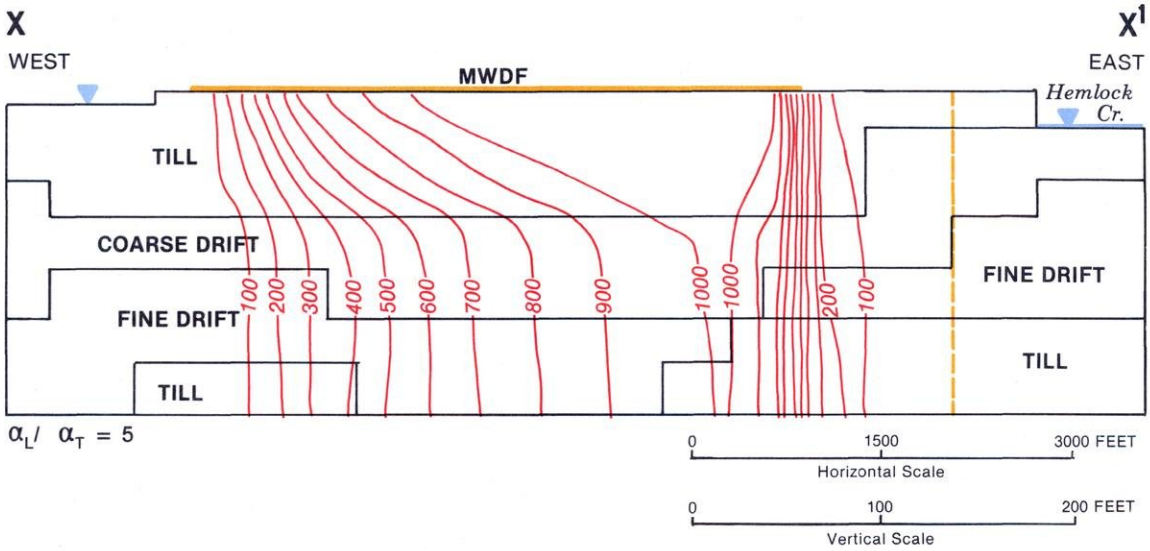

Figure 3-3. Predicted Groundwater Drawdown at Year 28
Study area boundary
35 Predicted groundwater drawdown in feet
0 4000 8000 FEET
N
LAKE METONGA
LAKE LUCE
Soo
Swamp
Creek
Outlet
Cr. 20-8
Spur
Railroad
Line
Hemlock
Cr. 28-11
Access
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Road
Swamp
Rice Lake
Hoffman Spr.
MINE/MILL SITE
OREBODY
Skunk Lake
Haul Road
MWDF
Mole Lake
Pipeline
Oak Lake
Little Sand Lake
Duck Lake
Deep Hole Lake
Pickerel Creek
FOREST CO.
LANGLADE CO.
Ground Hemlock La
Cr. 33-8
Kimberley L.
Walsh Lake
Cook Lake
Clark Lake
St. Johns Lake
Martin Spgs.
Cr. 11-4
Cr. 12-9
Cr. 13-2
Cr. 13-15
Rolling Stone Lake
AINSWORTH TWP
NASHVILLE TWP
LANGLADE CO
FOREST CO.
R.12E.
R.13E.
Crawford Lake
Crane Lake
Pickerel Lake
KE INDIAN
VATION
55
W
M
K
Q

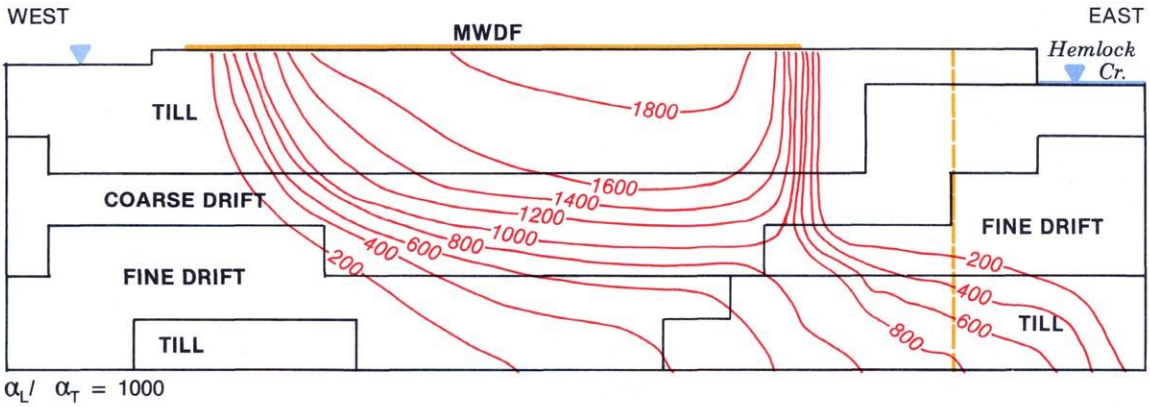

Figure 3-4. Predicted Groundwater Surface at Year 28
Study area boundary
1530 Groundwater contours above mean sea level (feet)
Groundwater flow direction
0 4000 8000 FEET
N
LAKE METONGA
LAKE LUCE
Soo Swamp
Creek
Outlet
Cr. 20-8
Access
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Spur
Railroad
Road
Swamp
Rice Lake
Hoffman Spr.
OREBODY
MINE/MILL SITE
Haul Road
Skunk Lake
Hemlock
Line
Cr. 28-11
MWDF
Mole Lake
Pipeline
Oak Lake
Little Sand Lake
Duck Lake
Deep Hole Lake
Pickerel Creek
FOREST CO.
LANGLADE CO.
Ground Hemlock Lake
Cr. 33-8
Kimberley L.
Walsh Lake
Cook Lake
Clark Lake
St. Johns Lake
Martin Spgs.
Cr. 11-4
Cr. 12-9
Cr. 13-2
Cr. 13-15
Rolling Stone Lake
ANSWORTH TWP.
NASHVILLE TWP.
R.12E.
R.13E.
Pickerel Lake
Crane Lake
Crawford Lake
1540
1545
1550
1555
1560
1565
1570
1575
1580
1585
1590



NOTES:
1. α_L / α_T = Longitudinal to transverse dispersivity ratio
2. Longitudinal dispersivity = 197 feet
3. Recharge rate = 8.5 inches/year
4. Other input parameters and conditions discussed in attachment A.7, Appendix 4.1A of EIR
5. MWDF configuration altered graphically to reflect most recent proposal

Figure 3-5. MWDF Steady State Sulfate Concentrations Predicted by D'Appolonia Horizontal Model





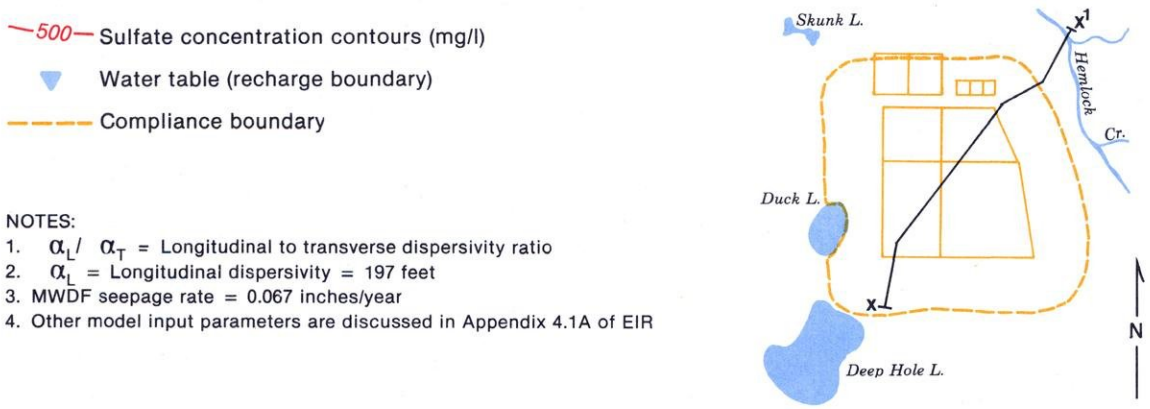
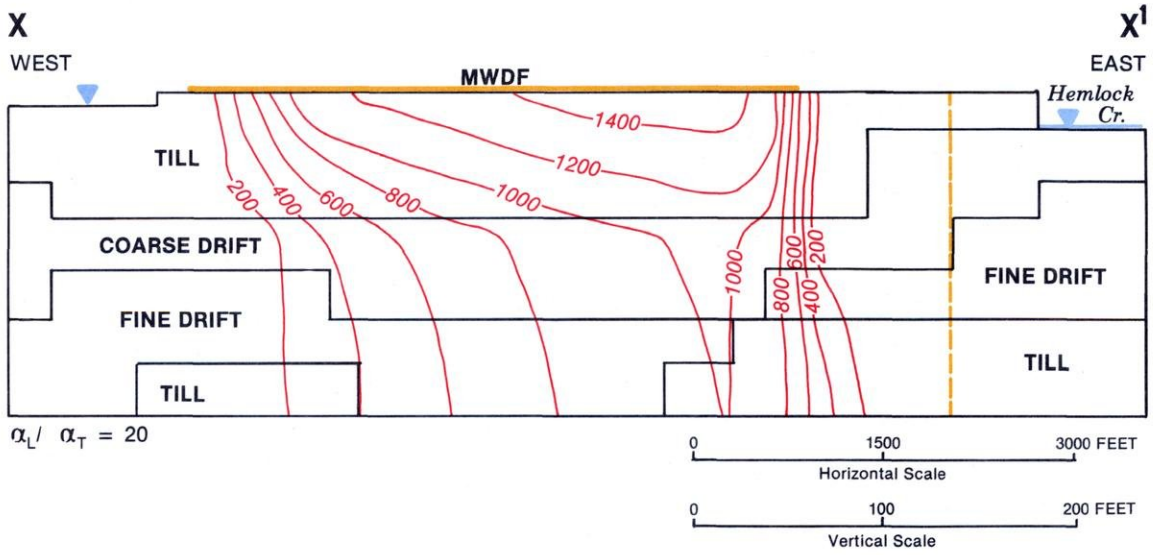
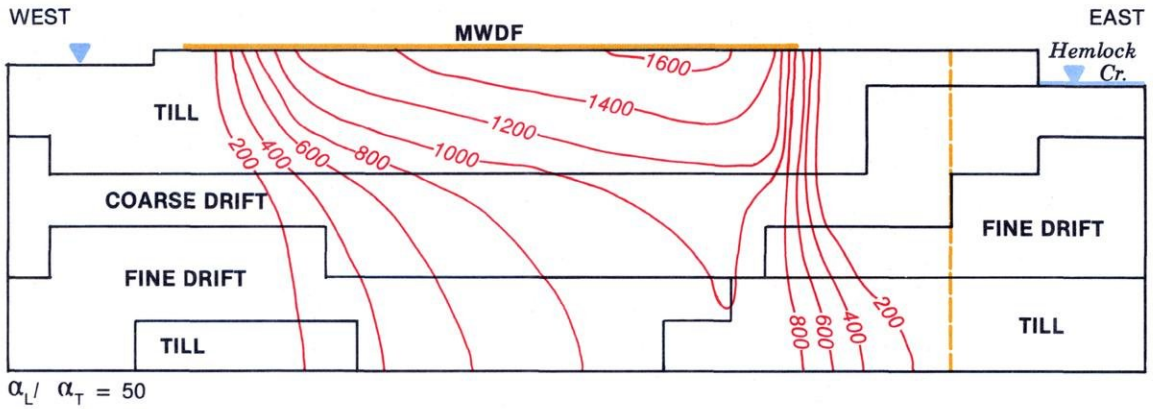


Figure 3-6. MWDF Steady State Sulfate Concentrations Predicted by D'Appolonia Vertical Model (High & Low Dispersivity Ratios)

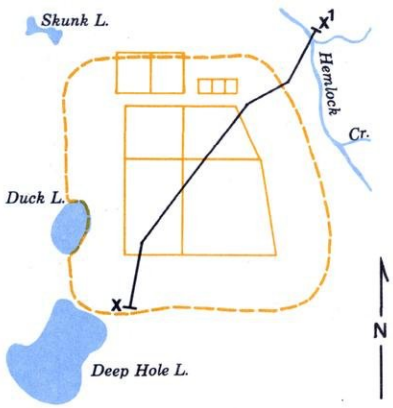




—1200— Sulfate concentration contours (mg/l)

Water table (recharge boundary)

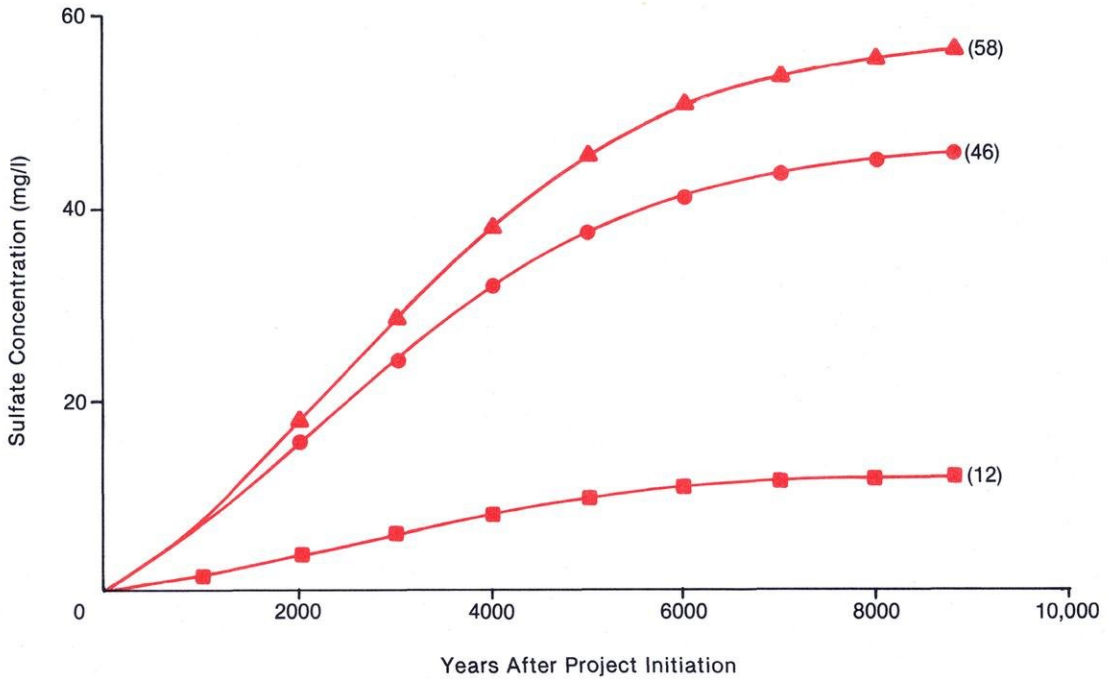
Compliance boundary



NOTES:

1. α_L / α_T = Longitudinal to transverse dispersivity ratio
2. α_L = Longitudinal dispersivity = 197 feet
3. MWDF seepage rate = 0.067 inches/year
4. Other model input parameters are discussed in Appendix 4.1A of EIR

Figure 3-7. MWDF Steady State Sulfate Concentrations Predicted by D'Appolonia Vertical Model (Moderate Dispersivity Ratios)



▲ Compliance boundary (118 ft. below water table)

● Eastern edge of MWDF (20 ft. below water table)

■ Hemlock Creek (at water table)

( ) Predicted steady-state concentration (mg/l)

NOTES:
1. Vertical to horizontal permeability ratio, Till = 1/1, Drift = 1/50
2. Longitudinal dispersivity = 197 feet
3. Longitudinal to transverse dispersivity ratio = 50
4. Other model and input parameters are discussed in Appendix 4.1A, EIR.

Figure 3-8. MWDF Sulfate Concentrations in the Groundwater Along the D'Appolonia Vertical Cross-Sectional Model

USGS/DNR Model Results - Strong horizontal flow occurs in the highly permeable outwash. Most of the contaminant movement would occur in the outwash even though higher concentrations could develop in the less permeable till and bedrock units. Figure 3-9 shows the direction of groundwater flow as modeled. Discharge of groundwater from the MWDF area into Hemlock Creek prevents contaminants from moving beyond Hemlock Creek. Figure 3-12 shows steady-state contaminant concentrations for various dispersivity ratios assuming MWDF seepage was held constant at 0.067 in/yr and the sulfate concentration of the leachate was set at 2,000 parts per million. To provide a check on model sensitivity the groundwater recharge rate was doubled, producing contaminant concentrations of 30 to 50 per cent that of the lower rates. The complete destruction of the MWDF membrane cap was simulated with a steady state seepage of 0.67 inches per year. This produced compliance boundary sulfate concentrations near that of the 250 mg/l drinking water standard. The complete loss of the cap membrane is considered such a remote possibility that it is not considered as part of a worst case scenario. Figure 3-11 has transient simulations showing sulfate concentrations after 50 years of MWDF operation. It should be realized that arrival of contaminants at the water table will be delayed by 20 to 120 years due their passage through the unsaturated glacial soils beneath the MWDF. Therefore, modeling the high rates of operational seepage for 50 years is a conservative case. A worst case short-term scenario (lack of a cap and slow tailings dewatering during the first 50 years) was simulated by using MWDF seepage rates of 0.6 to 2.4 inches/year (2.5-10.2 gpm). An additional assumption was that the cap would not be fully functional at this time, so the groundwater recharge at the MWDF margin was set at normal levels. Table 3-4 summarizes the model results for sulfate concentrations expected at the 1,200 foot MWDF compliance boundary.

Table 3-4
Results of USGS-DNR Steady State and Transient
Groundwater Quality Modeling (Vertical Profile)

	Maximum Sulfate Concentrations at Compliance Boundary (ppm)		
Steady State Simulations[1]	Outwash	Till	Bedrock
Dispersivity Ratio (a_L/a_T)[2]			
Seepage 0.067 inches/year			
10/1	20	25-30	ca. 60
60/1	15-20	15-20	35-45
60/0.1	25-40	35-45	35-45
Seepage 0.067 inches/year; recharge doubled			
10/1	10	10	25
60/1	<10	10	10
60/.1	10	10	15
Seepage 0.67 inches/year			
10/1	200	250	250
60/1	150	200	250
60/.1	250	250	250
Transient Simulations[3]			
Seepage 2.4 inches/year a_L/a_T = 60/1	30-40	10-25	1-10
Seepage 2.4 inches/year a_L/a_T = 60/0.1	35-40	10-25	ca. 1
Seepage 0.6 inches/year a_L/a_T = 60/1	2-3	ca. 1	<1

1 All have high groundwater recharge at the MWDF margins and a steady state MWDF seepage rate as noted.

2 a_L = Longitudinal dispersity/a_T = Transverse dispersity. Longitudinal dispersivity considers dispersion of a contaminant along the direction of groundwater flow. Transverse dispersivity evaluates contaminant dispersion at right angles (perpendicular) to the groundwater flow. Where the rate of longitudinal dispersivity to transverse dispersivity is large, contaminant dispersion throughout the aquifer would be minimal. If the ratio is high, contaminant would be more dispersed throughout the aquifer.

3 No marginal groundwater recharge used. Sulfate concentrations are after 50 years of MWDF operation.

The highest sulfate values reached during the worst case steady-state simulations of 0.067 in/yr seepage were approximately 60 parts per million. The simulations at 50 years indicate sulfate could move quickly from the MWDF if seepage rates are high and little marginal groundwater recharge is occurring. Seepage of MWDF leachate through the unsaturated zone may delay sulfate arrival to the water table until after the increased marginal seepage has been established. If this occurred, the early high rates of seepage would be directed downward into the till and bedrock and slow its movement toward the compliance boundary.

Department analysis indicated MWDF seepage may reach the water table after 20 years of MWDF operation. Thus, additional USGS/DNR vertical model simulations were made to evaluate contaminant movements associated with significant input of leachate at the water table during the operational period. The mine-induced groundwater drawdown projections made by the GEOFLOW area/flow modeling in the area of the USGS/DNR cross-section were used to simulate flow. The operational groundwater flow system simulated is shown in Fig. 3-9. The groundwater divide would be under the eastern side of the MWDF. MWDF seepage was simulated at both 0.6 and 2.4 inches per year over a 30 year period. No marginal recharge from the capping system was included during the 30 year period. The preconstruction groundwater flow system and a MWDF seepage rate of 0.067 inches per year was used for simulation time after 30 years. The simulation provides a very conservative worst case because the MWDF should only be in operation for about ten years after the earliest possible leachate arrival at the water table. The model also over-represents the MWDF operational seepage area because only the 2% base grades are expected to contribute significant quantities of seepage, but the MWDF sideslopes were included as part of the seepage area. The 2% base grade area would make up about 30% of the total lined area.

Fig. 3-10 presents the model results for the simulation of contaminant movements during mine operation. Mine inflow would induce westward flow of contaminants for the first 30 years, but after 30 more years the restoration of ground water flow toward Hemlock Creek has caused their movement in that direction. The results of all the transient simulations utilizing the early movement of contaminants during the mining operation are summarized in Table 3-5.

Table 3-5
Results of Transient USGS/DNR Vertical Profile Modeling Which
Incorporates Potential Groundwater Contaminant Movements During Mine Operation

Model Simulation	Maximum Sulfate Concentration At Compliance Boundary (ppm)		
	Outwash	Till	Bedrock
(2.4 in/yr seepage)			
a_L/a_T=10/1			
30 years	70	65	<10
60 years (east boundary)	20	25	25
a_L/a_T=60/1			
30 years	60	50	<1
60 years (east boundary)	30	25	10
60 years (west boundary)	90	90	<10
a_L/a_T=60/.1			
60 years (east boundary)	45	35	<10
30 years (west boundary)	140	100	<10
a_L/a_T=60/.1			
(Double recharge and specified flux)			
60 years (east boundary)	50	25	<10
30 years (west boundary)	200	100	<1
(0.6 in/yr seepage)			
a_L/a_T=10/1			
60 years (west boundary)	30	25	<1
a_L/a_T=60/1			
60 years (west boundary)	25	15	<1
a_L/a_T=60/.1			
40 years (west boundary)	35	30	<1

a_L = Longitudinal Dispersivity
a_T = Transverse Dispersivity

All simulations indicate sulfate concentrations would remain below the drinking water standard at the compliance boundary.

IMPACTS TO SURFACE WATERS FROM THE GROUNDWATER DRAWDOWN

Pumping water from the mine would cause a drawdown of the groundwater table in the area (Figure 3-3). Lowered groundwater levels would, in turn, cause increased seepage from lakes and decreased groundwater flow into streams.

Since lakes and streams are considered public property, state laws require protection of public uses and rights in surface waters. Examples of public rights include fishing, swimming, boating, and aesthetics. Detailed analyses were conducted to determine the extent of impacts to surface waters and associated public rights. These analyses are further discussed below.

Exxon has proposed a plan to mitigate declines in stream flows and lake levels (see Chapter 1). The proposed mitigation plan may not provide enough water to adequately mitigate all mine-induced impacts to surface waters. A shortfall in the amount of mitigation water would result in detrimental impacts to public rights. The specific rights and/or surface waters which would be affected by a shortfall would depend upon how the available mitigation water was allocated. For this reason, it is not possible to provide a resource-specific analysis of surface water impacts with the proposed mitigation plan implemented. Instead, the following discussion provides analysis of impacts from the groundwater drawdown without any mitigation. A discussion of the effectiveness of the various mitigation measures is also included. An alternative approach to mitigation, which would provide adequate water, and the impacts of mitigation pumping are described in Chapter 4.

In this section, predicted lake levels and stream flows are calculated to a high degree of precision. While this is useful for volumetric estimates, uncertainties in field data and limitations in predictive capabilities do not allow predictions to the implied level of precision. The analysis does, however, provide an effective means of analyzing impacts to surface waters.

LAKE IMPACTS WITHOUT MITIGATION

The groundwater drawdown would affect water levels in lakes near the mine to varying degrees. The extent to which a lake would be impacted by the drawdown depends on its relationship to the groundwater and its proximity to the mine. In drainage lakes near the mine, groundwater discharges directly into the lakes, and the groundwater drawdown would decrease the amount of groundwater inflow. Area drainage lakes which could be affected by the groundwater drawdown include Rice, Rolling Stone, Ground Hemlock, Crane, and Pickerel Lakes.

In seepage lakes, the groundwater drawdown below the lakes would cause increased seepage through the lake bottom, resulting in decreased lake levels. Little Sand, Duck, Deep Hole, and Skunk Lakes are seepage lakes close to the mine, and are the most likely to be significantly affected. Less information is available on Mole, Walsh and St. John's Lakes. However, data indicate that these also are seepage lakes, but are too far away from the mine to experience any discernible impacts.

Oak Lake and several small ponds near the mine are entirely perched above the water table, and would not be affected by changes in the groundwater level.

Impacts to Seepage Lakes (Without Mitigation)

In order to evaluate the effect of mine pumping on the seepage lakes near the mine (Little Sand, Duck, Deep Hole and Skunk Lakes), the DNR and USGS developed a computer model for simulating lake conditions. Lake hydrologic properties such as water gains (precipitation, runoff, stream inflow), water losses (evaporation, outflow and seepage), lake size and depth, lake sediment permeabilities and thickness, and groundwater conditions were a part of the evaluation. To simulate potential impacts to the lakes, a 31-year period of precipitation and evaporation records was used. This period represents likely climatic conditions that may occur during the proposed mining period, including drought and wet periods. The ability to precisely predict impacts to lake levels is limited by uncertainties in the estimates of lake hydrologic properties. In particular, the lake seepage factors (sediment permeabilities and thickness) and the amount of groundwater drawdown underneath the lakes are estimates which are uncertain and which have substantial effects on the predictions of lake level changes.

In order to encompass the range of uncertainty, two predictions of impacts to lakes were made; 1) an "expected" case, which is the most likely outcome, and 2) a "maximum" case, which represents an estimate of the highest lake seepage rate which could reasonably be predicted. Both cases use DNR's estimates of lake sediment permeabilities and thicknesses, and predict impacts which are generally greater than estimates made by Exxon consultants. The "maximum" case analysis used the highest lake bed and aquifer permeabilities which could reasonably be expected to occur. An 8.5 inch annual recharge value was used for the expected case analysis. A 10-inch annual recharge value (and a correspondingly large aquifer hydraulic conductivity) was used to generate the maximum increase in lake seepage which could be caused by the drawdown. Use of the 10-inch annual recharge for simulating maximum lake seepage impacts assumes that, under existing conditions, a higher proportion of the rainfall actually reaches the groundwater. This assumption effectively "adds" more water to the hydrologic system for the maximum case analysis than for the expected case analysis. As a result, the maximum case analysis provides the highest predictions of impact to lake seepage rates. However, the prediction of impacts to lake levels is not significantly different between the expected and maximum case analysis. Therefore, only a single lake level value is presented.

Minimum lake levels required to protect public rights on these lakes were established by the DNR using field observations and measurements. Variable levels were established for Little Sand and Deep Hole Lakes to reflect seasonal requirements of lake biota.

Without mitigation, mine pumping would significantly affect levels in Little Sand, Deep Hole and Skunk Lakes. Duck Lake also would be impacted but to a lesser degree. Table 3-6 provides expected declines in lake levels from the groundwater drawdown along with the expected and maximum increases in lake seepages. Little Sand Lake would experience the most severe impacts, with an average lake level decline of approximately 6.9 feet and lake seepage increasing between 568 and 710 gpm. Deep Hole and Skunk Lakes would decline approximately 0.6 and 1.9 feet, respectively, while Duck Lake would decline less than 0.2 feet. All lakes would drop below the minimum level necessary to protect public rights, although Duck and Deep Hole Lakes would be expected to regain minimum levels during part of the year. Declines in lake levels would cause a comparable decrease in lake surface areas. Skunk Lake would become small and very shallow most of the time and evolve into a seasonally flooded wetland.

Table 3-6
Hydrologic Impacts to Lakes From the Groundwater Drawdown (Without Mitigation)[1]

Lake	Existing Modeled Lake Surface Area (acres)[2]	Recomm. Minimum Lake Level (MSL)	Reduction in Lake Level[4] (ft)	Increase in Lake Seepage[5] (gpm) Exp. Case	Max. Case	% Time Below Minimum Levels	New Modeled Lake Surface Area (acres)
Little Sand	245	1591.00-1591.50	6.9	568	710	100%	145
Duck	97[3]	1610.59	0.2	8	12	30%	95
Skunk	15[3]	1597.01	1.9	258	438	95%	3
Deep Hole	121[3]	1605.00-1605.25	0.6	87	102	50%	114

[1] All values are averages.
[2] Lake surface areas vary somewhat due to lake level fluctuations.
[3] Includes wetlands
[4] Predicted declines in lake levels are from modeled average lake levels.
[5] Assumes lakes are at average levels.

Lake impacts due to lowering of the groundwater table would develop progressively as the mine site is dewatered. Estimates indicate the groundwater table would be drawn down only a small amount

during the construction phase. The groundwater drawdown would begin to develop more fully by project year 4, and would be almost fully expressed by project year 7. Lake impacts, therefore, would be expected to develop early in the operations period.

Following the end of mine pumping, there would be an initial, rapid recovery period during which the groundwater would flow into the deeper central part of the cone of depression. This would result in a flattening of the groundwater drawdown cone, although the level would remain below that of premining conditions. After about 8 years, the groundwater levels would return to very near their original levels. All related surface water quantity impacts would disappear by this time. About 30 years would be required for a complete recovery to premining groundwater levels.

Impacts to Lake Fisheries - The expected drawdown on Little Sand Lake would dewater most of the preferred spawning habitat for largemouth bass, bluegill, pumkinseed and black crappie. The drawdown would likely create fish winterkill conditions. Reductions in fish biomass proportional to reductions in lake acreage would also be expected. Fish in Deep Hole Lake would experience little change in species composition and a minor decrease in biomass with the expected lake declines. Fisheries in Duck Lake would not be significantly affected by the expected drawdown.

Impacts to Macroinvertebrates - Declines in lake levels would dewater shoreline areas of macrophyte growth and rock/rubble substrate. These habitats are the most diverse and productive macroinvertebrate habitats. While macrophytes would grow in new areas after a lake drawdown, substantial losses of macroinvertebrates would result from reductions in lake areas.

Impacts to macroinvertebrates would be proportional to the amount of productive habitat lost. The drawdown on Little Sand Lake would expose most of the rock/rubble and macrophyte areas. Similarly, the decline on Skunk Lake would expose substantial portions of the lakebed. Deep Hole Lake would lose approximately 20% of the rock/rubble areas and 35% of the macrophyte areas. Macroinvertebrates in Duck Lake would not be adversely affected.

Impacts to Wetlands - Lower portions of existing wetlands contiguous to Skunk and Deep Hole Lakes would be dewatered by expected declines in lake levels. Such dewatering would result in oxidation of organic sediments in these wetlands and minor release of stored nutrients to adjacent waterbodies and vegetation. Drier, oxygenated wetland sediments also would result in a fairly rapid invasion of open wetlands by shrubs and trees. The sizable bog wetland adjacent to Duck Lake is not expected to be adversely impacted by the expected reductions in lake level. Existing forested wetlands would undergo less visible vegetation changes, since trees in these wetlands are tolerant of drier conditions. Such wetland areas between Duck, Deep Hole, and Little Sand Lakes and immediately downstream from Little Sand Lake may be impacted by a decrease in surface water discharge from these lakes.

Although existing lakeside wetlands would likely be dewatered, the lowered lake levels would create new wetland acreages for Little Sand, Deep Hole and Skunk Lakes. For Little Sand Lake, expected reductions in lake levels would increase the shallow littoral zone over two times the present comparable acreage. The lake level reduction would be more conducive to emergent and submergent wetland establishment. The same situation would likely happen in Deep Hole Lake, although less shallow water acreage with muck bottom would be created under expected impact conditions.

The Skunk Lake open water area would decrease substantially. All of the lake area would be shallow enough to support emergent wetland vegetation.

Impacts to Water Quality - Little or no change in lake water quality would occur as a result of increased seepage.

Impacts to Recreation, Navigation and Aesthetics - Declines in lake levels would alter the size, shape and shallow water characteristics of Little Sand, Skunk and Deep Hole Lakes. Major reductions in size and depth of Little Sand Lake would reduce boating and fishing opportunities and would be considered aesthetically unpleasant. Deep Hole Lake would be somewhat smaller. Both lakes might have increased turbidity due to wave action on newly exposed muck substrates. Skunk Lake would lose most of its open water areas.

Impacts to Drainage Lakes (Without Mitigation)

Drainage lakes in the area which could be affected by the groundwater drawdown include Rice, Rolling Stone, Pickerel, Crane and Ground Hemlock Lakes. These lakes are all on the outer boundary of the groundwater system, and would experience minor decreases in the amount of groundwater discharges. Table 3-7 shows the expected decrease of groundwater inflow (without mitigation pumping) to these lakes. Annual decreases range from 0.05 - 1.6% of lake volumes. This magnitude of decrease represents a very small fraction of overall lake water budgets and would not cause any measurable changes in lake levels or water quality.

Table 3-7
Maximum Reductions in Groundwater Inflow to Drainage Lakes

Lake	Estimated Lake Volume (acre-feet)	Decrease in Rate of[1] Groundwater Inflow gpm	cfs	Annual Decrease in Groundwater Inflow (acre-feet/year)	Decrease as % of Total Lake Volume
Ground Hemlock	1232-1848	7.2	.0160	11.58	0.62-0.94
Crane	2955-4433	7.5	.0167	12.09	0.27-0.41
Pickerel	6062-9093	1.8	.0040	2.90	0.02-0.05
Rolling Stone	2688-4032	26.3	.0585	42.35	1.05-1.58
Rice	416-624	2.4	.0054	3.91	0.63-0.94

[1] Maximum decreases in rate of groundwater inflow are taken from worst-case GEOFLOW model simulations.

Rice Lake is not expected to be impacted by flow reductions in Swamp Creek. Flows in Swamp Creek above Rice Lake would decrease up to 16% under low flow conditions without mitigation. However, this is a relatively small quantity of water representing a minor fraction of the overall lake budget and would not cause measurable changes in Rice Lake levels.

Rolling Stone Lake levels and water quality would not be directly affected by a decrease in groundwater inflow. However, the decrease in the groundwater contribution from tributary streams (Upper Pickerel, 12-9, 11-4) caused by the groundwater drawdown would result in decreased flows into the lake. These flow reductions would not affect lake levels, but lowered dissolved oxygen levels in the northern portion of the lake might occur during winter. Lowered dissolved oxygen levels could increase the frequency and severity of winter fish kills.

STREAM AND SPRING IMPACTS WITHOUT MITIGATION

Mine dewatering would cause a drawdown in the groundwater level in the region of the mine. The resultant cone of depression (Figure 3-3) would deprive local streams of a portion of the groundwater source which contributes to their flow. The loss of groundwater discharge to streams would result in one or more of the following impacts: reduced flows (discharge); alteration of flow frequency (low flow would occur more often); reduction in stream velocity, depth or width; or a lowering of channel water surface elevation. The cone of depression would be very small during the construction period because mine inflow during construction would be relatively small. Mine inflow is expected to increase substantially after project year 5, as underground mining expands. The groundwater drawdown impacts to streams would approach their maximums by project years 6-8, and would diminish as the groundwater rebounds to premining conditions following mine closure.

To assess the hydrologic impacts of the groundwater drawdown on streams, the site area hydrology was modeled using the GEOFLOW computer program developed by D'Appolonia. The site area was modeled in the two horizontal dimensions in order to simulate groundwater flow in the stratified drift (outwash). Stratified drift is the main groundwater flow unit and the most permeable of the glacial deposits. Once the model had been calibrated to simulate natural hydrologic processes in the vicinity of the mine, the predicted amount of water withdrawal as a result of mine pumping was used in the model to evaluate stream impacts.

Due to uncertainties in aquifer characteristics, maximum stream flow reductions also were developed by DNR to evaluate stream impacts.

Physical Impacts to Streams - Table 3-8 contains the model predictions for expected and maximum case flow reductions in Upper Swamp, Hemlock, Hoffman (includes Hoffman Springs) and Upper Pickerel Creeks, and Creeks 12-9 and 11-4 (includes impacts to Martin Springs). These predicted flow reductions assume the absence of surface water mitigation. Under the expected scenario, flow reductions during low flow period ($Q_{7,10}$) are predicted to be between 7% and 35% below existing low flows. For the maximum case scenario, the flows are predicted to be 9% to 50% below existing low flows. The greatest percentage reductions in flow are predicted for Hemlock Creek, Hoffman Creek, and Creek 12-9.

Table 3-8
Flow Reductions in Streams (Without Mitigation)[1]

Location[2]	Flow Category	Existing Flow	Flow at Expected Impact	Expected Flow Reduction	%	Flow at Maximum Impact[7]	Maximum Flow Reduction	%
Swamp Creek	Min. Recom. Flow	11.0	10.49	0.51	5	10.33	0.67	6
(SG 3)	Q 7, 2	6.7	6.19	0.51	8	6.03	0.67	10
	Q 7, 10	4.7	4.19	0.51	11	4.03	0.67	14
Swamp Creek	Min. Recom. Flow	18	16.94	1.06	6	16.71	1.29	7
(Hwy 55 Bridge)	Q 7, 2	11	9.94	1.06	10	9.71	1.29	12
	Q 7, 10	8	6.94	1.06	13	6.71	1.29	16
Swamp Creek	Min. Recom. Flow	29	27.71	1.29	4	27.30	1.70	6
(Outfall Structure)	Q 7, 2	19	17.71	1.29	7	17.30	1.70	9
	Q 7, 10	15	13.71	1.29	9	13.30	1.70	11
Hemlock Creek[3]	Min. Recom. Flow	2.7	2.25	0.45	17	2.10	0.60	22
	Q 7, 2	2.0	1.55	0.45	23	1.40	0.60	30
	Q 7, 10	1.4	0.95	0.45	32	0.80	0.60	43
Hoffman Creek[4,5]		0.30[4]	0.22	0.08	25	0.15	0.15	50
		0.55[5]	0.41	0.14	25	0.28	0.28	50
Creek 12-9	Min. Recom. Flow	2.5	2.12	0.38	15	1.95	0.55	22
(SG 23)	Q 7, 2	1.5	1.12	0.38	25	0.95	0.55	37
	Q 7, 10	1.1	0.72	0.38	35	0.55	0.55	50
Upper PickerelCreek[6] (SG 19)		1.0	0.89	0.11	11	0.75	0.25	25
Creek 11-4[6]		0.40	0.33	0.07	18	0.31	0.09	22

1 Flows are measured in cubic feet per second.
2 See Figures 1-20, 1-26 and 2-8 for sampling locations.
3 At staff gauge - 6.
4 Immediately downstream from Hoffman Springs
5 At staff gauge E, midway between Hoffman Springs and Swamp Creek.
6 Measured at town road crossing.
7 Maximum decreases in groundwater inflow are from worse-case GEOFLOW simulation.

Table 3-9 contains stream surface water elevation data for existing conditions and expected and maximum impact scenarios. These impacts are predicted in the absence of surface water mitigation. The maximum change in low flow stream channel surface elevation is 0.21 feet in Creek 12-9. The second largest impact predicted (0.12 feet) is in Hoffman Creek.

Table 3-9
Channel Water Surface Elevations (Without Mitigation)[1]

Location[2]	Existing Condition	Expected Impact	Maximum Impact
Swamp Creek (SG 1)[3]			
Min. Recommended Flow	1545.16	1545.15	1545.14
Q 7, 2	1545.00	1544.98	1544.97
Q 7, 10	1544.91	1544.86	1544.85
Creek 12-9 (SG 2)[4]			
Min. Recommended Flow	100.37	100.31	100.31
Q 7, 2	100.19	100.07	100.07
Q 7, 10	100.07	99.94	99.86
Hoffman Creek[3]			
(SG 3)	1537.72	1537.67	1537.64
(SG 4)	1532.65	1532.59	1532.53
Creek 11-4[4] (SG 5)	91.20	91.15	

[1] Data on Swamp Creek from EIR Appendix 4-1A (1985) and USGS exceedance tables. All other from DNR evaluations. Flows of Swamp Creek and Creek 12-9 vary seasonally reflecting changes in precipitation and runoff. Hoffman Creek and Creek 11-4 maintain relatively constant flows supplied almost completely by groundwater discharge.
[2] See Figures 1-20, 1-26 and 2-8 for staff gage locations.
[3] Elevations above mean sea level.
[4] Assumed datum, feet (relates to a benchmark of known elevation).

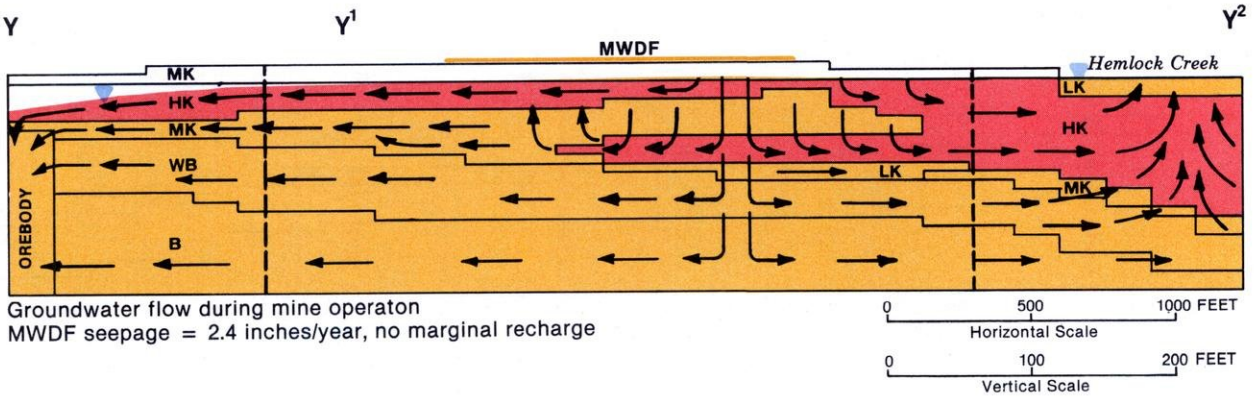
Impacts to Public Rights - A minimum recommended water level was established for streams potentially impacted by the groundwater drawdown. The minimum level is needed to maintain the hydrologic and ecologic integrity of the stream. Although adverse impacts occur when a stream is at or below the minimum recommended stage, such natural, low flow conditions are infrequent and do not permanently impact the stream ecology or associated water uses (e.g., recreation, fishing, swimming, canoeing). Criteria used to determine a minimum stage include protection of fish and aquatic life habitat, navigation, water quality, and water uses downstream from the project site. Table 3-8 shows the minimum flows required to maintain the integrity of stream ecology and water uses for streams predicted to be impacted by the groundwater drawdown.

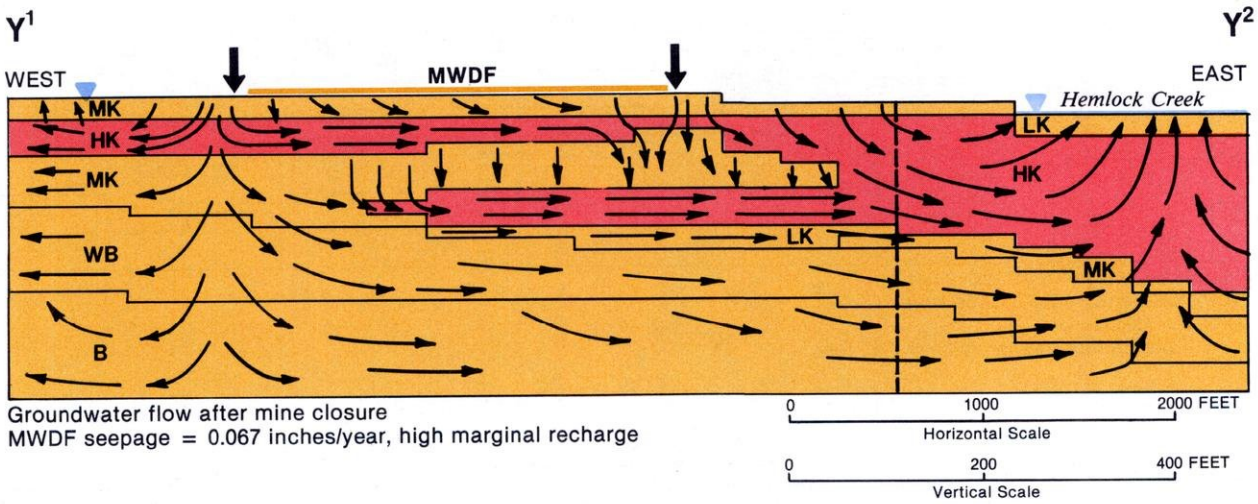
Stream flows for both the expected and maximum case predictions are below the minimum flows recommended by DNR. The prolonged mine-induced lower flows in streams would impact public rights and fish and other aquatic organisms. The impacts would continue until stream flows rebounded. Stream flows could rebound in the following ways: 1) increased contributions from precipitation and runoff, a natural but temporary occurrence; 2) increased contributions from groundwater as the water table recovered to preconstruction levels (at the end of the project); or 3) from flow augmentation (pumping).

Most of the streams within the area of the groundwater drawdown have a history of recreational use, primarily in the form of bank fishing. In addition, navigational use, chiefly canoeing, has been limited. On some of the streams, beaver activity has reduced the likelihood of canoeing. Reductions in fish biomass caused by reduced stream flows probably would decrease fishing pressure and canoeing as anglers would choose alternate areas.

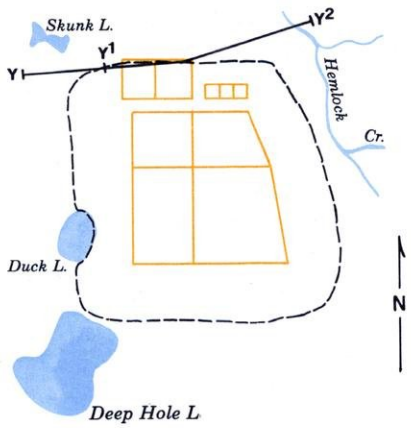
Hoffman Springs and Hoffman Creek flows would be reduced by up to 50% under maximum impact conditions, thus exposing a part of the sand and gravel channel for most of the year. Although the exposed channel bottom would be damp enough to support hydrophytic vegetation such as watercress, the much reduced flows within its former banks would be noticeable and might be considered aesthetically unpleasant.

Table 3-10 contains a qualitative, summary characterization of the maximum predicted hydrologic impacts to streams. These characterizations relied on professional judgment and were applied to each stream individually. For example, a 5% flow decrease in Swamp Creek compared to an equal flow decrease in Hemlock Creek would result in different impacts due to different physical characteristics of the streams. The order of impact characterization terms is minimal, small, and large.



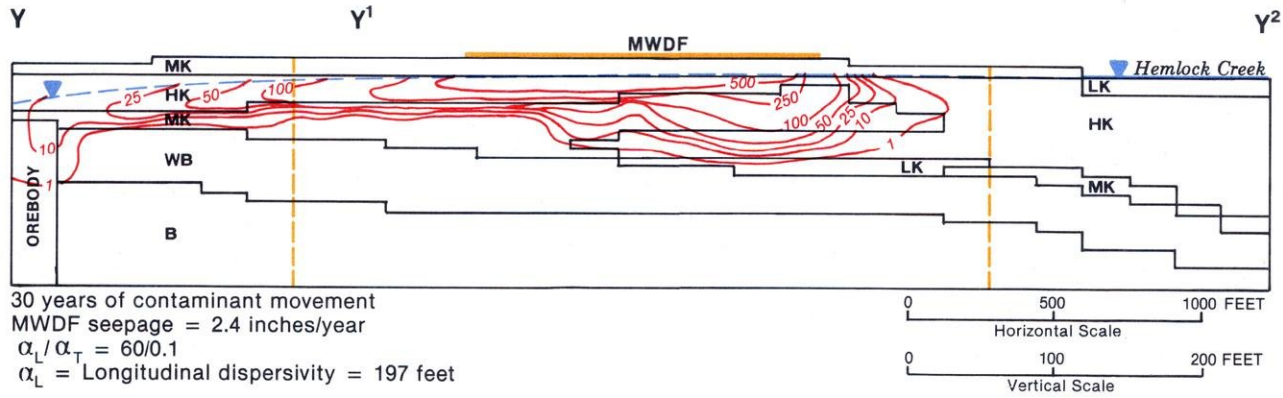


Water table(recharge boundary)
Groundwater flow direction
Marginal recharge around MWDF
Compliance boundary
HK Glacial outwash
MK Glacial till
LK Lower conductivity till
WB Weathered bedrock
B Bedrock
High rates of groundwater flow
Low rates of groundwater flow

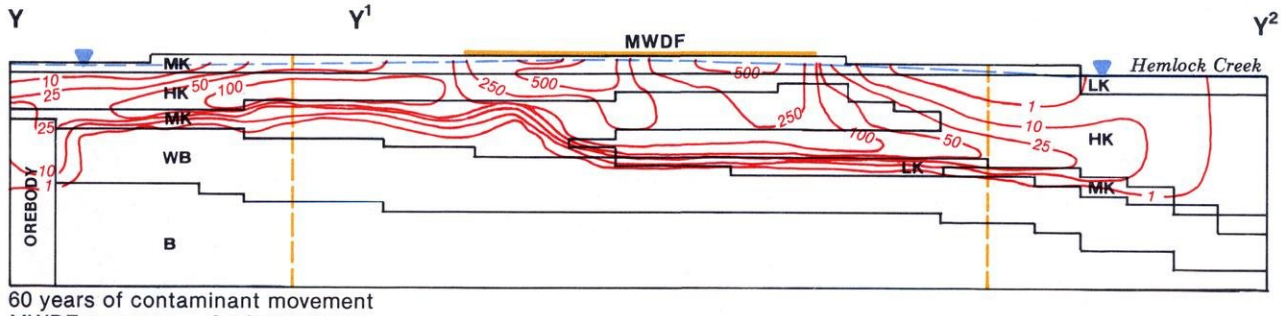


NOTE:
1. Cross-section location Y-Y2 intersects earlier MWDF configuration

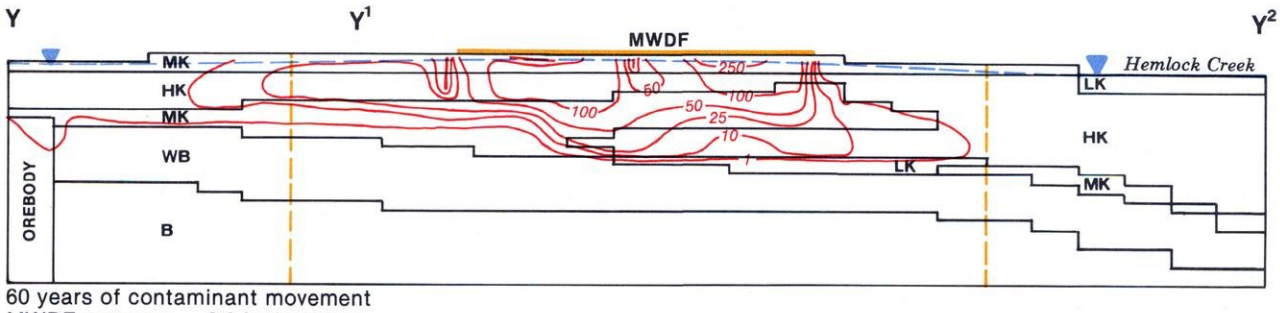
Figure 3-9. Groundwater Flow Variations at MWDF as Predicted by USGS/DNR Vertical Model



30 years of contaminant movement
MWDF seepage = 2.4 inches/year
α_L/α_T = 60/0.1
α_L = Longitudinal dispersivity = 197 feet



60 years of contaminant movement
MWDF seepage = 2.4 inches/year
α_L/α_T = 60/0.1
α_L = Longitudinal dispersivity = 197 feet



60 years of contaminant movement
MWDF seepage = 0.6 inches/year
α_L/α_T = 10/1
α_L = Longitudinal dispersivity = 32.5 feet

Water table (recharge boundary)

250 Sulfate concentration contours (mg/l)

Compliance boundary

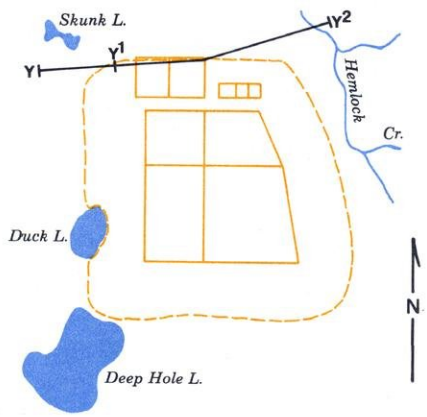
HK Glacial outwash

MK Glacial till

LK Lower conductivity till

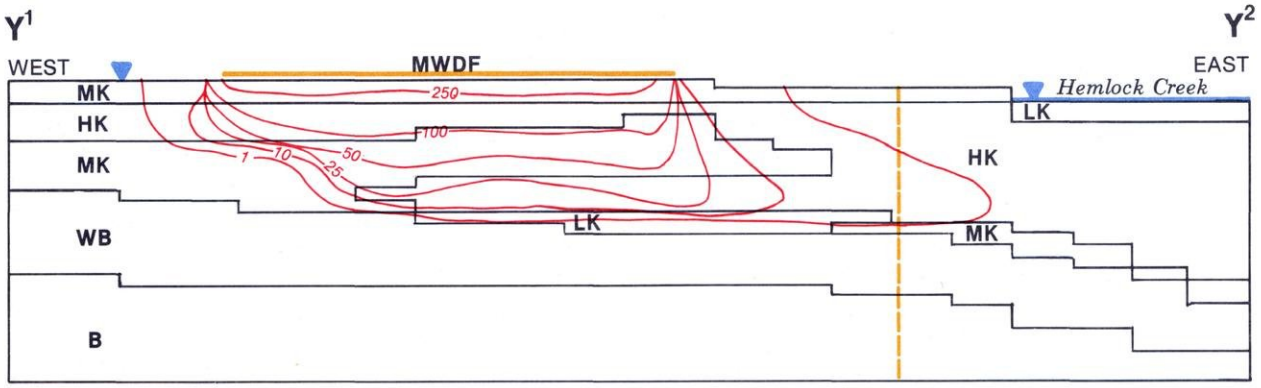
WB Weathered bedrock

B Bedrock



NOTES:
1. α_L/α_T = Longitudinal to transverse dispersivity ratio
2. Cross section location Y - Y² intersects earlier MWDF configuration
3. Worst case contaminant movements through unsaturated soils are coupled with groundwater flow produced by mine operation

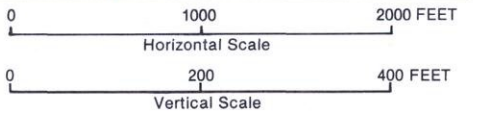
Figure 3-10. MWDF Sulfate Concentrations Predicted by USGS/DNR Vertical Model — Mine Operation Groundwater Flow Conditions

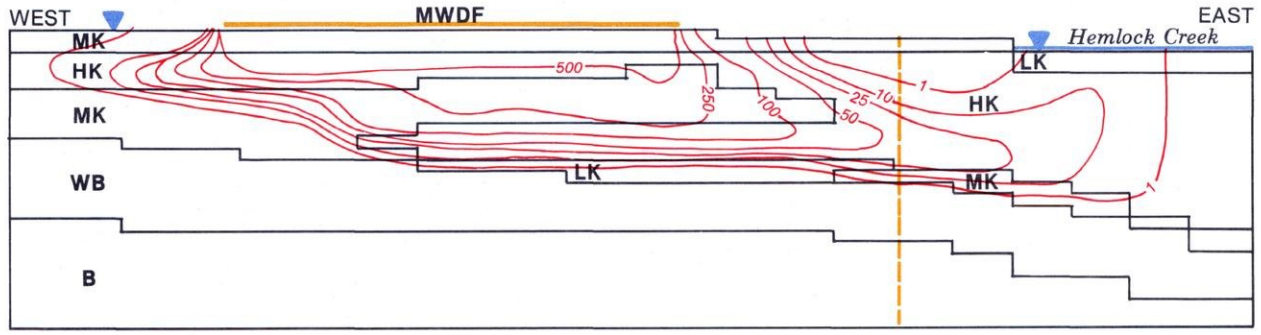


MWDF seepage = 0.57 inches/year, $\alpha_L/\ \alpha_T$ = 60/1



MWDF seepage = 2.4 inches/year, $\alpha_L/\ \alpha_T$ = 60/1





MWDF seepage = 2.4 inches/year, $\alpha_L/\ \alpha_T$ = 60/0.1

- Water table (recharge boundary)
- 25 — Sulfate concentration contours (mg/l)
- Compliance boundary
- **HK** Glacial outwash
- **MK** Glacial till
- **LK** Lower conductivity till
- **WB** Weathered bedrock
- **B** Bedrock

NOTES:
1. $\alpha_L/\ \alpha_T$ = Longitudinal to transverse dispersivity ratio
2. α_L = Longitudinal dispersivity = 197 feet
3. All scenarios assume no MWDF marginal recharge
4. Cross-section location Y-Y^2 intersects earlier MWDF configuration

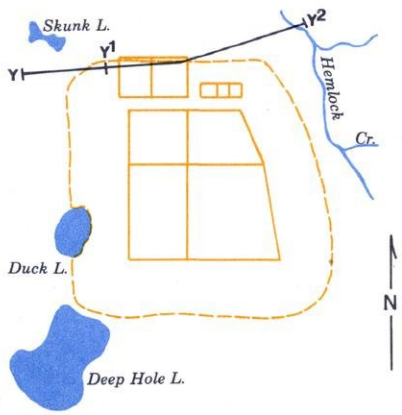


Figure 3-11. MWDF Sulfate Concentrations After 50 Years Predicted by USGS/DNR Vertical Model — Post-Mining Groundwater Flow Conditions

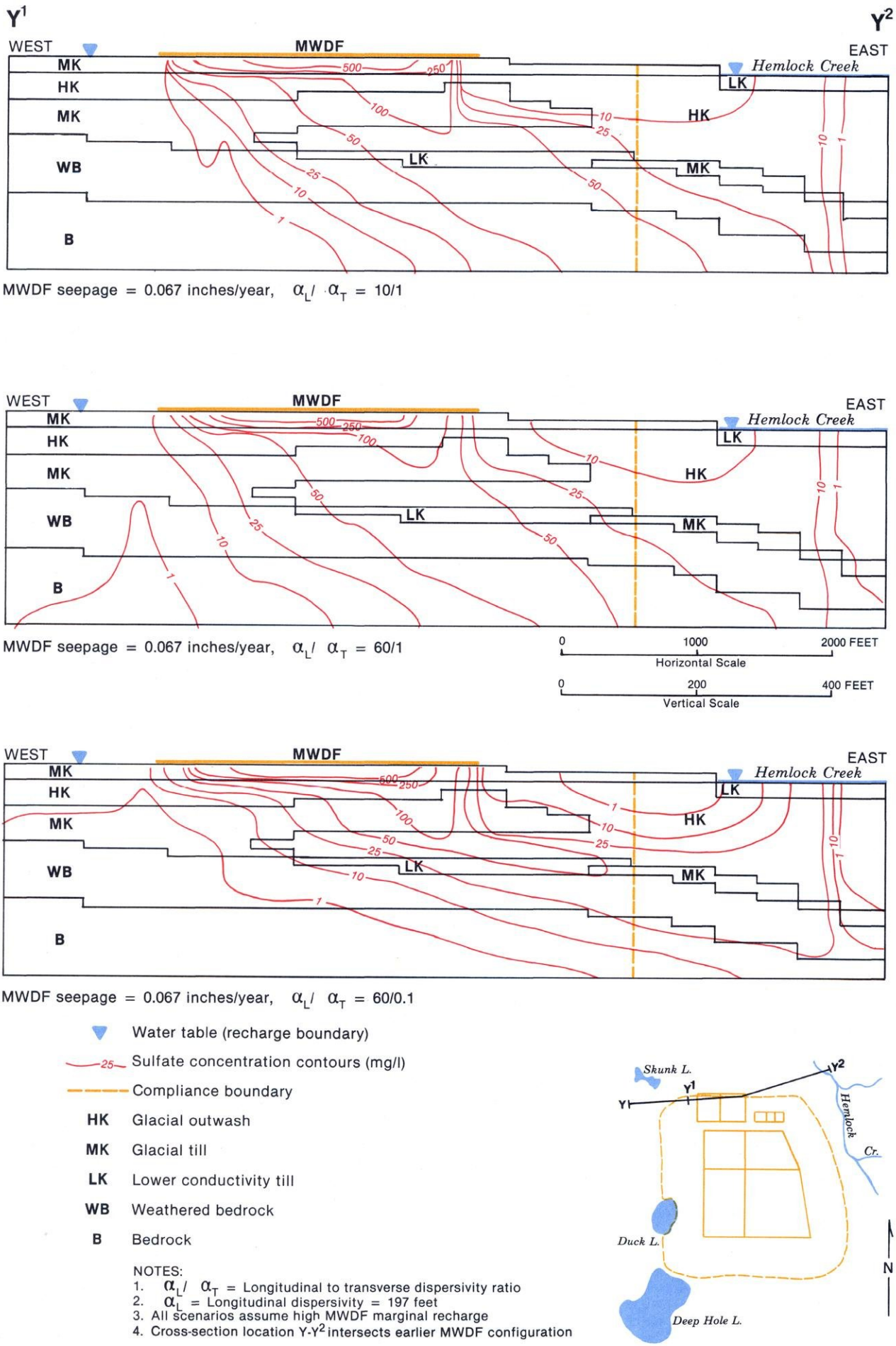


Figure 3-12. MWDF Steady State Sulfate Concentrations Predicted by USGS/DNR Vertical Model — Post-Mining Groundwater Flow Conditions

Table 3-10
Characterization of Maximum Predicted Hydrologic Impacts to Streams (Without Mitigation)

	Reduction to flow	Reduction in Depth	Reduction in Width	Reduction in Velocity	Reduction of Channel Water Elevation	Frequency of Lower Levels
Swamp Creek						
Outfall	Minimal	Minimal	Minimal	Minimal	Minimal	Small
Highway 55	Small	Minimal	Minimal	Minimal	Minimal	Small
Staff Gage 3	Small	Small	Minimal	Small	Small	Small
Hemlock Creek	Large	Minimal	Minimal	Minimal	Minimal	Small
Creek 12-9						
Staff Gage 1	Large	Large	Large	Large	Large	Large
Hoffman Creek						
Staff Gage 1	Large	Large	Large	Large	Large	Large
Staff Gage 2	Large	Large	Large	Large	Large	Large
Upper Pickerel Cr.						
Staff Gage 19	Large	Small	Small	Minimal	Minimal	Small
Creek 11-4						
Staff Gage 1	Large	Small	Small	Small	Small	Small

Impacts to Wetlands - Within the area of predicted groundwater drawdown, most wetlands would not be influenced by groundwater levels. They are believed to be hydrologically "perched" (separated from the water table by an unsaturated zone) because of their large vertical separation from the water table. Changes in groundwater levels caused by mine dewatering would not impact perched wetlands.

Nearly 600 acres of streamside and isolated wetlands might be influenced by the groundwater drawdown. These wetlands are believed to be connected to the regional groundwater table due to their low topographic position, proximity to known groundwater levels, or actual groundwater discharges that contribute to adjacent stream flows. These wetlands are located along the south side of Swamp Creek (north of the mine site), along the east side of Upper Pickerel Creek (one-half mile east of Mole Lake), along Hoffman and Martin Springs and their associated streams, and between Little Sand and Rolling Stone Lakes along Creek 12-9. Over 60% of the acreage of these water table wetlands is in the two wetlands along Upper Pickerel Creek and Creek 12-9.

Mine dewatering would markedly lower the groundwater surface after project year 5, and the lowered surfaces (steady state) would be maintained during mine operations. Establishment of the lower groundwater levels would cause gradual shifts in vegetative composition in these wetlands. Shifts would be mainly in the herbaceous vegetation that regrows each year, not in the woody perennial vegetation. The shifts in herbaceous vegetation would involve subtle changes in the relative amounts and locations of moisture sensitive species already present, rather than replacement by invading species. Woody canopy species of the forested water table wetlands (white cedar, balsam fir, black spruce, black ash, red maple, and tamarack) are more tolerant to extended periods of lower water, so no changes in forested wetlands are expected. Slightly reduced growth rates would be the main impact of lower water levels to the established woody vegetation.

During mine operations, there would be a gradual infringement of some water table wetlands with terrestrial vegetation at the wetland/upland boundary. This would be due to diminished groundwater discharge at the higher elevations along the wetland/upland boundary. For example, along Swamp Creek north of the mine site, groundwater discharge feeds wetlands up to 20 feet above the surface of Swamp Creek through a network of diffuse seepage springs. The groundwater drop may be up to 4 feet at the edge of these wetlands, thereby reducing or eliminating spring flow. These higher

wetlands would be subjected to gradual invasion by adjacent upland vegetation because of the less saturated soil conditions. Changes in wetland boundaries in this fashion would be very subtle.

Seasonal and average annual reductions in stream flow caused by mine dewatering may cause some encroachment of streamside wetland vegetation. Bank and side channel habitat dewatered due to lower water surfaces would be quickly vegetated with such species as spike-rush (Eleocharis spp.), manna grass, (Glyceria spp.), watercress (Nasturtium officinale), water buttercup (Ranunculus spp.), and marsh marigold (Caltha palustris).

Impacts to Stream Fisheries - Reductions in the quantity of groundwater contributions to streams would directly affect fish populations, particularly trout. In general, the more groundwater discharge there is to a stream, the more available habitat there is for fry development, juvenile and adult stages. Groundwater contribution to a stream is an important factor in regulating winter and summer temperatures. It is especially important for trout in summer. For brook trout, groundwater availability is directly related to abundance of young-of-the year. Successful brook trout spawning occurs only in areas with stream bottom groundwater discharge. Brook trout populations in Hemlock, Hoffman, Upper Pickerel and Upper Swamp Creeks and Creek 12-9, and nontrout populations in all the streams would be adversely affected by reduced groundwater contributions to streams under impact conditions.

The following are measures of fish abundance in the streams which would be impacted. Brook trout populations (expressed as biomass in pounds per stream mile) in high quality or Class I (substantial natural reproduction) trout water, such as Hoffman and Creek 12-9, provide an average summer biomass of 46 and 37 pounds/mile, respectively. Class II (limited natural reproduction) trout waters sustain an average fall biomass of 67 pounds/mile of brook trout. Hemlock, Upper Pickerel and Upper Swamp Creeks are examples of Class II trout waters. These are average figures, and actual biomass varies.

The response of nontrout fishes to lowered stream flows is not as well documented as trout population responses. Nevertheless, there is a correlation between stream flow and nontrout abundance as well. Fisheries impacts for the local streams are summarized in Table 3-11. Evaluation of average fish biomass was correlated with predicted stream flow reductions.

Table 3-11
Predicted Stream Fishery Impacts (Without Mitigation)[1]

	Expected Impact			Maximum Impact		
Stream	Recommended Min Flow	Q7,2	Q7,10	Recommended Min Flow	Q7,2	Q7,10
Swamp Creek (at outfall)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Swamp Creek (Highway 55)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Swamp Creek (SG-1)	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate
Hemlock Creek	Minimal	Minimal	Moderate	Moderate	Moderate	Substantial
Creek 12-9	Minimal	Moderate	Moderate	Moderate	Moderate	Substantial

	Expected Impact	Maximum Impact
Hoffman Creek	Moderate	Substantial
Upper Pickerel Creek	Minimal	Moderate
Creek 11-4	Minimal	Minimal

[1] Guidelines used to summarize impacts to fish biomass are:
minimal-flow reduction < 20% - average fall biomass reduction < 25%
moderate - flow reduction 20-39% - average fall biomass reduction 25-48%
substantial-flow reduction > 40% - average fall biomass reduction > 49%

Impacts to Other Aquatics - Impacts to bottom-dwelling macroinvertebrates (benthos) would result from predicted decreased stream flows. Species diversity and aquatic invertebrate abundance are correlated with stream substrate, velocity and depth. Water level decreases accompanied by

exposure of the bottom or reduction of aquatic vegetation would result in a loss of invertebrate habitat such as riffles, stream margins, and undercut banks.

Table 3-12 summarizes impacts to macroinvertebrates predicted to occur from reduced stream flows. Impacts associated with water level decreases in streams were determined by assessing instream flow needs for macroinvertebrates. Flow needs, in terms of hydraulic forces close to the bottom of streams, were used to develop a numerical ranking (Reynold's number) highly correlated with macroinvertebrate diversity and abundance. Hydraulic data were used to model projected Reynold's numbers for most of the impacted streams and assess impacts to macroinvertebrates.

Table 3-12
Predicted Impacts to Stream Macroinvertebrates (Without Mitigation)[1]

	Expected Impact			Maximum Impact		
Stream	Recommended Min Flow	Q7,2	Q7,10	Recommended Min Flow	Q7,2	Q7,10
Swamp Creek (at outfall)	Small	Small	Small	Small	Small	Small
Swamp Creek (SG-1)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Hemlock Creek	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Creek 12-9	Minimal	Minimal	Moderate	Small	Small	Moderate
	Expected Impact			Maximum Impact		
Hoffman Creek	Small-Moderate			Moderate-Large		
Upper Pickerel Creek	Small			Small		
Creek 11-4	Minimal			Minimal		

[1] Criteria used to summarize impacts to macroinvertebrates are:
minimal - habitat decrease of < 10%
small - habitat decrease of 10-20%
moderate - habitat decrease of 20-50%
large - habitat decrease of > 50%

[2] Impact analysis for Hemlock and Upper Pickerel Creeks was not done using Reynold's number computation.

Impacts to aquatic plants from the predicted reductions in stream flow are expected to be minimal. Existing water chemistry, sunlight availability, and continuous flows would prevail under impact conditions. Habitat for emergent aquatic plants could increase as a result of stream bed exposure or increased stream bank availability. Plants which are strictly aquatic would have less available habitat, particularly in Hemlock and Hoffman Creeks and Creek 12-9, where percent flow reductions would be greatest.

Stream Water Quality Impacts - Little change to stream dissolved oxygen levels would occur based on the predicted reductions to stream flows. Any changes would be within seasonal variability and would not be expected to impact the aquatic biota. Total available dissolved oxygen would be reduced in proportion to the flow reductions.

WILDLIFE IMPACTS WITHOUT MITIGATION OF LAKES AND STREAMS

The following section addresses impacts to selected wildlife species from expected lake level declines and both expected and worst case stream flow declines. Wildlife species chosen are those which are present in the area, represent a variety of animal groups, and have life histories associated with surface waters. Some of these species are locally abundant (beaver, frog), while others are widely distributed but rare (osprey, common loon). Some species have very large home ranges (bald eagle, otter), while others have restricted home ranges (frogs, turtles, muskrats). The proposed mine site area contains only one pair of breeding bald eagles and common loons, two pairs of osprey and perhaps two breeding pairs of otter. On the other hand, relatively large populations of certain frogs, turtles and beaver are present.

The expected lake level reductions would eliminate existing wetland shoreline habitat adjacent to Deep Hole, Little Sand, and Skunk Lakes. Reduced lake levels, however, would result in an increased shoreline edge width. This exposed area could support a wetland plant community. Little Sand Lake

level reduction would increase the acreage of the 0-3' water depth zone. The new 0-3' zone would have a muck bottom instead of the original sand and cobble bottom.

Table 3-13
Impacts to Selected Wildlife Species Without Mitigation of Lake Levels and Stream Flows

	STREAMS		LAKES
	Expected Case	Maximum Case	Expected Case
Species			
Common Loon	U	U	O
Osprey	U	U	O
Bald Eagle	U	U	O
Beaver	O	O	O
Muskrat	H-	R	R
Mink	H-	H	H-
Otter	H	H-	O
Raccoon	O	O	H+
Wood Duck	O	H-	H-
Hooded Merganser	O	H-	U
Mallard	O	H-	O
Black Duck	O	H-	O
Great Blue Heron	O	H-	H+
Green Heron	O	H-	O
American Bittern	U	U	H+
Sora Rail	U	U	H+
Common Snipe	U	H-	H+
Black Tern	U	U	H+
Spotted Sandpiper	O	H-	H+
Solitary Sandpiper	U	U	H+
Painted Turtle	O	H-	O
Salamander species	O	O	O
Frog species	O	H-	O
American Toad	H-	H-	O
Garter Snake	O	O	H+

Legend
U - Unsuitable or marginal habitat for breeding or foraging, thus no impact.
R - Reproductive impact; affects reproductive success or survival.
H+ - Habitat increase, but no expected changes in populations.
H- - Habitat decrease, but no expected changes in populations.
O - No impact or too minor to detect.

Table 3-13 shows the impacts to wildlife species without mitigation of lake levels and stream flows. The majority of the wildlife species would not be expected to have changes in reproductive success or increased mortality rates to the same extent as the lake level and stream flow reductions. Various species would lose or gain habitat as stream and lake levels change. Habitat loss for some species would result in habitat gains for other species.

Only one species analyzed would have reproductive success impacted by surface water reductions. Muskrat populations would be reduced by the expected lake level reductions on Little Sand Lake and by maximum case stream reductions. The predicted reductions in surface waters due to expected and maximum case impacts would not reduce most regional or local populations of wildlife. Overall impacts would be limited to a small number of individual animals. For many of the species listed, reductions in lake levels would increase habitat due to the development of emergent aquatic plants, grasses and shrubs along the lake shores.

EVALUATION OF THE SURFACE WATER MITIGATION PLAN

The surface water mitigation plan proposed by Exxon would rely primarily on pumping groundwater from three systems:

1. A system of "dedicated" wells constructed near the impacted water bodies and pumped exclusively for mitigating impacts to those water bodies.

2. A semicircle of wells around the orebody designed to collect a portion of the groundwater flow before it reaches the mine, and

3. A groundwater intercept system within the mine designed to collect mine inflow before it becomes contaminated.

Systems 1 and 2 involve pumping the overburden aquifer to obtain mitigation water. This pumping, in turn, causes additional drawdowns of the water table and additional (secondary) reductions of groundwater discharge to surface waters. The semicircle of wells concept is intended to alleviate some of the secondary impacts from mitigation pumping. A portion of the water which would otherwise flow into the mine would be intercepted by wells surrounding the mine and would be available for surface water mitigation. Pumping the semicircle of wells, however, would increase the groundwater drawdown, causing additional impacts to lakes and streams. This approach has a net benefit due to the additional water made available for mitigation. The following section analyzes the extent of the secondary impacts from the various mitigation systems and assesses the net effectiveness in alleviating surface water impacts.

Evaluation of Continuous (Steady State) Mitigation Pumping

In order to provide a comprehensive assessment of the effectiveness of the various mitigation measures, the GEOFLOW model was used to simulate several different scenarios of mine dewatering and mitigation pumping.

First, model parameters were set to conservatively approximate expected conditions for mine inflow, lake seepage and aquifer conductivity. Lake sediment conductivities were derived from the DNR/USGS lake model. An annual groundwater recharge of 8.5 inches was used. The analysis assumed that 18 wells located in a semicircle around the southern half of the mine area would be pumped at 50 gpm and that water well WS-1 would be pumped at 30 gpm for a total of 930 gpm.

A second set of model runs was conducted to simulate worst case conditions. For these simulations, mine inflow, lake seepage and aquifer conductivity values were set to allow the largest reasonably possible impacts to surface waters. An annual groundwater recharge of 10 inches was used. These simulations assumed a semicircle of wells pumping a total of 1250 gpm. A well east of Martin Springs was pumped at 60 gpm. In addition, model runs simulating transient (short-term) pumping of wells WS-2 and C-2 (Hemlock Creek and Creek 12-9) and wells C-3 and C-4 (Swamp Creek) were conducted.

The simulations show that pumping from the semicircle of wells would decrease mine inflow from 1539 gpm to 1090 gpm for expected conditions and from 1963 to 1314 gpm for worst case conditions. The pumping would also increase drawdown beneath the lakes, thereby increasing lake impacts. Table 3-14 shows GEOFLOW - predicted increases in lake seepage caused by mitigation pumping for both expected and worst cases. Pumping from the semicircle of the wells would increase the total lake seepage from between 154 to 212 gpm.

Table 3-14

Effects of Mine Dewatering and Mitigation Pumping on Project Area Lakes[1]

Lake	Preconstruction Lake Seepage		Lake Seepage During Mine Dewatering		Increased Seepage Due to Dewatering		Seepage During Mine Dewatering With Mitigation Pumping		Increased Seepage Due to Dewatering and Mitigation Pumping	
	Expected	Max.	Expected	Max.	Expected	Max.	Expected	Max.	Expected	Max.
Duck	102	16	108	25	6	8	110	27	8	11
Deep Hole	243	296	313	372	70	76	331	401	88	105
Little Sand	106	230	534	771	428	541	628	917	522	688
Skunk	2	49	104	102	102	53	144	135	142	86
TOTAL	453	591	1059	1270	606	678	1213	1480	760	890

[1] GEOFLOW predicted lake seepage rates vary slightly from those presented in Table 3-6 due to different methods of calculation. Numbers are in gallons/minute.

Mitigation pumping also would further decrease the amount of groundwater discharging to area streams. Table 3-15 provides model-predicted declines in groundwater discharging to streams resulting from the mine dewatering and mitigation pumping. Mine dewatering alone would reduce the total groundwater discharge to the model boundaries between 961 gpm and 1271 gpm for expected and worst cases. Addition of the semicircle of mitigation wells would further reduce groundwater discharges by about 30%.

Table 3-15
Effects of Mine Dewatering and Mitigation (Semi-Circle of Wells) Pumping on Groundwater Discharge to Project Area Streams

Stream	Preconstruction Flows cfs (gpm)[1] Expected	Maximum	Reduction Due to Dewatering cfs (gpm) Expected[2]	Maximum[3]	Reduction Due to Dewatering Plus Steady State Pumping cfs (gpm) Expected[4]	Maximum[5]
Hemlock Cr.	2.00 (900)	2.48 (1114)	0.45 (204)	0.60 (269)	0.57 (255)	0.76 (341)
Swamp Cr. from Confluence with Hemlock Cr. to SG-3	0.38 (172)	0.52 (233)	0.06 (27)	0.07 (31)	0.08 (35)	0.08 (36)
Swamp Cr. from SG-3-STH 55	2.26 (1015)	2.64 (1185)	0.55 (247)	0.62 (278)	0.72 (323)	0.78 (350)
Boundary[6] Segment DE STH 55-Pickerel Cr.	0.81 (364)	1.00 (449)	0.23 (103)	0.31 (139)	0.31 (139)	0.41 (184)
Boundary Segment EF Pickerel Cr.-Rolling Stone L.	0.98 (440)	1.19 (534)	0.20 (90)	0.25 (112)	0.26 (117)	0.33 (148)
Boundary Segment FG Rolling Stone L.-Pickerel L.	2.43 (1091)	3.04 (1365)	0.04 (18)	0.06 (27)	0.05 (22)	0.07 (31)
Boundary Segment GA Pickerel L.-Walsh L.	2.47 (1109)	2.82 (1266)	0.20 (90)	0.25 (112)	0.26 (117)	0.32 (144)
Creek 11-4 Martin Spring	0.547 (246)	0.51 (229)	0.07 (31)	0.09 (40)	0.11 (49)	0.14 (63)
Creek 12-9	2.73 (1226)	3.21 (1441)	0.38 (171)	0.55 (247)	0.52 (233)	0.78 (350)
TOTAL DISCHARGE[7]	13.94 (6259)	7.41 (7814)	2.14 (961)	28.00 (1257)	2.83 (1271)	3.67 (1647)

[1] Expected flows derived from simulations assuming an 8.5 inch annual recharge rate. Maximum flows are from the 10.0 inch annual recharge simulation.
[2] Mine Inflow = 1,539 gpm. Mine simulated with resistive layer derived from Prickett.
[3] Mine Inflow = 1,963 gpm.
[4] Mitigation water supply was simulated through semi-circle of 18 wells pumping a total of 900 gpm. 30 gpm was pumped from WS-1 for mine/mill water supply purposes. Total Pumping = 930 gpm. Mine Inflow = 1,089 gpm.
[5] Mitigation water supply from semi-circle of wells pumping 1,250 gpm. 60 gpm was provided for Martin Springs (Node 637). Total pumping = 1,310 gpm. Mine Inflow = 1,314 gpm.
[6] Stream boundary segments DE, EF, FG, and GA are those identified by Figure A.2-1 of EIR.
[7] Total groundwater discharge flows are calculated by summing all stream segments and subtracting those nodes shared between a stream segment or wetland area (Nodes 66, 362, 729, 1028, 733, 734, 735).

Groundwater discharges to Hoffman Springs were not directly modeled by GEOFLOW, and because of the complex hydrogeology of the area, impacts are difficult to predict. About a 25% reduction in flow would be expected from mine dewatering alone. The model indicates that the addition of mitigation pumping would increase the impact to about a 35% reduction. In order to provide a sufficiently conservative projection, a 50% (125 gpm) reduction was assumed.

Analysis of the secondary impacts of continuously pumping dedicated wells shows that, over the long-term, the secondary reductions in groundwater discharge to the surface waters being mitigated approaches the amount of pumpage. Thus, the dedicated wells proposed for Pickerel Creek and Hoffman Spring would not be effective in mitigating the projected impacts. The well at Martin Springs would be more effective and would be capable of mitigating the projected impacts. Water pumped from this well would be comprised mostly of groundwater which would otherwise be discharging to Rolling Stone Lake.

The total continuous (steady state) mitigation requirements under the worst case scenario would be about 1226 gpm (Table 3-16). The semicircle of wells along with C-5 at Martin Springs provide a total of 1310 gpm, thereby exceeding the steady state mitigation need by 84 gpm.

Table 3-16
Summary of Worst Case, Steady State Mitigation Requirements

Lake Seepage Increase	890 gpm
Creek 11-4/Martin Springs Flow Reduction	63 gpm
Upper Pickerel Flow Reduction	148 gpm
Hoffman Creek Flow Reduction (estimated)	125 gpm
Total	1226 gpm

Evaluation of Short-Term (Transient) Mitigation Pumping

Dedicated wells are proposed for intermittent pumping into Swamp Creek (C-3, C-4), Hemlock Creek (WS-2), and Creek 12-9 (C-2). The GEOFLOW model was used to analyze the secondary impacts of short-term pumping of dedicated wells. First, WS-2 and C-2 were simulated as pumping at the maximum rates which would be required for both expected and worst cases.

The results show that, for the expected impacts, mitigation pumping of dedicated wells becomes increasingly ineffective as the 100 day pumping period progresses. For Hemlock Creek, at the end of 100 days, about 30% of the water pumped had been diverted from groundwater previously discharging into the stream. It would take over one hundred days after the cessation of mitigation pumping for the groundwater discharge to the stream to recover. Pumping at the headwaters of Creek 12-9 showed similar though lesser secondary impacts. In addition, after 100 days of pumping at both areas, the seepage from nearby lakes had increased 26 gpm (3%), of which 18 gpm were from Little Sand Lake.

For the worst case scenario, secondary impacts are more pronounced (Table 3-17). Pumping WS-2 at 345 gpm for 100 days results in approximately 50% (175 gpm) of the mitigation water being withdrawn from Hemlock Creek. After 100 days of recovery there was still a residual impact of 58 gpm to the creek. For Creek 12-9, the secondary impact increased from 36 gpm at 50 days to 67 gpm at 100 days. After 100 days of recovery, stream flow was still reduced by 27 gpm. Seepage from the four area lakes increased from 27 gpm at 50 days to 52 gpm at 100 days. The residual impacts after 100 days of recovery was 31 gpm of increased lake seepage.

Table 3-17
Reductions in Groundwater Discharge From Short-Term Pumping of Mitigation Wells WS-2 and C-2 (Worst Case Simulation)[1]

Stream	Preconstruction Groundwater Flow	Flow with Mine[2] Dewatering Plus Steady State Mitigation	Flows After Pumping[3] WS-2 and C-2 for 50 days	Flows After Pumping[3] WS-2 and C-2 for 100 days	Flow After 100 Days of Recovery
Hemlock Creek	2.48	1.72	1.47 (112)	1.33 (175)	1.59 (58)
Swamp Creek from Confluence with Hemlock Creek to SG-3	0.52	0.44	0.44 (0)	0.43 (4)	0.43 (4)
Boundary Segment DE STH 55 - Pickeral Creek	1.00	0.59	0.59 (0)	0.59 (0)	0.58 (4)
Boundary Segment GA Pickerel Lake Walsh Lake	2.82	2.50	2.50 (0)	2.50 (0)	2.47 (13)
Creek 12-9	3.21	2.43	2.35 (36)	2.28 (67)	2.37 (27)

[1] Flow values in cfs. Numbers in parentheses are reductions in flow in gpm.
[2] Steady state mitigation was simulated by a semi-circle of 18 wells pumping a total of 1250 gpm. 60 gpm was provided from Martin Springs by pumping Node 637.
[3] Well WS-2 pumped at 345 gpm. Well C-2 pumped at 355 gpm.

A second simulation was used to assess secondary impacts of mitigation wells placed north of Swamp Creek. In order to use the GEOFLOW model, it was assumed similar hydrogeological conditions existed on both the north and south sides of Swamp Creek. Two wells, C-3 and C-4, were modeled pumping 120 and 140 gpm in the absence of any mine inflow. The impact of pumping was compared to preconstruction conditions since the mine is not expected to influence groundwater levels north of Swamp Creek. Results of this analysis are shown in Table 3-18. Secondary impacts caused a total reduction in groundwater flow to Hemlock and Swamp Creeks of 98 gpm after 50 days and 153 gpm after 100 days. The residual flow reduction after 100 days of recovery was 44 gpm.

Table 3-18
Reductions in Groundwater Discharge From Short-Term Pumping of Mitigation Wells C-3 and C-4[1]

Stream	Preconstruction Groundwater Flow	Flow after Pumping[2] Wells C-3 and C-4 for 50 days	Flow after Pumping[2] Wells C-3 and C-4 for 10 days	Flow After 100 Days of Recovery
Hemlock Creek	2.48	2.42 (27)	2.38 (45)	2.45 (13)
Swamp Creek from Confluence with Hemlock Creek to SG-3	0.52	0.42 (31)	0.42 (45)	0.50 (9)
Swamp Creek from SG-3 to STH 55	2.64	2.55 (40)	2.50 (63)	2.59 (22)

[1] Flow values in cfs. Numbers in parentheses indicate reductions in flow in gpm.
[2] Well C-3 pumped at 120 gpm. Well C-4 pumped at 140 gpm.

The transient analyses of short-term pumping discussed above shows a potential shortfall in the amount of mitigation water due to secondary impacts. Table 3-19 indicates a total shortfall of 273 gpm after 50 days of pumping, 447 gpm after 100 days of pumping, and 160 gpm after 100 days of recovery. The amount of time required for complete recovery of the aquifer or the possible cumulative affects of transient pumping over several years cannot be accurately assessed without further model simulations.

Table 3-19
Summary of Shortfalls in Mitigation Water Due to Secondary Impacts of Short-Term Pumping (Worst Case)

Mitigation Well and Discharge Point	Shortfall After 50 days of Pumping (gpm)	Shortfall After 100 days of Pumping (gpm)	Residual Impact After 100 Days of Recovery (gpm)
WS-2 (Hemlock Creek)	112	175	58
C-2 (Creek 12-9)	36	67	27
Increased Lake Seepage	27	52	31
C-3 and C-4 (Swamp Creek)	98	153	44
Total	273	447	160

In summary, the proposed use of dedicated wells for steady state pumping to Pickerel Creek and Hoffman Springs would not be effective in mitigating impacts. Use of the semicircle of wells would likely provide adequate water for steady state mitigation for both expected and worst case predictions. The short-term pumping to streams requiring intermittent mitigation would be effective for only short periods of time and would result in a deficiency of mitigation water as the duration of pumping increased.

Other Mitigation Considerations

Several factors other than the availability of adequate quantities of mitigation water would influence the effectiveness of the mitigation plan. While computer modeling provides a good indication of the total hydrologic impacts, the precise impacts to a particular water body cannot be accurately determined. This uncertainty may lead to errors in apportioning the available mitigation water to affected water bodies. As a result, an additional increment of mitigation water beyond the actual mine-induced impact may be required to insure that adequate mitigation water is provided to each water body.

The proposed discharge locations on Pickerel Creek and Creek 12-9 might also reduce the effectiveness of mitigation pumping. The proposed discharge locations are a significant distance upstream from the flow monitoring stations. Mitigation supplements might be partially lost to streambank storage, evapotransporation and seepage to the groundwater before reaching the monitoring location. An additional amount of mitigation water likely would be required to compensate for these affects. Alternate discharge locations could also be utilized to avoid water losses.

The operational details of the mitigation plan, in particular the trigger points to turn pumping on and off and the amount of water pumped, are very important in determining the effectiveness of the mitigation plan. The current proposal uses trigger points to initiate stream flow mitigation such that mitigation pumping would be required about 25% of the time even without any mining impact. Also, mitigation pumping rates could be higher than actual impacts. Thus, the plan might result in mitigation of naturally caused flow reductions, contributing to the potential shortfall in mitigation water.

The triggering and operating mechanisms for lake mitigation similarly are important to successfully alleviating lake impacts. The current proposal is to begin mitigation pumping when lake levels drop to the established minimum level. The proposed pumping would occur at a rate which approximates the increased lake seepage caused by the mine. The assumption underlying the proposal is that, by replacing the mine-induced seepage by pumping when the minimum lake levels are reached, further lake level impacts are avoided natural levels.

In order to analyze the effectiveness of the above plan for mitigating lake impacts, the DNR/USGS lake model was used. The model simulated lake level declines caused by the groundwater drawdown. When minimum lake levels were reached, the model added water to the lakes at a rate equal to the mine-induced seepage. The modeling showed that lake levels would continue to decline even with mitigation. This is because the proposed mitigation rate, which is equal to the mine-induced seepage rate at minimum lake levels, is less than the average increase in lake seepage caused by the mine (Table 3-20). As a result, the mitigation pumping would not provide adequate quantities of water to the lakes to prevent adverse impacts. Little Sand Lake would be below minimum levels 82-85% of the time even with mitigation. Deep Hole Lake would fall below the minimum level about twice as frequently under the mitigation plan as it normally would. Average lake levels would be reduced by up to 1 foot.

Table 3-20
Hydrologic Impacts to Lakes From the Proposed Mitigation Plan

Lake	Average Mitigation Rate (gpm)[1]		Average Increase in Lake Seepage (gpm)		% Time Below Minimum Levels[2]		Reduction in Lake Level (ft)[3]
	Expected	Maximum	Expected	Maximum	Expected	Maximum	
Little Sand	420	537	553	693	(0) 82	(0) 85	0.95
Duck	3	3	8	12	(23) 33	(21) 25	0.23
Skunk	44	75	115	130	(0) 0	(0) 0	0.99
Deep Hole	32	45	86	102	(18) 35	(24) 43	0.40

[1] Mitigation rates are equivalent to the mine-induced seepage when lakes are at minimum levels.
[2] Numbers in parentheses are percent time below minimum levels under natural conditions.
[3] Declines are from average lake levels.

Mitigation pumping would continue after mine closure as necessary. The groundwater drawdown would rebound to within one meter of pre-mining conditions within about six years after mine pumping was halted. Surface water impacts from the groundwater drawdown are expected to be insignificant at this time. With the cessation of the wastewater discharge, water would no longer be removed from the project area, and adequate quantities of mitigation water would be available from the glacial aquifer.

ADDITIONAL PROJECT IMPACTS TO SURFACE WATERS, AQUATIC, AND TERRESTRIAL SYSTEMS

AIR EMISSIONS IMPACTS TO LAKES

The air deposition modeling results were used to assess the potential impacts to surface waters as a result of air emissions from the proposed mine site and tailings ponds. Impacts to Little Sand, Duck, and Deep Hole Lakes were evaluated. Because adverse water quality impacts to other project area lakes more remotely located from the mill and MWDF would not be expected, an in-depth analysis of them was not conducted. Air deposition rates for Skunk Lake would be similar to the deposition rates for Duck, Deep Hole and Little Sand Lakes. Deposition rates for Skunk Lake were not evaluated because it does not support a fish population, due to winter kills, or permanent aquatic species populations.

The analysis of water quality impacts from air emissions included the following steps:

1. Determination of a maximum aerial loading rate to each of the three lakes based on deposition rates supplied by the air modeling results.

2. Calculation of changes that might be expected from background lake concentrations as a result of the loading rates from air deposition sources.

3. Determination of the water quality (criterion) values necessary to protect fish, aquatic life, and recreational uses for Little Sand, Duck, and Deep Hole Lakes.

4. Comparison of resulting lake concentrations from step 2 to the standards determined in step 3 in order to predict if adverse impacts to water quality could result.

From the modeling results, a deposition rate was determined (in milligrams per square meter per year) for the surface area of each lake. The maximum deposition values for each parameter were used to simulate a worst case condition (Table 3-21).

Table 3-21
Maximum Aerial Loading of Heavy Metals to Little Sand, Duck, and Deep Hole Lakes ($mg/m^2/year$)

Airborne Pollutant	Little Sand	Duck	Deep Hole
Lead	2.0×10^{-3}	3.9×10^{-3}	1.6×10^{-3}
Copper	3.8×10^{-3}	6.1×10^{-3}	2.1×10^{-3}
Zinc	2.0×10^{-2}	3.1×10^{-2}	1.1×10^{-2}
Cadmium	7.0×10^{-6}	2.6×10^{-5}	5.4×10^{-6}
Arsenic	6.8×10^{-4}	2.4×10^{-3}	5.1×10^{-4}
Mercury	1.6×10^{-6}	5.3×10^{-6}	1.1×10^{-6}
Chromium	1.1×10^{-5}	4.1×10^{-5}	8.7×10^{-6}
Nickel	2.0×10^{-5}	7.0×10^{-5}	1.5×10^{-5}

Concentration levels for each parameter also were calculated based on lake retention times during average baseline conditions. The resultant lake concentrations from airborne contaminants are listed in Table 3-22 for Little Sand, Duck, and Deep Hole Lakes.

Table 3-22
Predicted Lake Impacts from Airborne Contaminants

Pollutant	Criterion Values[1]	Ave. Background Lake Levels[2] Little Sand	Duck	Deep Hole	Max. Concentrations Expected from Airborne Contaminants for Little Sand[3]	Duck[4]	Deep Hole[5]
Lead	.0016	<.01	<.01	<.01	2.2×10^{-6}	3.4×10^{-6}	9.2×10^{-7}
Copper	.0143	.005	.0045	<.003	4.1×10^{-6}	5.3×10^{-6}	1.2×10^{-6}
Zinc	.0712	.018	.017	.012	2.2×10^{-5}	2.7×10^{-5}	6.3×10^{-6}
Cadmium	.0022	<.0015	.0015	<.002	7.6×10^{-9}	2.3×10^{-8}	3.1×10^{-9}
Arsenic	.29	<.001	<.001	<.001	7.4×10^{-7}	2.1×10^{-6}	2.9×10^{-7}
Mercury	.00015	<.0001	<.0001	<.0001	1.7×10^{-9}	4.6×10^{-9}	6.3×10^{-10}
Chromium	.0082	<.001	<.001	<.001	1.2×10^{-8}	3.6×10^{-8}	5.0×10^{-9}
Nickel	.002				2.0×10^{-8}	6.1×10^{-8}	8.6×10^{-9}

[1] Criterion values necessary to protect fish and aquatic life for Little Sand, Duck, and Deep Hole Lakes. Values are the same for each lake due to a uniform hardness of 20 mg/l.
[2] Average background data from the Environmental Impact Report (1982) Vol. VII.
[3] Residence time is 2.39 years based on average baseline conditions.
[4] Residence time is .37 years based on average baseline conditions.
[5] Residence time is 1.28 years based on average baseline conditions.
NOTE: all values in mg/l

Data from Table 3-22 indicate that the maximum lake concentrations that could result from deposition of airborne contaminants are several orders of magnitude smaller than the average background lake concentrations (for some parameters, the average background values are less than the detection limit). The loading rate from airborne contaminants is unlikely to result in any measurable changes from background conditions. Consequently, no appreciable water quality impacts to Little Sand, Duck, and Deep Hole Lakes would occur as a result of deposition of airborne contaminants from the project.

FATE OF CHEMICAL REAGENTS IN THE ENVIRONMENT

The primary chemical reagents contained in the MWDF leachate, wastewater effluent, and wastewater sludges can be characterized as pH modifiers, inorganic reagents, and organic reagents. Reagents used for pH adjustment (lime, caustic soda, soda ash, and sulfuric acid) are readily soluble and would comprise about 72% by weight of the total reagents used. Predictions of leachate, effluent, and sludge qualities have accounted for the effects of these chemicals upon these waste streams. Inorganic reagents used in the mill circuit (copper sulfate, zinc sulfate, sodium dichromate, etc.) and water treatment system (ferric sulfate) would represent about 1/4 of 1% of the tailings mass on a weight basis. To the extent these inorganic reagents would be soluble in the proposed water circuit, the water use model included these species in water quality predictions. Since the inorganic reagents are largely comprised of the same minerals and metals as would be naturally found in the tailings, impacts on MWDF leachate quality are predicted to be negligible. The major constituents of the inorganic reagents (sulfate, carbonate, hydroxide, calcium, sodium, iron, zinc, copper, etc.) were included in the modeling of MWDF leachate composition, groundwater impacts, and the evaluations of major design features of the MWDF. The MWDF leachate composition predictions include leachate additions from water treatment sludges disposed of in the MWDF. EPA toxicity test results on sludges produced from synthesized contaminated mine water were found to be chemically stable and nontoxic.

The organic reagents proposed for use may be characterized as biodegradable with relatively low toxicity. Organic reagents would represent less than 1/10 of 1% of the total tailings mass on a weight basis. Experience at operating mills indicates most of the organics would be substantially removed in the reclaim ponds. Their concentration would be controlled by reagent addition at levels needed to maintain process effectiveness. The organic reagents are not on U.S. EPA's priority pollutant list, but monitoring for organic priority pollutants would be required upon commencement of mine backfilling. Routine effluent monitoring for total organic carbon would be required as an indicator for the presence of organic compounds. Additional monitoring might be specified if test results indicated more detailed information were needed. Biodegradable organics in the Swamp Creek discharge would be controlled by the BOD_5 effluent limitations. The acute and chronic bioassay monitoring would provide a measure of whole effluent toxicity including residual organic reagents.

Removal of organics in the mill circuit would occur by adsorption on tailings or backfill particles, preferential concentration in the ore concentrates, and chemical or biological decomposition in the reclaim ponds water treatment facilities. The only connection the process water circuit would have with water being discharged to Swamp Creek or Skunk Lake is through backfill water collected in the contaminated mine water collection/treatment system. Concentrations of organics in the backfill water and contaminated mine water have been predicted based upon literature data and the design of the mill water circuit. Concentrations would depend on actual removal rates and processes realized, variations in flow rates, and reagent dosages. The predicted concentrations for organic reagents, including collectors, frothers, flocculants, and depressants in contaminated mine water would be in the range of several tenths of a part per million (ppm) without any treatment. The design of the water treatment systems include the capability of removing organic compounds by addition of activated carbon.

Collectors - Xanthates are biodegradable, relatively nontoxic organic reagents used to enhance flotation. Since the xanthates may be adsorbed on the mineral surfaces at a rate exceeding 98%, they would be contained primarily in the ore concentrates. The predicted concentration in the untreated mine water is 0.1 ppm.

Frothers - Methyl isobutyl carbinol (MIBC) would be used to lower surface water tension for stable froth formation. The majority of the MIBC added to the floatation circuit would be found in the liquid phase of the ore concentrate stream. MIBC also may be adsorbed with the collector on the mineral particle surfaces. Only the lead thickener overflow stream, representing 40% of the total concentrate thickener overflow, would be directed to the backfilled preparation circuit. MIBC biodegrades readily and is projected to be biologically removed in backfilled stopes. The predicted concentration of MIBC in the untreated contaminated mine water is 0.2 ppm.

Polypropylene glycol methyl ether (DF 250) also would be used as a frother and would be associated with the mineral particle surfaces or the ore concentrate liquid phase. DF 250 would be used primarily in the zinc circuit and would be recycled with the zinc concentrate thickener overflow to the zinc circuit. Since DF 250 chemically degrades slowly and biodegrades very slowly, it is estimated that only 10% would be biologically removed in backfilled stopes. The estimated concentration of DF 250 in untreated contaminated mine water is 0.2 ppm.

Starch (carboxy methyl cellulose (CMC)) aids in the depression of galena (lead sulfide) in the copper-lead separation step by adsorbing on galena mineral surfaces. CMC is less susceptible to biodegradation than other types of starch, but would chemically degrade with time. This reagent is nontoxic and has been approved as a food additive. The concentration of CMC in untreated contaminated mine water is estimated to be 0.4 parts per million.

Flocculant - A synthetic polymer composed of polyacralamides probably would be used as a flocculant. Flocculants usually remain attached to settled particles but various flocculants degrade at different rates. Initial breaking of the polymer chains occurs rapidly but subsequent degradation occurs more slowly. A build-up of flocculant in recycled water usually is not a problem in metal mining operations. The estimated flocculant concentration in the untreated contaminated mine water is 0.1 ppm.

IMPACTS TO SWAMP CREEK AND THE WOLF RIVER FROM THE PROPOSED DISCHARGE

Water Quality Impacts

The proposed discharge of effluent from the wastewater treatment plant to Swamp Creek would contain a variety of contaminants. Small aquatic organisms (i.e., zooplankton) are generally the most sensitive to changes in water quality resulting from the discharge of toxic pollutants. In a few cases, macroinvertebrates or fish may be more sensitive than zooplankton species to water quality changes. The effluent limits for Swamp Creek are set to prevent any adverse impacts (short-or long- term) to the most sensitive species in the aquatic environment, whether the most sensitive organisms would be fish, macroinvertebrates, or zooplankton species. By setting standards to protect the most sensitive organisms, all the aquatic biota in the natural community would be afforded protection.

A stream classification of Swamp Creek below Rice Lake was conducted by Department personnel in 1983 to determine the habitat characteristics and the variety of aquatic organisms present in that stream. As a result of that stream classification, Swamp Creek was confirmed as a stream that shall meet the criteria for fish and aquatic life and recreational uses. This means that all aquatic organisms present in the stream, including the entire food chain are to be protected. In addition, fish spawning sites in Swamp Creek also must be preserved. Consequently, the site specific water quality criteria developed for Swamp Creek are designed to protect all aquatic organisms in that stream, including their reproduction, growth and well-being.

Carcinogens - Several of the constituents in the proposed effluent are known or suspected human carcinogens. Chromium is a known carcinogen, although information does not exist on the mode or level of exposure which may produce carcinogenic effects in humans. Cadmium is a suspected carcinogen, and information gaps similar to those for chromium exist. Inorganic forms of arsenic are known to cause skin and lung cancer in humans. However, there also is evidence that arsenic at very low levels may be an essential nutrient for humans. In the case of the discharge to Swamp Creek, arsenic is not considered a human carcinogen because the principal route of ingestion of that chemical is in the organic form (i.e., eating the fish). Organic arsenic has not been shown to be of toxicological concern as the inorganic form has, and it is not stored in the human body. Consequently, the effluent limits that apply for arsenic are based on fish and aquatic life criteria rather than human health criteria (refer to Table 1-8).

Effluent limits for these known or potential carcinogens currently are based on protection of fish and aquatic life. These limits would result in stream concentrations which are substantially lower than those currently allowed in drinking water supplies. If additional information becomes available in the future which indicates these limits are not adequate, more restrictive limits would be imposed to protect human health from incidental contact with the water and consuming fish from these waters.

Heavy Metals - Projected changes in the water chemistry for Swamp Creek and the Wolf River are shown in Table 3-23. They were calculated under $Q_{7,10}$ and average flow conditions. Only small increases above background levels for most of the heavy metals are expected in Swamp Creek below the discharge. However, little or no change in ambient concentrations in the Wolf River below the confluence with Swamp Creek is expected as a result of the proposed discharge. The calculations were based on an average effluent flow of 2.9 cfs (1300 gpm). At a maximum effluent flow rate of 6.68 cfs (3000 gpm), the instream concentrations would increase slightly above those projected.

It is possible that some of the heavy metals would get tied up with organic materials in Swamp Creek and settle out. However, low levels of suspended solids are expected in the wastewater (<10 mg/l daily average) and in addition, the heavy metals are primarily in the dissolved form. Consequently, the heavy metals would not be expected to settle out to any great extent. Thus, the instream concentrations projected in Table 3-23 for Swamp Creek and the Wolf River, as a result of the wastewater discharge, are expected to be fairly accurate, especially under equilibrium conditions.

In terms of the fate of the heavy metals in Swamp Creek, two scenarios are possible: 1) the metals could remain in suspension, or 2) they could be removed from the water column and become associated with the organic material or sediments. As mentioned above, dissolved metals, which will be the predominant form in the wastewater discharge, would not settle out as readily. Consequently, the dissolved metals would tend to remain in solution in the water column. There are, however, several factors that could increase the rate at which the metals move to the sediments (such as, a higher than average organic content in Swamp Creek, an increase in the concentration of suspended solids in the effluent, or a decrease in the amount of dissolved metals relative to the total). Because of the hydrologic characteristics of Swamp Creek below Rice Lake, it is possible that the heavy metals associated with suspended solids in the wastewater would settle out in the reaches below the discharge. However, since it is not possible to determine the precise fate of the heavy metals in Swamp Creek from the wastewater discharge, intensive monitoring of the water and sediment chemistry, as well as the aquatic biota, is necessary, and would be required as part of the mining permits.

Sulfate - Increases in sulfate above background concentrations are expected in the Wolf River, but would not be harmful to aquatic life. The projected concentration range for sulfate in the Wolf River (7-38 mg/l) is within the seasonal ranges observed in Wisconsin surface waters (this is based on data collected by the DNR over the last 20 years).

Thiosulfate - Reduced sulfur compounds from the milling process would be present in the wastewater discharge to Swamp Creek. In the creek they would be oxidized in the presence of bacteria to form sulfuric acid, which would lower the pH of Swamp Creek. The alkalinity present in Swamp Creek however, would buffer the acid production.

Alkalinity varies seasonally in Swamp Creek. The lowest total alkalinity levels (which correspond to a lower buffering capacity), as well as lower than mean pH levels, occur during periods of high runoff and higher than average precipitation in the spring. During periods of low stream flow in late summer, alkalinity and pH levels are higher, corresponding more closely with the groundwater quality. Thus, the critical time of the year in terms of buffering capacity occurs in the spring during periods of high runoff.

Contaminated mine water would be produced at about 1035 gpm and contain 85 mg/l of thiosulfate. A worst case evaluation must include the possibility that little or no thiosulfate oxidation would occur during subsequent treatment. However, it is likely there would be some oxidation occurring, especially during warmer periods of plant operation.

Two scenarios have been analyzed to assess the impacts to Swamp Creek as a result of the addition of thiosulfates from the discharge. For a worst case condition, a flow value of 15 cfs (the $Q_{7,10}$ for Swamp Creek), a mean alkalinity of 85 mg/l and a mean pH of 7.2 would be assumed. Under $Q_{7,10}$ conditions, it is unlikely that the alkalinity and pH values would be below mean concentration levels, because input to the stream would be primarily from groundwater. Using the above set of conditions for flow, alkalinity, and pH, a change in pH from 7.2 to 6.6 would occur as a result of the addition of

thiosalts to Swamp Creek. For an average or expected condition, a flow rate of 50 cfs in Swamp Creek, a mean alkalinity of 85 mg/l, and a mean pH of 7.2 were assumed. The resultant change in pH under these conditions would be from 7.2 to 6.9. The worst case change is within the range of seasonable variability for pH that normally occurs in Swamp Creek. Thus, adverse impacts to the aquatic biota would not be expected due to pH changes of this magnitude. However, subtle shifts in the aquatic biota could occur as a result of the changes in pH within the above range.

Table 3-23
Predicted Changes in Water Chemistry in Swamp Creek and Wolf River

		Swamp Creek Water Quality		Wolf River Water Quality	
Parameters	Projected Discharge (Monthly Averages)[1]	Background Stream Concen.[2]	Predicted Quality Below Mix Zone $Q_{7,10}$ flow/ ave. flow[3]	Background Stream Concentrations[4]	Predicted Quality Below Swamp Creek $Q_{7,10}$ flow/ ave. flow[5]
Arsenic	0.05	.0017	.010/.004	<.01	No change
Barium	0.03	.012	.015/.013	--	--
Cadmium	0.0006	.0002	.0003/.0002	<.0002	No change
Chromium^{+3}	0.06	.0016	.010/.005		
Chromium^{+6}	0.012	.0015	.003/.002	Ttl=<.003[6]	Ttl=.008/.004[6]
Copper	0.01	.0041	.005/.004	<.003	.004/.003
Iron	0.4	0.29	.31/.30	0.4	No change
Lead	0.04	.0014	.008/.004	<.003	.006/.003
Mercury	0.00017	.0002	.0002/.0002	<.0002	No change
Nickel	0.002	.006	.008/.007	--	--
Selenium	0.06	.0017	.011/.005	--	--
Silver	0.003	.00025	.0005/.0004	--	--
Zinc	0.06	.0148	.022/.017	<.020	No change
Cyanide	0.006	<.01	<.01/<.01	--	No change
Sulfate	410	5.2	71/27	4.2	38/7
Hardness	400	92	142/109	--	--

1 From Table 1 of the WPDES Wastewater Discharge Permit Application (Exxon, 1985). Values in mg/l.
2 From data collected by Ecological Analysts from 4/82 - 12/84.
3 Calculated values are based on a $Q_{7,10}$ of 15 cfs, an average flow of 50 cfs in Swamp Creek, and an average treatment plant flow of 2.9 cfs.
4 Calculated mean values are from data collected at the ambient monitoring station at County "T" on the Wolf River. No background data (and no predictions) indicated by --.
5 Calculated values are based on a $Q_{7,10}$ of 18 cfs and a mean flow of 106 cfs in the Wolf River at the Town road below Post Lake (this is above the confluence of Swamp Creek).
6 Total Chromium = chromium^{+3} and chromium^{+6}

Impacts to Fish and Aquatic Organisms

No measurable impacts to the fishery are expected from the proposed wastewater discharge to Swamp Creek. Sport fish species in this portion of Swamp Creek are limited by naturally depressed early morning dissolved oxygen levels in the summer. The relatively abundant forage or minnow fishery is expected to remain stable. The cool (45-50°F) effluent water would lower summer stream temperatures in the mixing zone and a short distance downstream. Further downstream, the water would be warmed to the ambient stream temperature. Effluent water also would have higher hardness values and contain elevated sulfate levels compared to background stream levels (Table 3-23). Fish not acclimated to the new conditions may move out of the mixing zone in order to avoid the higher levels.

Wild rice occurs in small and scattered patches along lower Swamp Creek below the mine discharge location. Wild rice does not grow in waters containing elevated sulfate levels. Average and low flow concentrations of 27 ppm and 71 ppm below the 200-300 foot mixing zone may adversely affect these stands, depending on the season and duration of the higher concentrations. Higher sulfate levels during winter months may not be injurious to the annual wild rice, but may be during the growing

season. Average flow sulfate concentrations are projected to be about five times the ambient levels, but are still at levels where wild rice grows naturally under reported conditions. In the event that wild rice is eliminated in the mixing zone or below due to water quality changes, it is likely that wild rice would periodically reseed itself along these stretches by seeds dispersed from Rice Lake. Therefore these wild rice patches would likely return after the wastewater discharges to Lower Swamp Creek ends.

Although water quality changes to the Wolf River are not expected to occur as a result of the wastewater discharge to Swamp Creek, the toxicity data base for a particular group of aquatic organisms which are very sensitive to water quality changes (i.e., stoneflies) were examined in detail. This investigation was aimed at determining if sublethal adverse impacts could occur to sensitive aquatic organisms in the Wolf River.

To determine if there would be any sublethal impacts to stoneflies in the Wolf River at the projected instream concentrations, all the available data in the literature for acute (short-term) toxicity to stoneflies were examined. That toxicity information is shown in Table 3-24 for the heavy metals that would be present in the wastewater. Data are not available for chromium +3, selenium, silver, or zinc. Unfortunately, there are no chronic toxicity data on stoneflies in the literature, and there is no acceptable method for estimating the chronic sensitivity of stoneflies based on available toxicity data on other aquatic species.

Under low flow conditions in the Wolf River, none of the predicted metal concentrations in the river would approach acute toxicity levels. The acute toxicity levels for arsenic and copper are more than 2000 times higher than the predicted water quality concentrations; for cyanide, 10,000 times higher; and for cadmium and chromium, more than 90,000 times higher. Although there are slight increases predicted for total chromium (.005 mg/l), and copper (.001 mg/l) for the Wolf River, they would not cause any long-term problems to the survival, reproduction, or growth of stonefly populations in the river. The same would be true for all other very sensitive aquatic organisms inhabiting the Wolf River below the confluence of Swamp Creek.

Table 3-24

Predicted Wolf River Water Quality Compared to Metal Concentrations Toxic to Stoneflies[1]

Substance	Acute Toxicity (mg/l)[2]	Predicted Wolf River Water Quality[3] Low Flow	Average Flow
Arsenic^{+3}	22	<.01	<.01
Cadmium	18	<.00002	<.0002
Chromium^{+6}	1870	.008[4]	.004[4]
Copper	8.3	.004	.003
Cyanide	0.4	no change[5]	no change[5]
Mercury	2.0	<.0002	<.0002
Nickel	33.5	no change[5]	no change[5]

1 Based on literature sources for six different stonefly species.
2 Acute (short-term) toxicity refers to a concentration which is lethal to 50% of a test population over a 96-hour period (96 hr. LC-50).
3 From Table 3-23.
4 Refers to total chromium (Cr^{+3} + Cr^{+6}).
5 No change from existing Wolf River conditions; background data not available.

Heavy metals discharged into Swamp Creek would increase the average stream concentrations about two times above background levels for most parameters. This would be for average stream flows and excludes any reductions that may occur due to attenuation. For the $Q_{7,10}$ flows, projected stream concentrations would be about three times greater for most heavy metals, excluding attenuation. Ambient metal concentrations in Lower Swamp Creek are very low (Table 3-23). For most metals, ambient stream concentrations are less than 3 parts per billion, but for zinc, copper, and barium the concentrations are between 4 and 15 parts per billion.

Bioconcentration refers to the direct uptake of a chemical from the water column to an organism. Bioconcentration factors are laboratory derived numbers that preclude food chain uptake. Table 3-25 provides a range of bioconcentration factors for Wisconsin aquatic species for the heavy metals that would be present in the Exxon discharge.

Table 3-25
Bioconcentration Factors for Fish and Invertebrates

Chemical	Fish	Invertebrates
Arsenic	0-17	10
Cadmium	3-540	160-2400
Chromium^{+3}	no data	no data
Chromium^{+6}	1-3	no data
Copper	1-290	200-500
Cyanide	no data	no data
Lead	45	500-1700
Mercury	5000	no data
Nickel	61	no data
Silver	less than 1	15-240
Zinc	no Wisc. data	1100

Bioaccumulation, which accounts for food chain uptake, is site specific. In the case of the Swamp Creek discharge, specific impacts, in terms of bioaccumulation in aquatic organisms, cannot be accurately determined until the discharge actually occurs. Consequently, the monitoring plan has been designed to measure through tissue analysis, the bioaccumulation of the heavy metals in fish and benthos. If it is demonstrated by this monitoring effort that adverse impacts are occurring to the aquatic biota or potentially impacting human health, then the existing effluent limits to Swamp Creek would need to be reassessed.

Comparison of ambient heavy metal concentrations in Lower Swamp Creek water with those in macroinvertebrate (bottom-dwelling organisms) tissue samples in the stream shows that macroinvertebrates bioaccumulate some heavy metals (copper, zinc, cadmium, lead, and arsenic). For copper, zinc, and cadmium, the concentrations in macroinvertebrate tissue are from 1000-4000 times higher than ambient stream levels, and for lead and arsenic it is from ten to several hundred times higher in the tissue compared to the stream levels. For lead and arsenic, the projected increase in tissue concentration is from 2 to 3 times greater due to the wastewater discharge. For the other parameters that bioaccumulate in macroinvertebrate tissue (copper, zinc, and cadmium), there is no predicted change in tissue concentration as a result of the wastewater discharge. Although sublethal impacts (impacts other than direct mortality) are possible as a result of projected increased bioaccumulation of lead and arsenic in macroinvertebrate tissues, such adverse impacts have not been documented based on the available data in the literature.

Of the heavy metals that would be present in the proposed discharge, mercury has been shown to bioconcentrate in fish (approximately 5,000 times above background stream levels). For mercury, no increase in tissue concentrations in fish is expected in Swamp Creek or the Wolf River, since the monthly average effluent limits have been established to prevent exceedance of FDA standards ("action levels") in fish.

Of the other heavy metals in the proposed discharge, cadmium, copper, lead, nickel, and arsenic bioconcentrate in fish to some extent. Based on the projected increased stream concentrations for Swamp Creek under average and $Q_{7,10}$ flows, small increases in fish tissue concentrations for the above mentioned parameters may be expected for Swamp Creek. However, this is not expected to cause concern either for the humans that would eat the fish or, in terms of sublethal effects, to fish species. For higher level trophic organisms, other than humans or fish (i.e., eagles or osprey), scientific data on the bioconcentration of heavy metals does not exist in the literature. Consequently, impacts to these fish-eating birds as the result of ingestion of heavy metals cannot be assessed at this time. For the Wolf River, no increases in the heavy metals in the fish tissue are projected as a result of the discharge. This is because the instream concentrations in the Wolf River are not expected to increase above background levels for those metals that bioconcentrate in fish.

MWDF SEEPAGE IMPACTS TO SURFACE WATER QUALITY

Leachate which would leak from the mine waste disposal facility (MWDF) would move downward through the unsaturated sediments beneath the MWDF and into the saturated zone. As the leachate moved through the glacial sediments, some of the leachate constituents would be attenuated through a variety of physical, biological, and chemical processes. The movement of sulfate, however, would not be retarded, and once it entered the saturated sediments it would move at the same rate as the groundwater. The groundwater flow beneath the MWDF is primarily eastward toward Hemlock Creek, with a smaller component moving southwest toward Rolling Stone Lake. Eventually some groundwater would be discharged as surface water recharge to Hemlock Creek, and Creeks 11-4 and 12-9. This section analyzes the impacts of sulfate movement from the MWDF on these surface waters. There is no appreciable groundwater recharge of the local lakes, thus there are no predicted impacts to them from MWDF leachate.

The results of Exxon's horizontal contaminant modeling were used to calculate annual loading of sulfate from the MWDF on surface waters receiving groundwater discharge. Exxon's EIR Appendix 4.1A contains values for sulfate moving to Hemlock Creek and the wetlands and springs northeast of Rolling Stone Lake. D'Appolonia, Exxon's consultant, estimated it would take about 9000 years for the sulfate discharges to reach steady state (maximum) concentrations. It would take about 1500 years for 25% of the full concentrations to be attained; about 3000 and 4500 years would be required for 50% and 75% of the steady state values to be attained. DNR/USGS modeling indicated the contaminants might attain steady state flow within the glacial aquifer in 25-50% of those times estimated by D'Appolonia.

Impact calculations were based on the steady state or maximum sulfate concentrations in the contaminated groundwater, the amount of contaminated groundwater discharging to Hemlock Creek, and the $Q_{7,2}$ flow (the flow which is exceeded 95% of the time). The mixing zone concentration of sulfate downstream from the groundwater contribution is predicted to be 6.9 mg/l. This is within the seasonal ranges (<1-9 mg/l) observed in Hemlock Creek. Therefore, there would be no appreciable impacts to water quality or to the aquatic biota in Hemlock Creek or downstream waters as a result of sulfate contributions from the MWDF.

For the springs and wetlands north of Rolling Stone Lake, which form the headwaters for Creeks 11-4 and 12-9, there would be an average loading rate of <1 mg/l (0.35 mg/l) of sulfate from the MWDF via groundwater transport. Thus, there would be no measurable impact on sulfate levels in Creeks 11-4 and 12-9 from the MWDF.

OTHER IMPACTS TO STREAM WATER QUALITY

During construction of the proposed facilities there would be temporary increases in stream turbidity. Increases would occur during construction of the railroad and access road bridges across Swamp Creek, the effluent discharge structure on Lower Swamp Creek, the natural gas pipeline across Drake, Rocky Siding, and Swamp Creeks, and during power line construction across Gliske Creek. Several small feeder streams to Swamp Creek (24-14, 24-13 and 24-4) also would be affected during access road construction.

Turbidity and siltation impacts should be minimized by the use of the proposed erosion control practices. Crossings of Swamp Creek by the access road and the railroad spur would be protected with temporary sheet piling to minimize stream siltation. Once the bridges were constructed, permanent rock rip-rap would be placed on the adjoining abutments to minimize bank erosion. Other practices include reseeding with quick germinating vegetation, soil mulching, and use of silt fences or straw bales to slow runoff and filter out soil particles. If the erosion controls were installed as proposed and DNR staff supervised critical construction activities, it is unlikely that sedimentation would significantly affect aquatic flora and fauna or streambed habitat. Impacts of increased sedimentation to fish populations should be localized and not permanent.

AIR EMISSIONS IMPACTS TO STREAMS

There are no anticipated impacts to streams from airborne contaminants.

FACILITY IMPACTS TO VEGETATION

Surface construction activities for the mine and related facilities would directly impact approximately 865 acres. Two of the facilities, the MWDF and landfill, would be constructed in successive phases. The borrow area would be used at the end of mining for final reclamation. In addition, some reclamation activities would accompany construction work, thus at no time would there be more than about 420 acres of net disturbed land. Surface facilities and the amount of land and vegetation type that would be impacted by development are presented in Table 3-26.

Table 3-26
Impacts to Vegetation Types by Surface Developments

	Size	Northern Hardwoods[1]	All Wetlands	Open Land, Agriculture
Mine/mill Surface Facility	115 acres	115	0	0
Mine Waste Disposal Facility	365 acres	316	49	0
Water Reclaim Ponds	50 acres	41	9	0
Haul Road/Waste Pipeline Corridor	10 acres	9	1	0
Railroad Corridor	46 acres	37	4	5
Access Road	35 acres	26	3	6
Electric Power Line (new r.o.w. only) (80' x 9.2 mi.)	89 acres	72	5	12
Natural Gas Line (new r.o.w. only) (30' x 6.3 mi.)	23 acres	4	1	18
Discharge Water Pipeline (50' x 6.1 mi.)	37 acres	25	7	5
Landfill	15 acres	15	0	0
Borrow Area (for reclamation)	40 acres	40	0	0
MWDF Construction Support Area	25 acres	25	0	0
Mitigation Plan Corridors (new r.o.w. only)	9 acres	6	3	0
Interceptor Well System	7 acres	7	0	0
Totals	866	738	82	46

[1] Includes aspen-birch and clear cuts.

The mine/mill surface facility would be located in an upland wooded area directly above the orebody. The woods have previously been fragmented by roads, drill pads, and staging areas constructed during Exxon's exploration activities. Except for roadways and a small staging area, these opened areas have been reseeded with a grass/legume mix. Construction of the mine/mill facility would require the long-term conversion of these reclaimed areas and remaining intermingled woodlands to a highly developed condition for the duration of the mine, until post-mine reclamation is implemented. No wetlands would be destroyed by development of the mill facility.

The mine waste disposal facility (MWDF), water reclaim ponds, landfill, and construction support areas would eliminate approximately 455 acres of mostly upland wooded habitat. Construction of the MWDF would be phased over the life of the mine, so impacts caused by construction would not occur at one time. Approximately 49 acres of wetlands would ultimately be covered by the MWDF. The remaining acreage is dominantly second growth hardwood forest. Wetland losses would be irreplaceable since the surface of the reclaimed MWDF would be reworked to maximize runoff from the cap. Long-term reclamation would be establishment of an indigenous forest cover on top of the MWDF cap.

The access road would permanently convert 35 acres to a developed use. This road may not be removed at the end of the mine life. Of these 35 acres, 26 acres are upland woods (second growth hardwoods and aspen/birch), 6 acres are agricultural or old field, and 3 acres are wetlands. The natural gas pipeline would parallel the access road and share the corridor with the power line right-of-way.

The railroad spur and siding corridor would require approximately 46 acres. Of this total, 37 acres are upland woods (predominantly second growth hardwoods), 5 acres are farm fields or old fields, and 4 acres are wetlands. The railroad spur would cause a long term conversion to developed

use. The ultimate disposition of the railroad spur would depend upon future uses of the mine/mill complex after mining. If abandoned after mine shutdown, the tracks and rock ballast would be removed and the corridor reclaimed. Forest and/or herbaceous vegetation would be reestablished through human and natural processes.

The electric power line would require a new 80-foot wide corridor along approximately 9.2 miles of the proposed route. An existing corridor would be utilized along U.S. Highway 8. Most of the new right-of-way is presently forested with a mix of second growth hardwoods and aspen/birch stands. A total of 72 acres of upland forest and 5 acres of lowland forest would be cleared. About 12 acres of agricultural or open lands would be utilized by the right-of-way. After construction of the power line, the corridor would be kept clear of trees and tall shrubs by means of herbicide application, manual clearing, or a combination of these methods. Power line rights-of-way in northern Wisconsin with similar maintenance usually have the following vegetation: hazelnut, blackberry/raspberry/dewberry, blueberries, fireweed, and a wide variety of other common open land species of the north.

According to the Agricultural Impact Statement written by the Department of Agriculture, Trade, and Consumer Protection, for the electric transmission line routes, the proposed route would result in the least overall agricultural and commercial forestry impacts. The largest acquisition from any individual for the transmission line would be 24.2 acres from Consolidated Papers, Inc. The transmission line would be located through areas which have been identified by Consolidated Papers, Inc. as areas which would be minimally affected by transmission line construction and right-of-way clearing.

The wastewater discharge pipeline would extend for 6.1 miles between the mine/mill site and an outfall structure on Swamp Creek downstream from Rice Lake. The 50-foot wide corridor would traverse mostly forested land, requiring the clearing of trees. About 7 acres of wetland also would be traversed by the pipeline. During pipeline construction, sidecasting and backfilling activities would disrupt surface vegetation. If done with care, vegetation and soil disruption could be kept to a minimum and the pipeline route could revert to natural vegetation. Reforestation would be allowed since the pipeline corridor would not have to be maintained or removed. Thus, this pipeline is viewed as having a short-term impact to vegetation.

The proposed right-of-way for the natural gas pipeline would run south from the existing ANR main line to the mine site. For its entire length, about 8 miles, the 30-foot-wide pipeline corridor would parallel existing roads or the access road. The corridor would be maintained in a treeless, shrubless condition after pipe laying to facilitate pipe repair and maintenance. Long-term vegetation established would be similar to that found on mowed public road rights-of-way.

Developments for mitigation plan implementation would include pipeline corridors to Hoffman Springs, Martin Springs, Creek 12-9, Upper Pickerel Creek, Swamp Creek, Skunk, Little Sand, Deep Hole, and Duck Lakes, associated discharge structures, as well as power line and access rights-of-way to well locations. About 17 acres in total would be affected, 6 of which are forested uplands, and 3 of which are wetlands. The remainder, about 8 acres, would be on existing rights-of-way. Rights-of-way would be cleared and maintained free of trees and shrubs by cutting or herbicide application during project operations. Following project closure, although not immediately, the rights-of-way would be allowed to succeed naturally to woody vegetation. Development of the full interceptor wells system would result in the clearing of additional acres of upland forest.

As an addition to the lake supplement proposal, lake outlet control structures might be constructed on Little Sand, Duck, and Deep Hole Lakes. It is assumed that two structures would be required for Deep Hole Lake because during high water periods water flows westward toward Little Sand Lake and southward toward Creek 12-9. Access requirements and construction activities associated with lake outlet control structures would result in alteration of about 0.5 acre of wetlands and 0.5 acre of upland forest in total.

No endangered/threatened plant species or other significant vegetation features (besides wetlands) have been identified in these corridors.

WETLAND IMPACTS

Because avoidance and protection of wetlands was an important facility siting criterion, direct wetland impacts by facility components would be small. However, wetlands are a relatively common landscape feature, and some would be unavoidably impacted. In addition, some wetlands would be impacted only temporarily, and there exists the potential to create others during final site reclamation.

The various mine facilities would directly alter a total of 81.9 acres of wetlands (Table 3-27). These wetlands represent 4.8% of the 1,706 acres of wetlands existing within the 64,000 acre Environmental Study Area, an area within a radius of approximately 5.0 miles from the proposed mine/mill site. As a percent of the total ecological type, deciduous swamp wetland would be impacted most by facility construction activities (9.6%). On an acreage basis, conifer swamp would be impacted most (39.1 acres).

The mine waste disposal facility and associated water reclaim ponds would ultimately destroy 57.7 acres of wetlands. This is the largest direct impact to wetlands of any of the mine facilities. These impacts would be spread over the several phases of the mine's operational life. The total impacted acreage would include wetlands beyond the actual facility berms that would be altered by associated construction activities, the dike perimeter roads, and sedimentation ponds. Most of the wetlands that would be permanently lost are types typical to the Environmental Study Area and region. The northwestern corner of the western reclaim pond, and a planned sedimentation pond adjacent to it would infringe upon a part of a regionally uncommon type of deciduous swamp. This swamp contains bur oak (Quercus macrocarpa) as a codominant species, a situation which is rare this far north.

Certain mine facilities would impact wetlands only temporarily. The pipeline and utility corridors would disturb wetlands as they are being installed, but wetlands should recover if construction methods are correctly implemented. Nonforested wetlands should recover from these disturbances within one to two years. Where forested wetlands would be crossed, the disturbance would be more long lasting, but such areas should recover to original vegetation in several years except where maintenance requires corridors to be kept free of trees (e.g., powerlines and natural gas pipeline).

There would be some indirect impacts to wetlands close to facilities due to changes in drainage patterns and runoff areas. However, wetlands that would be impacted in this way are high in their drainage basins and have small drainage areas. Changes in drainage area due to facility construction would be very small, and would not be expected to perceptibly change wetland characteristics. Construction runoff should not harm nearby wetlands due to the installation of a series of sedimentation ponds that would intercept the majority of suspended sediments before they would enter any wetlands or other surface waters.

If outlet control structures were built on Little Sand, Duck and Deep Hole Lakes, there could be changes in lake levels, particularly during the spring season, depending on how the structures would be managed. If the structures were managed to maximize lake water storage, there could be flooding impacts to lake edge wetlands, particularly around Duck and Deep Hole Lakes. While seasonal fluctuations occur and are tolerated by some wetland species, prolonged and heightened flooding could result in mortality to sensitive wetland vegetation such as the tamarack swamp forest around Duck Lake.

Table 3-27
Direct Facility Impacts to Wetlands[1]

	Conifer Swamp	Deciduous Swamp	Shrub Swamp	Bog	Shallow Marsh	Total Wetlands
Mine/Mill Surface Facility	0.0	0.0	0.0	0.0	0.0	0.0
Mine Waste Disposal Facility	28.3	5.9	9.4	5.6	0.0	49.2
Water Reclaim Ponds	1.1	7.0	0.0	0.0	0.4	8.5
Haul Road/Waste Pipeline Corridor	0.6	0.0	0.0	0.0	0.0	0.6
Railroad Corridor and Siding	2.6	0.0	0.4	0.9	0.0	3.9
Access Road	2.7	0.2	0.3	0.0	0.0	3.2
Discharge Water Pipeline	3.9	0.9	0.6	0.7	0.9	7.0
Landfill	0.0	0.0	0.0	0.0	0.0	0.0
Borrow Area	0.0	0.0	0.0	0.0	0.0	0.0
MWDF Construction Support Area	0.0	0.0	0.0	0.0	0.0	0.0
Electric Power Line						5.0
Mitigation Plan Corridors						3.5
Natural Gas Pipeline						1.0
Total Directly Impacted (acres)	39.2	14.0	10.7	7.2	1.3	81.9
Study Area Total (acres)	946.0	146.0	146.0	320.0	148.0	1,706.0
% of Total Directly Impacted	4.1	9.6	7.3	2.2	0.9	4.8

[1] Figures in acres

IMPACTS OF HEAVY METALS DUST

Dust generated from mining, ore processing, and tailings storage would be a potential source of airborne pollution to the environment immediately surrounding the mine facility. Dust from ore would contain small amounts of the heavy metals lead, copper, zinc, cadmium, manganese, cobalt, arsenic, mercury, and chromium. While the amount would be minimized by use of filters, covered facilities, and wetting agents (dust suppressants), some dust would escape to the environment. The amount of heavy metals in the airborne dust has been predicted for the area surrounding the mine by using the Industrial Source Complex Long-Term Model. The model predicts both seasonal (quarterly) and annual dust depositions for nearly 300 receptor sites within a two mile radius of the mine/tailings pond site. Table 3-34 (Air Quality Impacts section) presents annual predicted heavy metal depositions.

Comparison of the yearly deposition rates (Table 2-20) in the Great Lakes region with those modeled rates for the Exxon project indicates that the additional deposition ranges from less than 0.05% of background for manganese, chromium, lead and cadmium, to less than 0.2% of background for copper, zinc and arsenic.

Comparison of modeled dust deposition related to mining activity at the Crandon site with measured background levels elsewhere indicates negligible additional heavy metal loadings to nearby ecosystems. These additional loadings also would be negligible compared to existing heavy metals concentrations in soils and in site vegetation samples. Assuming tailings dust is controlled as anticipated, heavy metal contamination of surrounding ecosystems via this vector would not be expected to be a problem.

IMPACTS TO WILDLIFE

Impacts to wildlife in the environmental study area and the region would result from direct habitat loss, noise of facility construction and operations, and secondary impacts caused by an increase in human population.

Impacts of Habitat Loss to Wildlife - Wildlife would be impacted by the eventual disturbance to 866 acres of vegetation. Upland vegetation losses would include 738 acres of northern hardwood and aspen-birch stands (including clear cuts), 46 acres of old field habitats and agricultural fields, and 82 acres of wetlands (including coniferous swamps, deciduous swamps, shrub swamps, open bogs, and four shallow marshes).

The habitat loss would have a small impact on regional wildlife populations. The habitat in question presently supports about 30 deer (fall population), 55 ruffed grouse, 4,400 songbirds, numerous small

mammals, one or two black bears, bobcats, and fishers, as well as several coyotes and red fox. Most of the small animals along with the reptiles and amphibians in the area also would be lost.

Woodland clearing for the mill, MWDF, reclaim ponds, landfill, construction support area, borrow area, and corridors would result in the loss of habitat for forest species such as the snowshoe hare, gray squirrel, fisher, barred owl, hermit thrush, black-throated green warbler and Blackburnian warbler. Habitat for species populations requiring disturbed and open habitats would increase; such species include woodchuck, killdeer, striped skunk, raccoon, barn swallow, and common grackle.

The access road, electric power line, and rail spur would cross a narrow corridor of the Swamp Creek deer yard (Fig. 2-11). A population of 30 to 50 deer overwinter in this yard. The access corridor development, mine construction, and mine operation would not greatly impact the distribution of wintering deer.

While migrating waterfowl and shorebirds would be attracted to the MWDF and reclaim ponds, these birds would use the area for a very temporary period because the shoreline habitat would be a beach-type sand, there would be no invertebrates present for food, and there would be no shoreline or aquatic vegetation for food or cover.

Birds temporarily using the pond would be exposed to environmental contaminants. Because of the temporary use and lack of food, no acute or chronic mortality is expected and no movement of contaminants outside the ponds is expected.

Impacts of Habitat Loss to Sensitive Species - Wisconsin endangered species in the environmental study area include bald eagles and ospreys. Mine construction and operation would not directly affect the hunting territory or nesting habitat for bald eagles. One osprey pair nests 0.4 miles from the tailings area and one pair nests 0.2 miles from the mine/mill site perimeter. Osprey nesting activities probably would not be impacted by the project.

Wisconsin threatened species present in the area include one or two pairs of Cooper's hawks and red-shouldered hawks. The habitat loss of 866 acres would eliminate possible nest sites for these species.

Wisconsin Watch Species are defined as species about which some problem of abundance or distribution is suspected but not yet proved. Watch species in the project area include spotted salamanders, leopard frogs, fox snakes, garter snakes, and common flickers. Site preparation and development would eliminate habitat for these species. Spotted salamanders, garter snakes and common flickers are regionally common. Leopard frogs and fox snakes are regionally uncommon or rare. Habitat for southern flying squirrels, rare in Forest County, would be reduced. The direct loss of habitat would have a small impact on regional populations of sensitive species because the type of habitat which would be lost is very common.

Noise Impacts of Construction and Operation on Wildlife - Most site area wildlife species could adapt to the routine noise caused by traffic, heavy equipment, and milling operations. Sensitive species such as ospreys, black bears, and common loons also could adapt to the increase in the background noise level. Thus the noise caused by construction and operation of the mine should have negligible impacts on wildlife populations in the environmental study area.

Eagles can adapt to an increase in noise levels according to literature references. However, some eagles are more temperamental and become more disturbed then others. A buffer zone around active eagle nests would minimize adverse noise impacts.

The principal reaction to transient and unexpected noise by wildlife is startle or fright. Wildlife generally flee from the noise source temporarily or for long periods if the noise persists. Some wildlife have a tendency to adapt to noise that is predictable and unchanging. For example, the observed reactions of birds to high noise levels include fright reactions, altered behavior, and, in some cases, attraction to noisy areas.

Some animals would tolerate increased noise levels whereas others would temporarily avoid such areas. During periods of noise generating activity in the project area (e.g., periods of heavy equipment use during construction), wildlife may temporarily avoid the area where the activity is

occurring. Any noise effect should be localized around the area of activity with impacts decreasing as the distance from the noise source increases. Domestic animals are located sufficiently away from the proposed activities and should not be affected by noise.

Secondary Impacts to Wildlife - The 866 acre habitat loss, the construction and/or operation of the access road, rail spur, discharge pipeline, and electric transmission line, and the predicted human population increase would reduce the carrying capacity of the environmental study area for timber wolves, bald eagles, and pine martens. Increased human populations and human disturbances would reduce the maximum population capacity of the region for sensitive wildlife species such as common loons, black bears, and bobcat. Increased human populations would increase the demand for hunting, fishing and trapping opportunities. More people in the region also could result in a higher incidence of poaching game animals and road kills.

Wildlife habitat would be impacted by timber management operations of forest lands controlled by Exxon. If silvicultural treatments such as uneven-aged selective harvests or even-aged clear cuts were conducted, they would have positive impacts to some wildlife species and negative impacts to other species.

Closure - After mine closure, wildlife populations would develop in response to regional forest succession or to forest management practices on the reclaimed site. Upland wildlife species presently found in the site area would reestablish populations in the reclaimed forest habitat in time.

IMPACTS OF COUNTY FOREST WITHDRAWAL

Exxon's Purchase Agreement With Forest County - In November 1980, Forest County entered into a land purchase option agreement with Exxon on approximately 880 acres of Forest County Forest Lands within sections 28, 29, and 30, Town 35 North, Range 13 East (Fig. 1-3). In November 1985, Exxon announced its intention to purchase all of the land. As an initial consideration when the option was signed, Forest County received $200,000. For each year after, the county received $44,000, until 1985, when the purchase option was exercised.

County Forest Withdrawals Procedure - Before Forest County can honor the option agreement and sell land to Exxon, the land in question would have to be withdrawn under the regulations required in the County Forest Law, section 28.11, Wisconsin Statutes. The DNR would review an application for withdrawal and consider the benefits and costs of continued entry or withdrawal. The DNR also must decide if the withdrawal for mining purposes would be a higher and better use than continued entry. Withdrawal would be approved or denied based upon these considerations.

County Forest Replacement Lands - Forest County would replace the County Forest lands through acquisition of comparable or greater acreage. Initial arrangements have been made to acquire replacement lands from the Nicolet National Forest. Forest County would buy scattered State Land Commission properties which complement forest lands sought by the Nicolet National Forest. The exact parcels to be purchased and traded have not been determined. The County lands gained would complement existing land holding, and be comparable in timber and general land character to the lands withdrawn.

Environmental Consequences - Forest County intends to replace the County lands withdrawn with at least an equal or greater acreage of new county forest land. There would be a net loss of land from public use, however, since the replacement lands are already under public ownership by the State Land Commission.

NOISE AND VIBRATION IMPACTS

Noise Impacts - Noise-sensitive locations near the project area and their respective background noise levels were discussed in Chapter 2 (Fig. 2-12). To assess community response to increased noise levels, guidelines have been established by the International Organization for Standards. Increases in noise were categorized as follows:

Table 3-28
Generalized Community Responses to Noise Increases

Difference, dB*	Category	Description
0	None	No observed reaction
5	Little	Sporadic complaints
10	Medium	Widespread complaints
15	Strong	Threats of community action
20	Very Strong	Vigorous community action

* dB = decibels

The anticipated increases in sound levels for the construction and operation phases of the project are listed in Table 3-29.

Table 3-29
Increase in Construction and Operation Phase Noise in Decibels[1]

Location[2]	Operation Net Increase Day	Night	Day-Night	Construction Net Increase Day	Night	Day-Night
			Winter			
1 - Mole Lake School	0	2	1	0	0	0
*2 - Mole Lake Comm. Ctr.	1	6	4	2	2	2
*3 - Mihalko Residence	1	9	3	6	4	5
4 - Residence 3712	1	1	1	1	0	0
5 - Exxon Field Office	7	10	10	6	5	6
*6 - Webb Residence	3	20	8	6	13	7
7 - Lake Metonga	0	0	0	1	0	0
8 - Rolling Stone Lake	1	2	2	3	1	2
*9 - Ground Hemlock Lake	5	4	4	10	1	5
10 - St. Johns Lake	3	1	1	2	0	0
			Summer			
1 - Mole Lake School	0	0	0	0	0	0
2 - Mole Lake Comm. Ctr.	1	1	1	1	0	0
3 - Mihalko Residence	0	0	0	3	0	1
4 - Residence 3712	0	0	0	0	0	0
5 - Exxon Field Office	2	20	3	0	14	1
*6 - Webb Residence	5	4	4	10	1	4
7 - Lake Metonga	0	0	0	0	0	0
8 - Rolling Stone Lake	0	0	1	1	0	0
*9 - Ground Hemlock Lake	1	5	1	3	2	2
10 - St. Johns Lake	1	2	1	1	1	1

[1] Locations where sound level increases may cause sporadic or widespread complaints are marked with an asterisk. Numbers indicate decibel increases over background noise. Source: Howard Needles Tammen & Bergendoff report to DNR.

[2] See Figure 2-12 for locations of noise monitoring sites.

Construction Noise - Construction activities would occur in several phases: site clearing, grading and excavation; equipment erection; facility fabrication; and finish work and landscaping. The excavation phase is expected to be the noisiest activity during the construction period.

The locations of construction activities were generalized to present a worst case situation. Two shafts were assumed under construction at the mine/mill site. Sound from the MWDF was assumed to be generated from six locations around the perimeter of the facility with one-sixth of the sound coming from each location. The sound during access road construction was assumed to be generated from four locations along the corridor. Construction noise from the railroad spur would be generated at the intersection of the spur with the Soo Line (Location C). Noise from the haul road and tailings transport pipeline would be generated halfway between the mine/mill and the MWDF. The water discharge pipeline noise would be generated south of Mole Lake, about 2,200 feet from Location 1. Construction activities for the water discharge structure would occur at the discharge location on Swamp Creek, approximately 1.0 mile downstream from CTH M.

Daytime construction noise levels were based upon the "worst case" assumption that construction activities would occur simultaneously at the following sites: mine/mill, MWDF, access road, rail spur, haul road, tailings transport and water discharge pipelines, and the Swamp Creek water discharge structure. Nighttime construction noise was based only on the simultaneous construction activity at the two shaft locations in the mine/mill site but no other equipment noise sources.

The noise levels for construction impacts were based on the type and quantity of equipment needed to complete a specific job. The total impact of construction (worst case) activities is shown in Table 3-29. During winter, change in daytime background sound level and day-night sound level would occur at almost all locations. Mine/mill construction would involve a phase in which activity would occur for a 24-hour period during winter. This activity would significantly increase nighttime sound levels at Locations 5 and 6 and moderately at Locations 2 and 3 (Fig. 2-12).

Under worst case conditions, residents living on the west shore of Little Sand Lake (Location 6) would experience a 13 dB change during the winter nighttime, while residents on the west shore of Ground Hemlock Lake (Location 9) would experience a 10 dB change during winter daytime. All other residents of noise-sensitive areas would experience less than or equal to a 6 dB change during daytime or nighttime periods. Total day-night noise levels increase by 7 dB at Location 6 and by 6 dB or less at all other locations.

Residents on the north shore of Little Sand Lake (Location 5) would experience a 14 dB increase during summer nighttime periods, while residents near Location 6 would experience a 10 dB increase in summer daytime noise levels. All other locations would increase by 3 dB or less. Day-night noise levels during the summer would increase by up to 4 dB.

Increased background sound levels due to worst case construction activities would not exceed EPA's short term (65 dBA) and long-term (55 dBA) goals at all locations. Increases in noise levels over 10 dB, however, could result in complaints or community action.

At some locations in the study area, the acoustical environment would substantially change as a result of construction activity, although these changes would be limited in duration. Background noise levels would increase at several locations, and under certain meteorological conditions noise from construction activities could travel greater or lesser distances than those calculated. Extreme cases of solar heating, inversions, and tunnelling of acoustic energy caused by meteorological phenomena and the rolling topography of the area could cause short term noise levels (15-30 minutes in duration) to be 10 to 20 dB higher or lower than those presented.

Another concern is that the human ear responds slightly differently from electronic devices. The human ear can readily discern changes in pitch of time-varying sounds, e.g., a dozer, even though the noise is below the sounds emitted by closer sources such as wind, birds, distant traffic, and human activity. The reasons for this are many. For example, wind moving tree leaves results in a higher frequency sound than the dozer noise. Sound intensity varies as a dozer is loaded and unloaded, aiding in discerning construction sounds from other background sources. If the intensity of the dozer sound was steady, a listener would have greater difficulty discerning a difference. The additional noise (dB) may be low but the varying intensity creates a distinctly different sound pattern compared to other sources. This difference could affect the public response to the change in the acoustical environment around the construction site.

Operations Noise - The major sources of noise during project operation would be associated with the following facilities:

Mine/Mill - For assessment purposes, the mine/mill site operations noise was assumed to be located at the northwestern end of the railroad tracks at the ore concentrate load-out. In addition, one vent fan each for the west and east exhaust raises, are considered.

MWDF - The operating noise was assumed to be produced by two trucks at the boundary nearest each noise-sensitive location. Six different locations were used for the contour calculations.

Access Road - The noise levels were calculated by estimating the number and types of vehicles that would be traveling along the road during the morning, afternoon and nighttime periods. The noise source location for the access road was chosen at the point along the road that is nearest to each noise-sensitive location. Four different locations were used in the contour calculations.

Railroad spur - The railroad spur operation noise level was obtained from the mine/mill noise contours. The noise source was located at the northeastern end of the spur.

Haul Road - The haul road was assumed to have three heavy trucks traveling at the midpoint of the road.

Pipelines (Tailings Transport and Water Discharge) and Discharge Structure - The tailings transport pipeline, water discharge pipeline, and water discharge structure were assumed to have no operating noise because they are located underground or in an enclosure.

Total noise during winter operations would be less than summer operations (Table 3-29). This is due to lower baseline noise levels during the winter. There would be an increase of 1 dB or less in day-night noise levels at Locations 1, 4, 7 and 10. Increases between 1 dB and 4 dB at Locations 2, 3, 8 and 9 are predominantly due to the MWDF. At Location 6, the haul road and the MWDF would contribute to sound levels. Day-night noise levels increase 10 dB and 8 dB due to the MWDF and haul road at Location 5 and 6, respectively.

Residents near Locations 3, 5 and 6 would experience 9 dB, 10 dB and 20 dB increases, respectively, in winter nighttime sound levels. All other locations would experience noise levels increases up to 6 dB or less. Nighttime sound levels change substantially during a worst case analysis at Location 6 due to the existing low background sound levels. Actual sound levels during operations are expected to be lower.

There would be little or no change (less than one dB) in background day-night sound levels in the summer at Locations 1 through 4 and 7 through 10 due to project operation. At Location 5, a change of about 3 dB is anticipated, predominantly due to MWDF activities. At Location 6, there is a change of about 4 dB, principally due to the haul road. The estimated noise levels would probably be lower during most of the actual operations. Summer nighttime noise levels increase 20 dB at Location 5. All other locations increase 5 dB or less.

The overall increase in sound levels at Locations 5 and 6 is, under a worst case analysis, above 10 dB and could result in complaints or community action. Construction noise would occur over a 30 month period with the greatest period of noise generation during the first two years. Operation noise impacts are potentially greatest during the winter months at night. The overall human response to the operations would be very similar to those discussed in the section on construction impacts. Noise sources during operation would last for longer periods of time and would continue over the 29-year operations phase.

Noise Management Plan Impacts - The noise management plan as proposed by Exxon should reduce noise to some degree. The plan's effectiveness, however, depends upon the enforcement and active oversight of its various provisions. For instance, speed limits need to be posted and enforced, equipment needs to be maintained, and work scheduling to avoid week and nighttime activity would require careful planning. Since the DNR does not have enforcement authority on noise issues, local residents may choose to pursue noise management issues with Exxon and the appropriate subcontractors.

Instantaneous Noise Impacts - The project would produce some noises that are instantaneous in nature. The short duration of these noise sources is similar to that of intermittent auto, snowmobile,

or airplane noise already present in the site area. Sources capable of emitting instantaneous noise would include warning horns prior to blasting and all clear signals after blasting, blasting if large boulders would be encountered during shaft sinking in the glacial materials, backup alarms on earthmoving equipment operating in reverse gear, and startup alarms for remotely-started and stopped equipment.

Most alarm devices would be high frequency in nature, thus there would be considerable atmospheric absorption. This would reduce annoyance to off-site, noise-sensitive locations. Further, the alarm systems on the trucks and other mobile construction equipment would be checked to ensure that the sound levels did not exceed the amount required for safety.

Traffic Noise - The Federal Highway Administration (FHWA) equation for predicting noise at distances of 50 feet or greater was used to estimate current and project-related noise levels on State Highway 55 north and south of the intersection with the proposed access road. This equation is the same as that used by the State of Wisconsin Department of Transportation. Noise levels on STH 55 north of the mine/mill access road would increase 2 dB as a result of increased traffic during construction and 1 dB during operation. South of the access road on STH 55 noise levels would increase 1 dB during both construction and operation. Increases of less than 3 dB would be barely noticeable in the natural environment.

Vibration Impacts - Blasting would occur during the construction and operation phases. Blasting should not have a large impact upon the environment during either phase. The most noticeable impacts are predicted for the construction blasting of the main and mine ventilation shafts. These impacts are predominately noise related rather than vibration related, and would occur during project years 1 and 2 and years 8 and 9.

Production blasts fall into two categories: face blasts and production blasts. Face blasts would occur frequently, at the end of every shift but would be of small size. Face blasting is associated with the development of drifts, ore drawpoints, and mining of the upper portion of the orebody during the cut-and-fill operations. Production blasts would occur several times a week on average but would vary in size depending on the phase of stope development. During the early phases of stope development, the space available to accommodate blasted ore would be small. As the stope slot would be enlarged, however, progressively larger blasts with more explosives would be used.

Shaft Sinking - Most of the excavation work in overburden soils would be without the use of explosives except where boulders are encountered and conventional excavation equipment could not loosen or break them.

The important blasting charge information related to seismic vibrations impacts is the weight of charge per delay, not the total charge weight. Each explosive firing for the main shaft in bedrock would require 352 pounds of dynamite. There would be 15 delays at each firing, with an average of 24 pounds (maximum of 32 pounds) of explosives per delay period to provide adequate shattering of rock. The east exhaust raise would use the same general level of explosives during bedrock excavation. Blasting in the main shaft and east exhaust raise would be conducted three times per 24 hour period. The west exhaust raise would have explosives fired twice per day. The total charge per firing would be 500 pounds of dynamite. Fifteen separate delays per firing would be used, with an average of 33.5 pounds (maximum of 50.2 pounds) of explosive per delay period. Blasting for drifts and ramps would be at the same level as for shafts.

Production Blasting in Stopes - Blasts in the stopes above the 450 foot level and during the cut-and-fill mining would require as much as 17,600 pounds of explosives per firing, but with the use of many delays. The charge in each delay would not exceed 550-660 pounds.

In the stopes below the 455 foot level, the usual blast would require 17,600 pounds overall, but six delays, with 2,925 pounds per delay, would be used. Table 3-30 indicates the charges per delay and resulting anticipated peak particle velocity.

Table 3-30
Peak Particle Velocity for Blasting Events

Blasting Event	Normal Charge Per Delay (lbs.)	Ground Surface Peak Particle Velocity 0.5 Miles Distant (in/sec)
Main Shaft Sinking	32	0.002
Mine Level Drifting	51	0.003
95m Stope Blasting	660	0.02
140m Stope Blasting	2,930	0.07
290m Stope Blasting	2,930	0.06

Peak particle velocity was the primary factor utilized in evaluating off site impacts. Various explosive charge weights and distances from the blast were used to develop charts depicting the estimated peak particle velocity expected during shaft sinking and production blasting.

For comparison purposes, the 0.01 to 0.1 inches per second range for the limit of human response is roughly equivalent to the vibrations one would feel in a house located about one city block from a fast freight railroad. Several of the planned explosive charges yield peak particle velocities values of 0.01 to 0.1 inches per second at distances of one-half to one mile. For example, a typical residence will vibrate locally (one room) under the impact of heavy walking, at levels from 0.2 inches per second or less. This form and level of vibration is common to humans in the area. Higher peak particle velocities are predicted at less than one-half mile for some of the heavier charges. Exxon does not intend to exceed 2.0 inches per second peak particle velocity for nearby structures (e.g., 650 feet from the blast site). There is the possibility, however, due to orientation of the orebody that private structures may be as close to the blast site as the Exxon structure being monitored. Thus, there are potential situations where the non-Exxon-owned structures may receive seismic vibrations that are in the unpleasant category, or possibly in the category where cracks in plaster walls may occur. A summary of Bureau of Mines data on the possible damage for various vibration levels is included in Table 3-31.

Table 3-31
Human Responses to Seismic Vibrations

Peak Particle Velocity (inches per second)	Human Response	Comments
0.01	Below human detection	-
0.1	Barely detectable	-
0.2	Detectable	People should be advised of blasting
0.4	Definitely detectable	-
0.6	Disturbing	Rigidly mounted mercury switches may trip out
1	Unpleasant	-
2	Very unpleasant	Safe blasting criterion for residential structures
3		Minor cracking of plaster
4	Intolerable	Minor falling of plaster, heavy cracking of plaster

The approximate nature of the available prediction techniques provide a range over which potential wall cracking would develop, especially when the long-term effects of fatigue enter the picture. Exxon has given some consideration to the use of smaller explosive charges.

Impacts to Structures - Damaging vibrations would not be produced on-site because of designed blasts and monitoring of blast impacts at various charge levels. A safe level of blasting vibrations is 0.75 inch per second for modern homes with gypsum board interiors and 0.5 inch per second for

plaster walls. However, vibration studies indicate on-site structures would probably experience peak particle velocity greater than these limits. The 2.0 inches per second limit set by Exxon may be too high to preclude some wall crack damage developing on-site and to private structures near the mine.

For off-site structures, a firing with 2,930 lb per delay would produce a predicted 0.06-0.07 inch per second peak particle velocity at one-half mile from the blast. Assuming the blast occurred near the exhaust raise, numerous residential structures would be located within the 0.06-0.07 inch per second estimate. Presumably, Exxon would not continue with the blasting if peak particle velocity greater than 2.0 inches per second occurred at the on-site structures. The structures closest to the blast would be subjected to 0.2 inch per second estimated peak particle velocity. If this should occur at a frequency less than 1 hz. (low) damage is possible. It is unlikely that the combination of low frequency vibration at peak particle velocity over 0.2 inch per second would occur. Thus, it is expected that no visible evidence of the blasting would be noticed off-site.

Blasting Effects on Persons - The tolerance of structures to seismic vibrations is usually much higher than human tolerances. For this reason, human response is more important when analyzing the level of seismic vibrations and the potential effects.

If the above estimates for peak particle velocity are utilized at the residences along the north side of Little Sand Lake, persons within one-half and probably one mile of the mine blasting would notice the vibrations. Estimated peak particle velocity of 0.07 inch per second could be expected within one-half mile of a blast for the higher explosive charges.

A level of vibration in the 0.5 inch per second peak particle velocity range is above a suitable level for occasional quarry blasting near residential areas. In other blasting situations, the peak particle velocity at the closest residence was reduced to 0.2 inch per second to keep the level of complaints to a "tolerable level." In that case, approximately four blasts took place over a period of two weeks. Even at 0.2 inch per second for the closest residences, complaints still came in from within one-half mile away from the blast.

There is no damage expected to off-site structures near the proposed mine. The vibrations resulting from the higher levels of blasting during production may cause varying levels of annoyance (from none to severe annoyance) among persons on nearby private property. If blasts would create peak particle velocities near the 0.2 inch per second limit for the off-site structures closest to the mine, the probability for complaints would be very low.

AIR QUALITY IMPACTS

Air Pollution Impacts on Meteorology

Air pollution emissions should cause only very small and localized impacts on meteorology during mine facility construction, operation or closure. Mine air exhaust would be high in humidity, and when the outside air temperature is below 20°F a visible plume may form as water vapor condenses. When the outside air temperature is below 0°F the exhaust raise plume should resemble a plume from a small utility cooling tower. The top of the exhaust vents would be approximately 16 feet above ground level, and on cold days ice or water could form near the exhaust vents. Under the worst case conditions the deposition would be about six gallons per minute of water from each exhaust raise.

Air Pollution Impacts

Construction - Table 3-32 summarizes air quality modeling results for construction activities compared to the national ambient air quality standards. Predicted concentrations would be well below the standards for all pollutants.

Table 3-32
Air Pollution Impacts

Pollutant	Period	National Air Quality Standards		Maximum Concentration Due to Exxon Sources			Total Concentration	
		Primary	Secondary	Const.	Operation	Background	Const.	Operation
TSP	24-hour	260	150	23.5	31.0	77.0	100.5	108.0
	Annual	75	60	7.1	9.3	17.9	25.0	27.2
SO_2	3-hour	No standard	1,300	***	73.7	25.0	***	98.7
	24-hour	365	No standard	***	29.2	25.0	***	54.2
	Annual	80	No standard	1.5	0.1	25.0	26.5	25.1
NO_2	Annual	100	200	0.11	0.17	19.4	19.5	20.6
CO	1-hour	40,000	40,000	***	5205.0	0.0	***	5205.0
	8-hour	10,000	10,000	***	179.0	0.0	***	179.0
Lead	Calendar Quarter	1.5	No standard	***	0.002	0.0	***	0.002

*** No air quality modeling done due to insignificant emission rates.
Abbreviations: TSP (total suspended particulates), SO_2 (sulfur dioxide), NO_2 (nitrous oxide), CO (carbon monoxide).
Concentrations are given in ug/m^3

The open burning of forest residue was not modeled along with other sources. A separate air quality analysis was done to estimate open burning impacts. Under certain meteorological conditions when large amounts of wood wastes would be burned, carbon monoxide and particulate emissions could cause a problem. Permit conditions would restrict the amount and method of residue burning to meet air quality standards. Open burning of wood wastes would be required to be done in an air curtain destructor, which combines a fixed wall, forced air supply, and a pit to reduce smoke output by promoting more complete combustion.

Air pollutants during construction would be primarily soil dust from earth moving operations, exhaust emissions from stationary equipment such as power generators, and dust from the mixing plant and unpaved roads. An additional source would be from trucks hauling waste rock to the storage area. No emissions of toxic metals would be expected during construction since little ore or tailings would be handled. Thus, only small impacts to the environment from air pollutants are expected during construction.

Operations - An air quality analysis for predicting concentrations of criteria pollutants (pollutants with U.S. EPA-established national ambient air quality standards) and eight heavy metals contained in the tailings was conducted. All criteria pollutant concentrations (Table 3-32) would be well below the primary, or health related, air quality standards.

The maximum predicted concentration of mercury in air emissions from the project is 2.4×10^{-6} ug/m^3. Compared to the acceptable concentration (section NR 154.19, Wisconsin Administrative Code) of 1 ug/m^3, the predicted concentration is much lower. The other seven metals have no established air quality standards, but the predicted concentrations are compared to 1% of the threshold limit values (TLV's) in Table 3-33. TLV's are established indoor work place air quality standards. DNR presently uses certain TLV percentages as a rough acceptability guideline when reviewing an air permit application for hazardous air pollutants having no national standards. Concentrations are predicted to be well below 1% of TLV's for all seven pollutants.

Table 3-33
Heavy Metal Concentrations in Air Emissions

Pollutant	% of TLV	Permissible Concentration ug/m^3	Maximum Predicted Conc. for the period ug/m^3
Arsenic	1% - 24 hour	2.0	3.9×10^{-2}
Cadmium	1% - 24 hour	0.5	4.0×10^{-4}
Chromium	1% - 24 hour	0.5	6.5×10^{-3}
Copper	1% - 24 hour	10.0	0.31
Manganese	1% - 1 hour(ceiling)	50	0.02
Nickel	1% - 24 hour	10.0	1.1×10^{-3}
Zinc	1% - 24 hour	50	1.74

In addition to soil dust, tailings dust may impact the area during the operation phase. The fine tailings generated by the milling process would be almost entirely in the silt and clay size range. Under the proposed method of tailings disposal, the tailings surface would remain wet as the slurry drains toward the pool. Fine tailing particles on the beach and inner sideslope, however, may dry and become airborne. Seasonal (quarterly) and annual deposition of nine toxic metals from operations were estimated. The emitted particles would be very small and consequently would remain airborne for long periods and be distributed over large areas. Therefore, metal deposition near the mine would be expected to be very small and below any concentration of concern. Maximum quarterly and annual metal deposition rates are listed in Table 3-34.

Table 3-34
Heavy Metal Deposition from Air Emissions
Maximum Deposition, Off-Site

Pollutant	Quarterly mg/m^2	Annual mg/m^2
Arsenic	1.3×10^{-3}	3.5×10^{-3}
Cadmium	1.4×10^{-5}	3.7×10^{-5}
Chromium	2.2×10^{-5}	5.9×10^{-5}
Copper	2.1×10^{-3}	5.9×10^{-3}
Lead	1.6×10^{-3}	4.4×10^{-3}
Manganese	4.0×10^{-4}	1.1×10^{-3}
Mercury	2.8×10^{-6}	7.6×10^{-6}
Zinc	9.6×10^{-3}	2.8×10^{-2}
Nickel	3.8×10^{-5}	1.0×10^{-4}

The predicted average annual total suspended particle (TSP) concentrations and maximum 24-hour (TSP) concentrations resulting from project operations are shown in Figures 3-13 and 3-14, respectively. These amounts represent the increase the project would add to the existing or background amounts. Figures 3-13 and 3-14 show lines of constant TSP concentrations in the air (isopleths). These isopleths show that project TSP impacts become insignificant beyond two miles from the project boundary.

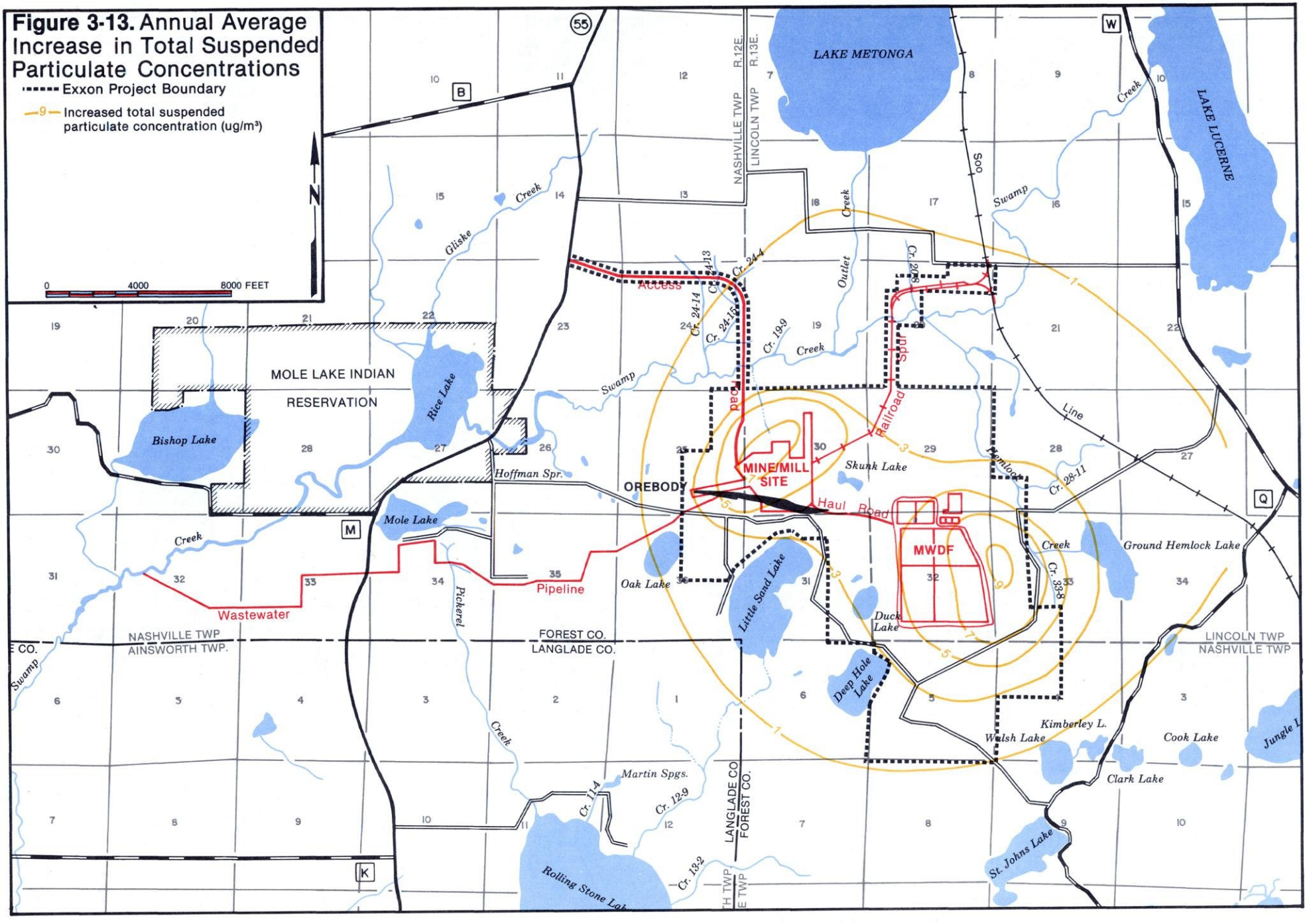
These isopleths were developed using a computer dispersion model with estimated project TSP emissions and weather data. For comparison, TSP monitors previously located at the site recorded background TSP concentrations to be at most 77 ug/m^3 for a 24-hour period, and 17.9 ug/m^3 for an annual period.

The predicted TSP concentrations would raise TSP concentrations at most to levels found in other rural areas of Wisconsin. The maximum total TSP concentrations predicted for the construction and operation phases are similar to the highest concentrations measured in Boulder Junction and Marshfield, Wisconsin in 1984. These concentrations are well below the national ambient air quality standard of 150 ug/m^3. Construction phase isopleth maps were not developed because of the short-term nature of the emissions. Maps for other pollutants were not developed because their predicted impacts are far less than TSP.

Project air pollution emissions should not be visible off the site. TSP is the only visible pollutant. The others are gaseous and invisible. Required air pollution emission controls should keep visible TSP and dust emissions on-site to a minimum.

Topography and wind patterns also would limit the potential impacts of off-site dispersal of tailings or soil particles. The predominant winds during summer are from the west, southwest, and south, while during the winter the northeast is the dominant direction. These wind patterns would tend to minimize potential dust impacts on lakes west of the site.

Risk Analysis - Five of the metals which would be in tailings dust are suspected carcinogens. Table 3-35 summarizes the potential cancer risk at the maximum off-site concentrations using unit risk factors developed by the U.S. EPA Cancer Assessment Group.


Figure 3-13. Annual Average Increase in Total Suspended Particulate Concentrations
Exxon Project Boundary
9 Increased total suspended particulate concentration (ug/m³)
0 4000 8000 FEET
N
LAKE METONGA
LAKE LUCERNE
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Oak Lake
Little Sand Lake
Duck Lake
Deep Hole Lake
Skunk Lake
Ground Hemlock Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Rolling Stone Lake
Martin Spgs.
Hoffman Spr.
Gliske Creek
Swamp
Outlet Creek
Soo Line
Hemlock Creek
Pickerel Creek
Access Road
Railroad Spur
Haul Road
MINE/MILL SITE
OREBODY
MWDF
Pipeline
Wastewater
Cr. 24-13
Cr. 24-14
Cr. 24-15
Cr. 24-4
Cr. 19-9
Cr. 28-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
NASHVILLE TWP
AINSWORTH TWP.
FOREST CO.
LANGLADE CO.
LINCOLN TWP
NASHVILLE TWP
R.12E.
R.13E.

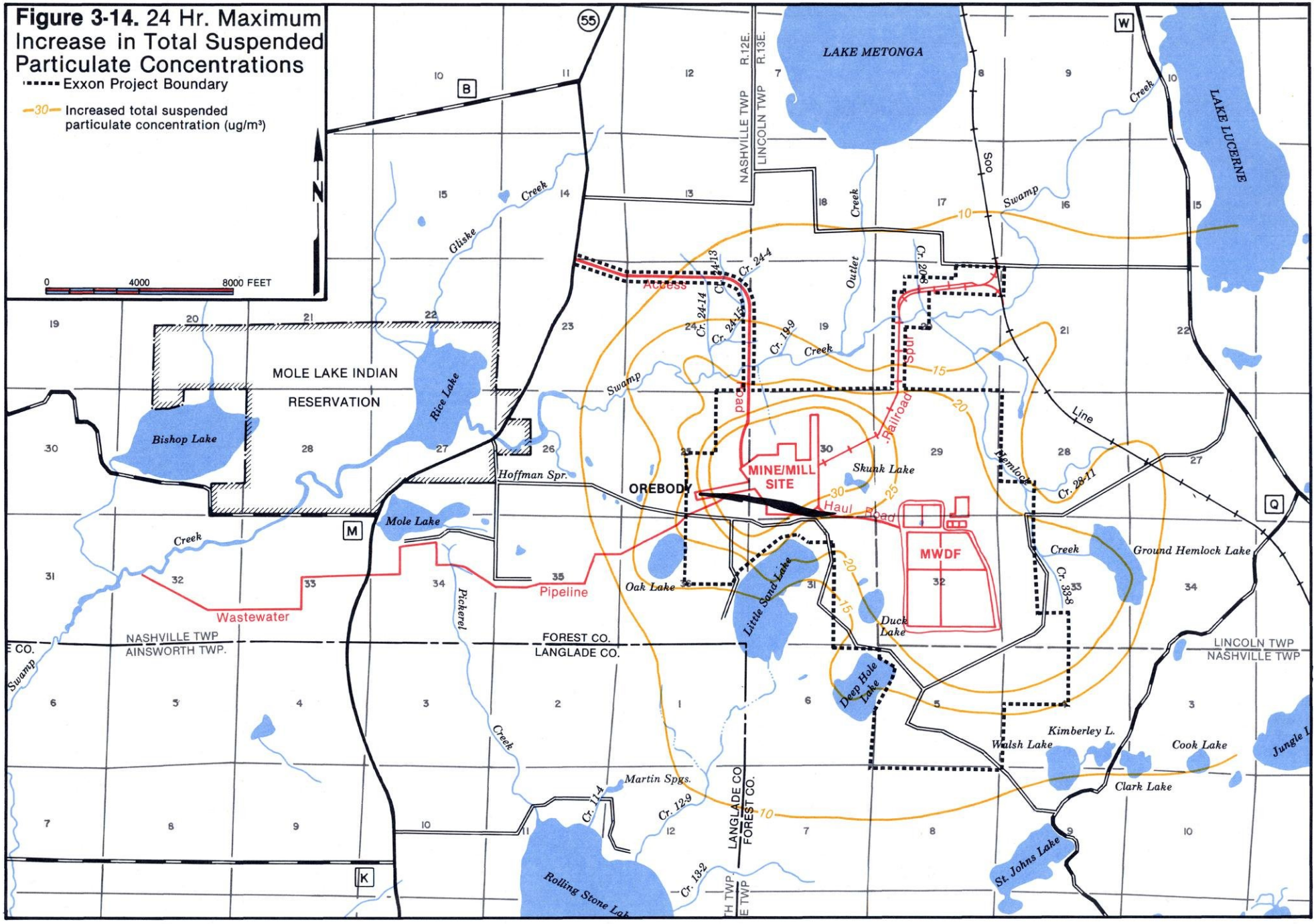

Figure 3-14. 24 Hr. Maximum Increase in Total Suspended Particulate Concentrations
Exxon Project Boundary
30 Increased total suspended particulate concentration (ug/m³)
N
0 4000 8000 FEET
LAKE METONGA
LAKE LUCERNE
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Oak Lake
Little Sand Lake
Deep Hole Lake
Duck Lake
Skunk Lake
Ground Hemlock Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Rolling Stone Lake
Martin Spgs.
Hoffman Spr.
Gliske Creek
Swamp
Outlet
Soo Line
Railroad
Haul Road
Access Road
MINE/MILL SITE
OREBODY
MWDF
Wastewater Pipeline
NASHVILLE TWP
AINSWORTH TWP.
FOREST CO.
LANGLADE CO.
LINCOLN TWP
NASHVILLE TWP
R.12E.
R.13E.
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
10
15
20
25
30
55
W
B
M
Q
K

Table 3-35
Cancer Potential of Heavy Metal Air Emissions

Pollutant	Unit Risk Factor Risk per Concentration [ug/m^3]	Annual Maximum Concentration	Cancer Risk
Arsenic	4.3×10^{-3}	1.1×10^{-3}	4.7×10^{-6}
Cadmium	1.8×10^{-3}	1.2×10^{-5}	2.2×10^{-8}
Chromium	1.2×10^{-2}	1.9×10^{-5}	2.3×10^{-7}
Nickel	4.8×10^{-4}	3.2×10^{-5}	1.5×10^{-8}
Total			5.0×10^{-6}

Risk analysis is presently the most common method used to evaluate the degree of hazard posed by exposure to air pollutants which are known or suspected carcinogens. It is frequently used because actual data on human cancer incidence are not available to show if or at what doses an air pollutant causes cancer in humans. Risk assessments are typically developed by exposing laboratory animals to high doses of a specific compound over a short period of time. The resulting rates at which these animals develop cancer are extrapolated to humans. This extrapolation adjusts for the lower doses humans would be exposed to and differences between the longevity, weight and breathing rate of the lab animal versus humans. This extrapolation of risk assumes that there is no threshold (safe) dose at which cancer would no longer develop.

Unit risk factors are developed from risk assessments. These factors are used to convert an ambient air exposure (to a known or suspected carcinogen) to an anticipated increase in a person's chances or risk of developing cancer due to that exposure. In the Exxon analysis, the unit risk factor was applied to the maximum predicted downwind concentrations of several known or suspected carcinogens. These maximum concentrations were predicted by use of dispersion modeling. They would occur at the project boundary (see Figure 3-13). The risk analysis assumes, then, that a person would be exposed to this maximum concentration for his or her lifetime and would not move to a less contaminated location. This is a conservative assumption since no one lives at the property (model) boundary.

The results of the air analysis indicate the predicted (cancer) risks due to exposure to the maximum predicted downwind concentrations of chromium, cadmium, and nickel were less than 1 in one million (10^{-6}). The predicted arsenic impact is greater than the 1 in one million threshold. However, this is not considered of consequence. The calculation is based on a conservative estimate of wind blown dust from the tailings ponds assuming no controls. Permit conditions would require suppression of tailings pond dust, and that would reduce the predicted arsenic risk well below the 1 in one million threshold.

Federal regulatory agencies have used risk assessments and unit risk factors to set acceptable concentrations of known or suspected carcinogens present in food, water and air. Permissible levels of risk used by these agencies range from 1 in 10,000 (1×10^{-4}) to 1 in one million (1×10^{-6}).

Currently, approximately 20% of deaths in the United States are due to cancer. This means a person's actual chances of eventually dying of cancer are 1 in 5 or 200,000 in one million. Lifetime exposure to a pollutant concentration with an estimated risk of 1 in one million, might increase a person's chances of dying of cancer to 200,001 in one million. Other pollutant exposures would contribute their appropriate levels of risk. It should be noted that the 20% rate is from actual data. The 1 in one million, however, is a conservative estimation.

Closure Air pollutant emissions during this phase would primarily be dust from soil handling and transport on unpaved roads. No metal emissions would be expected during mine closure since little ore or tailings would be handled. No significant air pollution impacts would be expected.

IMPACTS TO THE SOCIOECONOMIC ENVIRONMENT

The socioeconomic impact section includes analyses of impacts to the local study area population, its economic base, housing conditions, government structure and public finance, public facilities and services, sociocultural conditions, and Native American tribes. Much of the socioeconomic analysis was prepared by Denver Research Institute (DRI). Their work followed publication in 1983 by Research and Planning Consultants (Exxon's consultant) of the "Forecast of Future Conditions." That was a detailed, computer-based socioeconomic impact analysis of the proposal. To make DRI's work comparable with the "Forecast of Future Conditions," dollar amounts are stated in 1982 dollars. Many of the tables used in the following section were taken from DRI's "Final Socioeconomic Impact Analysis of Exxon's Proposed Crandon Project" and shortened to show only representative years of the project schedule. More detailed explanations of the methods and assumptions are contained in the Final Socioeconomic Impact Analysis.

The socioeconomic study area (Fig. 2-13) is the area expected to be significantly impacted by mine-related activity. In addition, the townships of Ainsworth, Schoepke, Monico and Laona, for example, which are outside the study area, would be impacted, but not as significantly. The type of impacts expected for these townships could come from one or more of the following sources:

1. Conversion of seasonal cottages to permanent use by mine workers.

2. Development of single family dwellings or mobile home parks along U.S. Highway 8, State Highway 55, and county trunk highways. Public ownership would limit development potential.

3. Increased traffic through the region between Antigo and Rhinelander and the project site. Many inmigrants would be expected to live closer to cities with shopping areas, businesses, and schools.

4. Increased school district costs in Elcho School District (impacting Schoepke, Ainsworth, and other Townships), resulting from an increased population of school children. These costs could be mitigated by the Mining Impact Fund.

5. Increased need for public services such as fire, police, and snow plowing to the extent private development would occur.

6. Increased assessed evaluation in school districts and townships to the extent that private development would occur.

7. Elevated business activity.

All of these impacts, as well as others, could be experienced in these townships, but they are not predicted to cause significant or unmanageable impacts or marketly stress the existing infrastructure of the predominantly rural character of the area. Through zoning and other local controls, townships could have a substantial influence on encouraging or discouraging some impacts.

Uncertainty in Socioeconomic Assessment

Socioeconomic baseline projections and future impact forecasts are subject to a series of uncertainties. Some of them have a compounding effect, with one uncertain forecast dependent on the outcome of other preceding uncertain forecasts. Specific statements as to exactly what would happen in what year in what place should be evaluated with caution, considering the uncertainties which are found throughout the predictions.

Assumptions must be made, therefore, about some of the factors of uncertainty and their outcomes. In other cases, the outcome would depend on which way a decision may be made by various state agencies, by Exxon, by local governmental officials (some of whom are yet to be elected), and by various families concerning where they will live, shop, and where their breadwinners would work.

Uncertain Outcomes

Exxon Decision-Making - If Exxon would receive the necessary permits, Exxon's decision to proceed would depend on the economic feasibility (return on investment) of the mine over its expected life. The return on investment can only be finally determined depending on the capital investment required, including meeting any design changes imposed by the permit conditions or by Exxon. Exxon then would consider anticipated revenues and costs, based on then current and future expected metal prices, and costs of labor, equipment, and materials. The high level of uncertainty here is exemplified by the metal price forecasts for estimating net proceeds tax revenues. The forecast 1986 prices (from forecasts prepared in 1984) are from 27 percent to over 100 percent above the actual September 1986 prices. Exxon would consider current national and international economic conditions and competition and those for the future, and expected markets for its output.

Exxon Coal and Minerals Company then would prepare its recommendation on whether or not to open the mine. If conditions look favorable, the project would be proposed to the parent company for a capital appropriation (in competition with other capital requests from within Exxon and its other subsidiaries). If a favorable decision were given Exxon, project construction could start.

Exxon has indicated it would require about one year from receiving all permits until construction could begin. If a go-ahead decision were made, Exxon would then select its contractor(s). In the past, an important part of such a decision would be selection of a union or a nonunion contractor. A union contractor would hire only through union hiring halls. However, this rigidity is decreasing, and there is a trend toward skilled union journeymen (and apprentices and helpers) working on nonunion construction. Barring a radical change in this trend a significant uncertainty would be whether Exxon and its contractor(s) decide to hire for maximum local representation or for maximum experience and skill. The Wausau-based North Central Wisconsin Building Trades Council alone has the skills called for in the numbers of employees Exxon would need, and mostly living within daily or weekend commuting distance. Green Bay and Eau Claire have similar numbers in their building trades councils. The significant exceptions are the mine development specialists, who would be largely nonlocal in any case.

A similar situation may exist if and when the mine is put into operation and the present Exxon permitting team would be augmented and evolve into the Crandon project operating management team. That latter team would decide the desired mix of local employees or skilled and experienced mining workers. A reservoir of many hundreds of unemployed or underemployed underground miners and mill specialists who presumably would like to have mining jobs live in the Michigan Upper Peninsula.

Another area of uncertainty is the local purchasing policy which would be followed by Exxon's construction management, its contractors, and the eventual operating management. The decision would depend on whether Exxon's policy of competitive bidding is followed strictly or if some concessions are made to in-state or local suppliers. Finally, there is the uncertainty about a temporary or permanent shutdown prior to the scheduled closure of the mine. In addition, there is the possibility of project extension beyond the scheduled mine life.

State Agency Decision-Making - Several state agencies (other than DNR) would have periodic decisions to make which could affect the socioeconomic environment. For instance, the legislature may have to periodically (between now and the beginning of flow from the net proceeds occupational tax) decide whether or not to furnish money from other sources to the Investment and Local Impact Fund.

The Mining Investment and Local Impact Fund Board would have to decide how to allocate limited funds. It may wish to recommend changes in its enabling legislation, e.g., to provide for impact monitoring.

The Department of Transportation would repeatedly (between now and the actual start of construction) have to decide whether to make substantial highway improvements. Highway improvements could be made in anticipation of the project construction, and thus, potentially reduce future traffic congestion in the mine area, or they could be made after traffic volumes had become problematic.

Local Governments - Uncertainties in zoning and land use regulation would affect private investment and settlement patterns of temporary and permanent inmigrants. The prospect of new, large-scale mobile home parks, initially built to house construction workers, is likely. Adoption of mobile home park regulations might reduce public service costs while enhancing the quality of life for the residents. The Township of Elcho recently developed a master plan.

Financing the construction of capital facilities needed wholly or in part because of the development of the mine/mill may prove to be difficult. Criteria for assigning the project sponsor a specific portion of the required capital costs for project-related public facilities do not exist. Moreover, adding public facilities/services in anticipation of the project may forestall unacceptable circumstances but is risky because of uncertainty about inmigrant settlement patterns. In addition, increased operating, maintenance, and equipment costs for local government activities might occur in several jurisdictions affected by the project. Roads, bridges, traffic control, and law enforcement all offer this possibility. A jurisdiction may have to choose between degraded services or increased property taxes unless outside funds are available.

There is uncertainty about the extent to which the project would attract skilled employees away from local public employers. Where high levels of unemployment exist, such as Forest County, project-related vacancies could be filled by local people. On-the-job or more formal training and reduced experience levels, however, would add to local government costs or degrade service for a while.

One of the most significant uncertainties affects the four jurisdictions which would benefit from the large increases in assessed valuation due to project construction. The windfall could be distributed in several ways: (1) major reductions in present property tax rates; (2) major increases in public facilities construction or public services and ancillary equipment, e.g., road maintenance equipment; or (3) some effort by Forest County or the Crandon School District to augment public services in the City of Crandon. The city would not have a direct share of the assessed valuation windfall, but would have some additional demands on its services and amenities if the mine were developed.

The job turnover rate may increase, particularly during the first years of the project, as local residents are hired by the project. If the rate were high (not uncommon among new mines, particularly when employing people without mine experience), there may be substantial turnover in the local labor market.

Individual and Household Decision-Making - The decisions on where to work, where to live, where to shop, and how to get from home to work would cause significant socioeconomic impacts. There is a great level of uncertainty about this decision-making because of the number of people involved and the unknown time factor. Inmigration patterns may be affected by changes in amenity levels within a single community, e.g., the rehabilitation of the Antigo High School or other changes in the amenities offered by other communities.

POPULATION IMPACTS

This section analyzes the potential changes in the local study area population caused by the project. Population impacts are directly related to housing impacts, public facility and service needs, fiscal revenues and costs, as well as social and economic effects of the project. The distribution of the inmigrants influences the allocation of impacts to the various school districts, towns, and cities in the study area.

In order to determine the net population impact of the project, future population growth without the project must be subtracted from the estimated with-project population growth. The forecast used the existing population as input and added annual predictions of inmigration and births while subtracting deaths and outmigration over the duration of the proposed project (3 years construction, 29 years operation, 4 years closure). Rates for the impact predictions are based on 1970-1980 trends.

Population impacts are dependent on project employment needs. Total project employment would include not only the direct jobs at the Exxon project, but the additional or secondary jobs created by increased regional economic activity. The extent to which the local labor pool would supply employees for the project would reduce the amount of inmigrant labor required. Thus, the number and characteristics of the inmigrating workers (and their families) who would obtain construction, operations and indirect or secondary jobs could be used to predict the impact population. By applying a family size factor appropriate to each predicted construction, operations and secondary inmigrant, the total inmigrant population estimate was developed.

Minor changes in the local study area population already have occurred as a result of preconstruction activity. Projections for the local study area population show an initial rapid increase in population peaking in the third year of construction, followed by a sustained growth over the operations period to a population level about 1600 higher than the baseline (without-project).

The projected population in the local study area was divided into three geographical areas: the project area, the Rhinelander area, and the Antigo area. The project area includes the City of Crandon and the Townships of Crandon, Lincoln, Nashville, and Elcho. The Rhinelander area includes the City of Rhinelander, and the Townships of Crescent, Pine Lake, Newbold, and Pelican, and the Antigo area includes the City and Township of Antigo (Fig. 2-13). These three areas are expected to receive more than 75% of the inmigrant population moving into the study area. The remaining inmigrants are expected to be dispersed throughout the balance of Forest, Langlade and Oneida Counties. Table 3-36 shows the population increase and without-project population projections for the project, Rhinelander, and Antigo areas and total local study area.

Table 3-36
Population Projections[1] for With- and Without-Project Scenarios

		Project Area		Rhinelander Area		Antigo Area		Local Study Area[2]	
Project Phase	Year	Without Project	Impact Population Net Increase	Without Project	Impact Population Net Increase	Without Project	Impact Population Net Increase	Without Project	Impact Population Net Increase
Preconstruction	1986	5066	8	18,661	10	10,702	6	53,459	33
Construction	1987	5070	148	18,770	133	10,736	69	53,617	454
Construction	1988	5075	345	18,880	326	10,771	183	53,776	1105
Construction	1989	5079	613	18,992	620	10,806	373	53,935	2076
Operations	1990	5083	395	19,105	493	10,840	380	54,095	1621
Operations	2000	5126	392	20,317	488	11,195	373	55,732	1603
Operations	2010	5170	393	21,687	490	11,563	375	57,437	1608
Operations	2018	5205	375	22,910	467	11,868	366	58,852	1542
Closure	2019	5210	249	23,071	313	11,906	288	59,033	1070
Closure	2020	5214	144	23,234	182	11,945	183	59,214	635
Closure	2021	5219	61	23,400	78	11,984	88	59,396	280
Closure	2022	5223	15	23,567	20	12,023	31	59,578	79

[1] Projections from Denver Research Institute 1986. Only representative years for each phase shown.
[2] Includes Forest, Langlade and Oneida Counties.

In the project area, the net population increase is projected to be more than 600 people by the third year of construction, decreasing to about 400 above the without-project population for the duration of operations. For the Rhinelander area, the comparable population increases are more than 600 and nearly 500 people. The population increase in the Antigo area is predicted to be about 375, during the operations phase. A 5% population increase, the largest increase, would occur in the project area during the third year of construction. All other projected population increases would be 2% or less.

After estimating the number of inmigrants, it was necessary to predict where they would choose to live. Allocation of the population to the various municipalities was based on the different characteristics and perceived preferences of the inmigrant populations (e.g., construction, operations, and secondary workers) and the existing housing and amenities offered by the local study area. For example, most construction workers would be in the area temporarily and would be less likely to bring their families. Therefore, many would accept temporary housing (motel, mobile home, campers), while operations workers, intending to stay in the area for many years, would be more likely to bring their families and choose a single family dwelling. In general, inmigrants would be attracted to the various communities according to their perceived attractiveness, including availability of schools, shopping centers, retail and service establishments, and aesthetic appeal. Commuting distance (and time) from the project also would be important to inmigrants in choosing where to live.

Table 3-37 shows the allocation of inmigrants for the three counties in the analysis.

Table 3-37
Residential Distribution of the Total Project Work Force

	Construction	Operations	Secondary
Forest County	40.0%	32.5%	21.0%
Langlade County	22.5%	26.5%	49.5%
Oneida County	37.5%	41.0%	29.5%

From Denver Research Institute (DRI), 1986.

ECONOMIC IMPACTS

The proposed project would be a source of new employment, personal income, and increased business activity in the study area during the construction and operations period. During the closure phase there would be an obvious decline in project-related employment and secondary economic activity. Exxon's direct project employment during years 1 through 3 of the construction phase would average 321, 723, and 1,228 persons, respectively. These are average annual employment figures and not peak employment.

Employment

The extent to which project jobs are filled by existing study area residents as opposed to inmigrants, particularly out-of-state inmigrants, is very important. Construction of the mine and related surface facilities is anticipated to be performed by two prime contractors and various related subcontractors. Exxon has stated it would encourage prime contractors and all subcontractors to use local labor and services to the maximum extent possible. In addition, criteria would be developed for subcontract awards which would contain a weighting factor for "local content." These preferential bidding policies (if adhered to) could afford existing study area residents some advantage in securing direct project employment.

The estimates of the numbers and types of direct project construction jobs filled by existing study area residents assume employment policies would encourage local hiring. On this basis, about 90 jobs in the first year, 202 jobs in the second year, and 370 jobs in the third year could be filled by existing study area residents. This estimate is conservative and represents about 28 percent of the total construction jobs to be filled by project contractors (Table 3-38).

Table 3-38
Estimates of Locally Hired Contractor Employees During Peak Project Construction

Job Category	Number of Employees[1]	Estimated Number of Locally Hired[2]
Mine Construction		
Pipefitters	5	1
Welders	5	2
Electricians	10	2
Millwrights	10	2
Mechanics	15	5
Equipment operators	10	5
Ironworkers	15	2
Carpenters	10	5
Laborers	15	15
Cement Masons	10	5
Shaft and drift miners/rock drillers	30	5
Hoistmen	10	4
Surveyors	5	1
Supervisors	10	0
Engineers	5	0
	165 Total	54 Total
Surface Facilities Construction		
Boilermakers	70	6
Carpenters	65	20
Electricians	195	8
Laborers	210	210
Operating Engineers	70	10
Millwrights	60	6
Painters	20	20
Pipefitters	160	10
Ironworkers	70	5
Drivers/mechanics/ oilers	70	10
Cement masons/ finishers	5	5
Surveyors (rodmen)	5	4
Supervisors	135	0
Engineers	25	2
	1,165 Total	316 Total

[1] Numbers reflect employment needs within job categories. Due to timing differences, totals may not agree with project employment totals.
[2] Denver Research Institute, 1986.

Exxon would follow a national competitive bidding policy in the procurement of all supplies, services, and equipment. Study area companies that could benefit from construction activities (assuming they successfully compete with state, regional, and national firms) include the following:

Electrical contractors
Plumbing contractors
HVAC contractors (heating, ventilating, and air-conditioning)
Painters
Masons
Welding contractors
Structural steel fabricators
Mobile equipment lease/hire
Haulage contractors
Suppliers of building/construction materials, including electrical and plumbing supplies
General and excavating contractors

Annual employment during the operations phase of the project is expected to average 620 persons per year. Table 3-39 contains the projections of total employment from construction, operations, and secondary sources in the local study area under the impact scenario. Secondary employment is predicted at a level of about one-half of the direct project employment. For every two direct jobs created at the mine/mill by the project, there would be one additional job (310 total) created. Project related employment of over 1,200 employees in the final year of construction and total new employment between 900 and 945 jobs during operations represents 5.5% and about 4% respectively, of the total three county employment.

Table 3-39
Project-Related Employment for Construction
Operations, and Secondary Sources by Year in the Local Study Area[1]

Phase	Year	Direct Employment		Secondary		Study Area
		Construction[2]	Operations	Employment[3]	Total	Total Employment
Construction	1987	205	29	39	273	21,981
Construction	1988	416	131	115	662	22,053
Construction	1989	569	416	246	1,231	22,126
Operations	1990	0	620	325	945	22,200
Operations	1991	0	620	372	992	22,275
Operations	1992	0	620	312	932	22,350
Operations	2000	0	620	314	934	22,972
Operations	2018	0	580	320	899	24,471
Closure	2019	0	325	306	631	24,558
Closure	2020	0	165	211	376	24,645
Closure	2021	0	55	114	169	24,733
Closure	2022	0	1	48	49	24,822

[1] From Denver Research Institute, 1986. Only representative years from each phase of mining are illustrated.
[2] About 50% of the project positions are estimated to be filled by inmigrants.
[3] Some portion of the secondary employment created would be filled by inmigrants.

About 50% or 310 of the operation positions could be filled by existing study area residents. Table 3-40 summarizes estimates of the number of existing study area residents who could gain employment at the mine/mill during operations. These estimates are based on an analysis of unemployment and work force composition in the study area and the specific job skills needed for the project.

Table 3-40
Estimates of Locally Hired Mine/Mill Operations Employees

Job Category	Number of Employees[1]	Estimated Number Locally Hired[2]
Administration		
Secretaries/clerks	17	17
Janitors	7	7
Security	8	8
Accountants	2	1
Warehouse	9	9
Purchasing	2	2
Paramedics	4	2
Employee relations/safety/training	9	3
Public Affairs	2	1
Environmental	5	2
Supervision	8	1
Engineers	4	0
	77 Total	53 Total
Mine Technical		
Supervisors/engineers	6	2
Geologists	3	1
Draftsmen	2	2
Engineers/geology technicians	8	2
Surveyors	5	5
Clerks	2	2
	26 Total	14 Total
Mine Operations		
Secretaries/clerks	4	4
Miners	80	9
Equipment operators	88	48
Laborers	65	65
Supervisors	26	5
Hoistmen	4	2
	267 Total	123 Total
Mine Maintenance		
Equipment mechanics	50	14
Pump/fan mechanics	1	1
Welders	4	2
Electricians	8	7
Maintenance	10	8
Clerks	4	4
Supervisors	9	0
	86 Total	36 Total
Mill Operations		
Secretaries/clerks	2	2
Mill operators	37	28
Laborers	11	8
Supervisors	7	0
	57 Total	38 Total
Mill Technical		
Lab technicians	12	3
Metallurgists/chemists/engineers	7	2
Technicians	2	0
Typists/clerks	1	1
	22 Total	6 Total

Table 3-40 (continued)

Job Category	Number of Employees[1]	Estimated Number Locally Hired[2]
Mill Maintenance		
Supervisors	2	0
Mechanics/oilers	18	10
Welders	4	2
Instrument Repairs	4	0
	28 Total	12 Total
Central Maintenance		
Supervisors	6	1
Machinists	2	0
Electricians	13	3
Mobile equipment maintenance	23	15
Craftsmen	1	1
Welders/fabricators	6	4
Carpenters	1	1
Secretaries/clerks	2	2
Maintenance planners	2	0
Engineers	1	0
	57 Total	27 Total
GRAND TOTAL	620	309

[1] Numbers reflect employment needs within job categories identified in Exxon's revised Environmental Impact Report, 1985. Due to timing differences, totals may not agree with project employment totals.

[2] Denver Research Institute, 1986. The estimated number of locally hired are based on the detailed job descriptions in: U.S. Department of Labor, Employment and Training Administration, Dictionary of Occupational Titles, Fourth Edition, Washington, D.C.: Government Printing Office, 1977. The job descriptions are quite detailed and indicate that substantial mining experience, often underground, is required to qualify for many of the jobs listed. This is particularly true of the mining jobs, many of the technical and managerial jobs, and some of the administrative and maintenance jobs.

Table 3-41 shows without-project employment projections for each county during selected project years and contains the predicted increase in employment by place of residence (county). For each county, maximum employment increases would occur in the third year of construction, followed by a slight reduction during operations. Sustained new employment during operations would be more than 300 jobs in Oneida and Langlade counties and less than 300 in Forest County.

Table 3-41
Employment Projections for With- and Without-Project Scenarios by Year and County[1]

		Forest County		Langlade County		Oneida County	
Phase	Year	Without Project	Net Employment Increase with Project	Without Project	Net Employment Increase with Project	Without Project	Net Employment Increase with Project
Construction	1987	2461	100	8444	73	11,076	100
Construction	1988	2463	233	8458	185	11,132	244
Construction	1989	2465	415	8472	360	11,190	456
Operations	1990	2467	270	8486	325	11,247	350
Operations	2018	2528	255	8906	312	13,037	332
Closure	2019	2530	170	8921	238	13,107	223
Closure	2020	2532	98	8937	148	13,177	130
Closure	2021	2534	42	8952	71	13,247	56
Closure	2022	2537	10	8968	24	13,317	15

[1] From Denver Research Institute, 1986. Only representative years from each phase of mining are shown.

The increased employment should be kept in perspective to its relative effect on the study area economy. The 900 new jobs (both direct and indirect) created by the project would represent about 4 percent of total employment in the three study area counties (Table 3-41). Effects, like strip developments of convenience stores, bars, and other largely transitory businesses may open to serve the mobile and largely transient construction labor force. In addition, the long-term operations workforce may not be sufficient to attract a major new shopping center, department store, or other highly visible commercial enterprise. Local development involves a trade-off between serving the temporary inmigrant population and protecting against inappropriate development by local regulation.

The project would diminish unemployment in an area which has recently experienced rates higher than the state and the U.S. as a whole. The prospect for adding approximately 1,200 jobs during the peak construction year and more than 900 jobs over the sustained operations period is encouraging to those whose employment potential has been curtailed by national economic circumstances.

Wage and Retail Impacts

The project would constitute an important new source of employment in the study area, and at full operational levels would account for about $12 million in disposable annual wage and salary income. Table 3-42 shows the projected effect of new employment on disposable personal income and retail sales for each year of the operations phase within the local study area. New employment directly and indirectly associated with the project would account for additional retail sales in the study area of approximately $4.3 million per year during a typical year of operations, or about 1% of the 1982 retail sales. The project would have a minor impact on retail sales.

Table 3-42
Average Annual Income and Retail Sales Associated with New Employment[1,2]

	Number of Employees	Average[3] Wage/Salary Rate/Hour	Disposable Income ($000s)	Disposable Income, and % Fringe Spent Locally[4] ($000s)	Retail Purchases in Local Study Area ($000s)	Purchases Subject to State Sales Tax ($000s)
Project Operational Employees						
Administration	77	$10.75	$1,159	$1,344	$406	$244
Mine Technical	26	13.50	491	569	172	103
Mine Operations	267	11.00	4,112	4,769	1,441	865
Mine Maintenance	86	12.50	1,505	1,745	527	316
Mill Operations	57	11.25	898	1,041	314	188
Mill Technical	22	12.75	393	455	137	82
Mill Maintenance	28	10.50	412	477	144	86
Central Maintenance	57	10.50	838	972	294	176
TOTALS Project Operations Employees	620		9,808	11,372	3,435	2,060
Secondary Employees (average of operations phase)						
	314	6.05	2,659	3,084	931	558
TOTALS			12,467	14,456	4,366	2,618

1 "New employment" in this table includes direct project and secondary employment.
2 Omitted from this table are components of personal income other than wage and salary income and fringe benefits spent locally.
3 Wage rate is a composite, weighted average compiled from U.S. Bureau of Census data in 1982 dollars.
4 Fringe benefits spent locally are estimated at approximately $2,500 per employee per year for health insurance and other locally obtainable benefits.

Source: From Denver Research Institute, 1986.

Exxon's estimates of potential project expenditures including labor costs within the State of Wisconsin during the 30-month construction period and during each year of operation are about $212 million and $49 million, respectively (Table 1-19).

The secondary affects accompanying increased spending in the study area would be concentrated in the sectors of residential construction, retail trade, FIRE (finance, insurance, and real estate), TCPU (transportation, communications, and public utilities), and other services. The benefits accruing to these sectors due to increased demand for goods and services would be offset by sectors adversely affected because they cannot compete for qualified labor because of the high wage rates offered at the project. For example, in Forest County, the average weekly wage in 1984 was $169.00 for service employees, and $170.00 for forest and wood products employees. In comparison, Exxon employees during the operations phase would make approximately $420.00/week. This differential would have several effects on the regional economy, with the most significant being the potential for employee turnover and wage inflation. However, it is anticipated that, due to the project's relatively small overall impact on study area unemployment, these effects would be concentrated in the immediate vicinity of the project and would be short-lived.

Impacts To Forestry Productivity

Timber Resources - Timber productivity on Exxon-controlled woodlands not scheduled for clearing and facility development would not be affected. A timber management plan drafted by Steigerwaldt Consultant Foresters, Inc., of Tomahawk, Wisconsin, would be followed by Exxon on woodlands not scheduled for development. The only forest impacts are expected on project areas that are developed.

The merchantable timber removed from Exxon-controlled areas and shipped to the wood-using industry is not considered a loss. The loss would occur when annual timber growth would not be allowed to accumulate on the developed area. The potential anticipated timber value loss is shown in Table 3-43.

Table 3-43
Estimated Annual Timber Value Loss in Developed Areas

Forest Type	Acres	Volume Loss/yr/acre Cords	MBF[1]	Stumpage Value Cords	Stumpage Value MBF	Total Stumpage Value
Upland Forest	738	.25	.070	$7.00	$70.00	$4,907
Lowland Forest	46	.20	.0	5.00	0	$ 46
Total	776	--	--	--	--	$4,953

[1] MBF is thousands of board feet.

The total cord equivalent of annual timber growth loss due to cleared and developed areas is 305 cord equivalents. This total contains approximately 198 cords of pulpwood and 53,000 board feet of saw timber.

Timber growth on reclaimed areas would resume as forest succession occurs on the abandoned and reclaimed corridors and other facilities. The only continued timber growth loss would exist on permanent inspection roads such as the one around the perimeter of the MWDF.

Economic Impacts - Table 3-43 indicates a potential annual stumpage loss of about $5,000 which would accrue to Exxon due to land clearing and installation of access corridors and other developed areas. This figure is slightly high because not all of the forested land would be cleared at project initiation. Portions of the MWDF would be cleared at later years, while the borrow area would be cleared following mining during final reclamation. However, over the approximate 30 year period of construction, operation and reclamation, a theoretical $150,000 of stumpage growth would be lost assuming today's prices and continuous demand. An annual loss of 305 cord equivalents of timber growth represents an insignificant amount (.2%) of the annual total county harvest, which in 1981 was about 147,000 cord equivalents.

Waste Disposal Fees

As required by state law, the operator of an approved waste disposal site must pay a fee to the state for each ton of waste disposed. The annual fee varies between .1 cent and 15 cents per ton of waste. Fees would be paid to the Waste Management, Groundwater, and Environmental Repair Funds for wastes disposed in the mine waste disposal facility (MWDF) and the on-site landfill (MRDF) during the life of the mine.

Table 3-44 contains the approximate amounts which would be paid based on the projected quantities of wastes and the current fee schedule for the project duration. The types of wastes include tailings, sludges, salt cake, waste rock, and reclaim pond sediment disposed in the MWDF and refuse in the MRDF. The total amount would be about $704,000.

Table 3-44
Projected Waste Disposal Fees

	Estimated Tons	Waste Management Fund[1]	Groundwater Fund	Environmental Repair Fund
MWDF	30,131,000	$85,300	$301,300	$301,300
MRDF	51,000	$ 3,200	$ 5,100	$ 7,700
		$88,500	$306,400	$309,000

[1] Includes 25% surcharge

HOUSING IMPACTS

According to the housing vacancy data available in 1980 and confirmed by direct observation, the amount of available housing in the local study area appears to be substantial. A relatively high volume of the housing stock, however, is considered to be substandard. Available housing may not meet the needs of the expected inmigrants. During the construction phase, a maximum of approximately 800 temporary housing units would be needed for the construction and secondary workers in the local study area (Table 3-45). This need could be met by a mix of existing housing vacancies (mobile homes, motel or lodge rooms, or seasonal conversions) and new construction (single family or multiple family dwellings and new mobile homes). A significant portion of the housing demand at peak construction employment could be met by temporary housing supply, such as mobile homes, trailers, and recreational vehicles.

During the changeover to operations employees, there would be a slight decrease in housing demand. About 480 housing units would be needed in the local study area for the operations staff. Operations workers would likely select a different mix of housing, with emphasis on single family dwellings, either from the existing supply or from new construction.

Housing supply could be augmented by conversion of second homes to primary residences during periods of high demand, and reconverted to second homes (i.e., withdrawn from "supply") after demand has peaked. In general, projections of housing needs indicate: (1) demand would be greatest in the townships surrounding Rhinelander; (2) moderate growth would occur around Antigo; and (3) the project would stem a baseline out-migration trend (and associated decline in housing demand) in the Crandon area as well as in Rhinelander.

Table 3-45
Housing Forecast by County

Phase	Year	Forest County Without Project	Forest County Projected Increase	Langlade County Without Project	Langlade County Projected Increase	Oneida County Without Project	Oneida County Projected Increase	3 County Total Increase
Construction	1987	2825	76	7003	51	9287	74	201
Construction	1988	2826	170	7014	122	9333	173	465
Construction	1989	2828	284	7025	220	9378	301	805
Operations	1990	2829	139	7036	162	9424	180	481
Operations	1991	2831	144	7047	173	9470	187	504
Operations	2018	2872	132	7347	156	10,797	171	459
Closure	2019	2873	87	7358	116	10,849	114	317
Closure	2020	2875	49	7370	71	10,902	65	185
Closure	2021	2876	21	7381	34	10,955	17	82
Closure	2022	2878	5	7392	11	11,008	6	22

Source: From Denver Research Institute, 1986. Only representative years shown.

IMPACTS TO PUBLIC FINANCE

IMPACTS OF INCREASED PUBLIC COSTS TO MUNICIPALITIES

Public Services and Facilities Costs - Estimates of future public costs in the study area shown in Tables 3-46 and 3-47 assume the maintenance of current standards. Public costs, however, would be greatly influenced by the standards of facility use and service levels expected by the future population. The increased costs were determined by multiplying the projected population increase by the public cost standards (Table 2-29). Approximately $90 million of total additional costs, including school district costs, would result over the life of the project. During the construction period, the costs would total approximately $7 million, with a $3.3 million increment occurring during the third year of construction. The sustained annual increase in public costs over the operations period would be approximately $2.8 million.

The $90 million figure is not a forecast of additional public outlays or spending. This figure represents the theoretical cost of maintaining the existing quality of public services and capacity of public facilities for the duration of the project.

The total projected increase in public services and facility costs over the project duration would be about $33 million for the municipalities listed in Tables 3-46 and 3-47. The four municipalities with increases of nearly $6 million or more include Forest, Langlade and Oneida Counties and the City of Antigo. Four municipalities have predicted increases of between $.8 and $1.2 million. They are the Cities of Crandon and Rhinelander and the Townships of Lincoln and Nashville. The higher predicted public service costs are primarily related to the estimated inmigrant population projected to settle in those municipalities and require services.

Table 3-46
Projected Increase In Public Facility and Services Costs
in Langlade and Forest Counties
(Thousands of 1982 Dollars)

Phase	Year	Forest Co.	Crandon City	Crandon Twnshp.	Lincoln Twnshp.	Nashville Twnshp.	Langlade Co.	Antigo City	Antigo Twnshp.	Elcho Twnshp.
Preconstruct.	1986	5	1	0	1	1	4	3	0	0
Construction	1987	86	11	1	12	13	48	34	1	3
Construction	1988	202	27	2	28	30	121	91	2	8
Construction	1989	363	50	5	48	51	237	184	5	14
Operations	1990	240	40	3	25	28	231	201	6	11
Operations	2010	241	40	3	25	28	214	183	5	10
Operations	2017	229	38	3	24	26	207	179	5	10
Operations	2018	151	27	2	14	16	156	140	4	7
Closure	2019	87	17	1	7	9	97	89	3	5
Closure	2020	36	8	0	3	3	46	43	1	2
Closure	2021	9	2	0	0	0	15	15	0	1
Closure	2022	2	1	0	0	0	3	3	0	0
Totals		7,900	1,284	98	837	933	6,917	5,919	162	331

Source: From Denver Research Institute, 1986. Only representative years shown.

Table 3-47
Projected Increase in Public Facility and Services Costs in Oneida County
(Thousands of 1982 Dollars)

Phase	Year	Oneida County	Crescent Township	Newbold Township	Pelican Township	Pine Lake Township	Rhinelander
Preconstruction	1986	0	0	0	0	0	0
Construction	1987	4	0	0	0	0	1
Construction	1988	54	1	2	3	2	21
Construction	1989	132	2	6	7	6	47
Operations	1990	196	4	10	14	11	33
Operations	2010	194	4	9	14	11	32
Operations	2017	195	4	9	14	11	32
Operations	2018	185	4	9	13	10	31
Closure	2019	124	3	6	9	7	23
Closure	2020	72	2	3	5	4	14
Closure	2021	30	1	1	2	2	7
Closure	2022	8	0	0	0	0	2
Totals		6,311	132	292	447	352	1,121

Source: From Denver Research Institute, 1986. Only representative years shown.

These cost projections represent impacts based on current local standards. Additional facility and service costs would be incurred, particularly when the project was exerting its peak impacts. These costs may or may not be fully attributable to the project in an accounting sense. The assessed valuation of the local study area municipalities would increase as the project was developed, thus offsetting some of the project-related costs. These new property tax revenues would come from improved properties, new residential building developments, and secondary business development.

Over the life of the proposed project, increases and additions to assessed valuations throughout the study area would provide a base for local property tax revenue that would offset a significant proportion of the approximately $90 million in increased public costs. This assessment is predicated on the assumption of uninterrupted operations and assumes further than predicted employment, population changes and economic activity would conform closely to actual study area conditions throughout the project.

School District Costs - Table 3-48 contains projections of increased school district costs estimated for the four local school districts. Increased cost projections were based on the existing cost per student multiplied by the estimated number of students who would reside within each district resulting from the increased population. Estimated increased costs to the four school districts for the project duration would be about $57 million (1982 dollars).

The estimated increased costs to school districts are based on the same per student standards applying to the impact scenario as existed prior to the project. However, the estimated increased costs do not reflect actual out-of-pocket increases, because additional residential and business development within each district would increase the assessed valuation and provide additional district revenue. The system of state school aids also would help offset revenue needs.

Table 3-48
Projected Increases in School District Costs Caused by the Project
(Thousands of 1982 Dollars)

Mine Phase	Year	District: Crandon	Elcho	Antigo	Rhinelander
Construction	1987	178	30	114	141
Construction	1988	429	71	294	344
Construction	1989	801	130	587	654
Operations	1990	600	96	562	516
Operations	1991	622	101	603	536
Operations	1992	594	95	551	510
Operations	2017	598	96	557	513
Operations	2018	569	92	539	489
Closure	2019	378	66	412	329
Closure	2020	218	40	258	191
Closure	2021	92	18	122	82
Closure	2022	23	5	41	21
Total		$19,427	$3,124	$17,954	$16,621

Source: From Denver Research Institute, 1986. Only representative years shown.

PUBLIC REVENUES RESULTING FROM THE PROJECT

Impacts to Project Area Assessments - The assessed valuation of the Townships of Lincoln and Nashville, Forest County, and the Crandon School District would increase as a result of the construction of the mine/mill. Table 3-49 shows the anticipated increases in assessed valuation for the four taxing jurisdictions by comparing the 1984 equalized values to the estimated increases. The proposed project would more than double Forest County's equalized valuation by the fourth year of development. The equalized valuation would decrease gradually throughout the operations period. In the final year of operation, the project would provide an estimated 211 million dollars of increased valuation in the county. The project would increase the Crandon school district's equalized valuation 179% above the 1984 amount.

The impact of mine/mill development on assessed valuations for Nashville and Lincoln Townships would offer a pronounced contrast because most of the development would be in Lincoln Township. Approximately 2% of the total assessed project valuation would be in Nashville during the first five project years. This percentage would increase to 4% between project years 6-15, and level off at 7% for the duration of the project. During the first five years of the project, Nashville's assessed valuation would increase a maximum of $5.5 million, or about 14%. In Lincoln Township, however, project development by project year four would increase assessed valuation by a factor of eight. Following closure of the mine/mill and site reclamation, there would be a commensurate reduction in assessed valuation in the four municipalities due to the absence of the mine/mill.

Table 3-49
Anticipated Increases in Assessed Value from Project Development by Municipality[1]

Phase	Year	Forest County	Crandon School District[2]	Lincoln Township	Nashville Township
Equalized Value[3]	1984	$246.7	$153.4	$ 33.0	$40.5
Anticipated Increases in Assessed Value Due To Project[4]					
Construction	1988	0.0	0.0	0.0	0.0
Construction	1989	47.0	47.0	46.1	0.9
Construction	1990	143.0	143.0	140.1	2.9
Operations	1991	275.0	275.0	269.5	5.5
Operations	1994	267.5	267.5	256.8	10.7
Operations	1997	260.0	260.0	249.6	10.4
Operations	2000	252.5	252.5	242.4	10.1
Operations	2003	245.5	245.5	228.3	17.2
Operations	2006	238.0	238.0	221.3	16.7
Operations	2009	230.5	230.5	214.4	16.1
Operations	2012	223.0	223.0	207.4	15.6
Operations	2015	217.0	217.0	201.8	15.2
Operations	2018	211.0	211.0	196.2	14.8
Closure	2020	130.5	130.5	121.4	9.1
Closure	2021	26.0	26.0	24.2	1.8
Closure	2022	0.0	0.0	0.0	0.0

1 From Exxon Minerals Company, 1986; selected years shown.
2 Crandon School District includes the Townships of Lincoln, Nashville, Crandon, Hiles and Argonne.
3 In millions of 1984 dollars.
4 Expressed in millions of 1985 dollars.

In addition to the increased valuations in local municipalities from the proposed mine and mill, there would be varying increases in the assessed valuation and property tax revenue receipts in each of the local study area jurisdictions in which new direct and/or secondary employees and related population choose to reside. These increases in assessed valuation and revenue would result from new residential, commercial, and industrial property or improvements in existing property.

Impact on Tax Rates for Local Jurisdictions - As with other socioeconomic effects of the project, most of the fiscal impacts would be experienced in the project area, the Antigo area, and the Rhinelander area. Proportionately, the greatest impacts would be experienced in the project area (Townships of Nashville, Lincoln, and Elcho, the City of Crandon, the Crandon and Elcho school districts, and Forest County). In Forest County, the Crandon School District, the Township of Lincoln, and the Township of Nashville, the primary fiscal problem would be the lag between public costs (particularly during the construction years) and the collection of increased property taxes on the project-related improvements. Without state or some other impact assistance, tax rates in these jurisdictions probably would rise substantially during the first two years of construction. When the mine/mill becomes taxable property, however, the significant increase in valuation would result in substantial reductions in property tax rates for persons living in the Township of Lincoln, Forest County, and the Crandon School district, with a smaller reduction in the Township of Nashville.

For jurisdictions which experience project-related impacts but do not share in the project property windfall, the fiscal situation would be more problematic. As an example, the town of Elcho, located within Langlade County, and the Elcho School District are expected to experience impacts from the project, but these jurisdictions would not contain project properties subject to taxation. They must rely instead on increased taxation of other residential, commercial, and manufacturing properties within their borders. While no new capital facilities are projected for these jurisdictions, a disproportionate growth in public operations and maintenance costs relative to the growth in revenue would very likely cause a short-term rise in the Elcho and Elcho School District tax rates. As with project-related property, a tax collection lag exists among other types of property as well. When a new population arrives in a community, causing pressure on existing public facilities and services, their presence is not felt in property tax revenues until their property is valued and assessed and

property taxes are levied and collected. However, unlike jurisdictions in the project area, no property valuation "windfall" is foreseen for the other settlement areas.

A recent study of the project's fiscal impacts was conducted for Lincoln Township by a consultant. In order to conduct a worst case impact scenario for the town's tax rate, he developed a computer model which included five variables of potential significance to the town. The model recalculated town taxes based on changes in the expected proportion of immigrant workers, per capita spending, amount of non-tax revenues, immigrant family size, and capital improvements. The model did not include the annual $100,000 construction period payments the township would receive.

Preliminary model results were projected for the last year of construction, a year when the township could experience a substantial population increase and when the project would not be on the tax roll. The worst case situation could result in a township tax increase of 192%, or the equivalent of $85 to the owner of property assessed at $50,000. With the availability of the construction period payments, however, and if it were used to offset a tax increase, it is possible that taxes during the final year of construction in the Township of Lincoln would not increase. Once the construction period would be completed, township tax rates are expected to fall by two-thirds. Township tax payers would then pay reduced tax rates for the lifetime of the project. The tax reduction would represent a savings of at least $30 annually to the owner of a $50,000 property.

Property Tax Payments to Local Municipalities - Exxon's proposed development of the mine and mill would increase assessed valuations in the four municipalities as indicated on Table 3-49. As a result, for the duration of the project, Exxon would pay taxes to those municipalities and the VTAE District based on its proportion of the total assessed valuation in each of these municipalities. An analysis of Exxon's hypothetical tax payments was made by Research & Planning Consultants, Inc., (Forecast of Future Conditions, 1983). That study used actual 1981 property value and tax levy information and assumed addition of the mine and mill to the tax levy at its maximum value to determine the amount of taxes paid to the four municipalities. The following estimates of tax payments are based on these same data, corrected by more recent predictions of assessed valuations shown on Table 3-49.

Table 3-50 indicates the actual 1981 equalized valuation for the five municipalities increased by the estimated assessed value of the facility. Since the assessed value would change during project operations, an average value was used. Table 3-51 shows the actual tax levies for the same municipalities, indicating which municipalities would loose state aids as a result of the project (levy adjustments), and what the total levy with the project would have been. Also shown are the hypothetical tax rates based on the revised levies and increased valuation. Table 3-52 indicates the hypothetical tax contribution under these fiscal conditions that the project would have paid to local municipalities.

These calculations are somewhat over-simplified in assuming that tax levies in the municipalities would not need to be increased with project development. In reality, project develoment would result in increased levies by municipalities as predicted in previous sections. The second simplifying assumption is that no contributions are made to assessed valuations from newly built private homes and industrial sources. These two assumptions counterbalance each other, however, because increased tax levies would be offset by an expanded tax base to pay for them.

From these calculations, Exxon would pay approximately $1.89 million dollars in local taxes annually. Despite the hypothetical nature of the estimated tax payments, they do indicate the approximate, relative, contribution the project would pay to local municipalities in property taxes. These would be paid from late construction through operations until the facility would be dismantled during closure, a duration of about 30 years as proposed.

Table 3-50
1981 Actual and Hypothetical Equalized Valuations[1]

	1981 Actual Equalized Valuations (Without-project)	Projected Increase in Average Assessed Value[2]	Hypothetical Total Equalized Valuation (With-project)
Forest County	235.5	215.7	451.2
Township of Lincoln	31.9	203.9	235.8
Township of Nashville	39.2[3]	11.7	50.9
Crandon School District	143.2	215.7	358.9
Nicolet VTAE District	2,765.1	215.7	2,980.8

[1] Expressed in millions of 1982 dollars
[2] Average during project operations from Table 3-49 deflated to 1982 dollars (millions).
[3] Approximate

Table 3-51
Actual and Hypothetical 1981 Tax Levies

	1981 Unadjusted Tax Levy (Without-project)	Levy Adjustments[1]	Total Levy	Hypothetical Tax Rate (Mill)[2] (With-project)
Forest County	612,806	120,000	732,800	.00162
Township of Lincoln	30,012	-	30,012	.00013
Township of Nashville	60,000	-	60,000	.00118
Crandon School District	1,150,043	886,800	2,036,843	.00568
Nicolet VTAE District	3,766,622	51,000	3,817,622	.00128

[1] Adjustments from loss of state aids due to project.
[2] Calculated by dividing total levy required by total assessed value.

Table 3-52
Hypothetical Project Tax Contributions to Local Municipalities

	1981 Hypothetical Tax Rate[1]	1981 Projected Increase In Average Assessed Value[2]	Exxon's Hypothetical 1981 Taxes
Forest County	.00162	215.7	349,000
Township of Lincoln	.00013	203.9	27,000
Township of Nashville	.00118	11.7	14,000
Crandon School District	.00568	215.7	1,225,000
Nicolet VTAE District	.00128	215.7	276,000
Total			$1,891,000

[1] From Table 3-51
[2] From Table 3-50 in millions of 1982 dollars

Corporate Income Tax - The state of Wisconsin may receive corporate income tax revenue estimated at $91 million (1982 dollars, $101 million in 1985 dollars) based on income from project mining and milling operations. This estimate was made by the Department of Revenue as part of their net proceeds tax calculations, and the assumptions are stated in that section.

An important assumption used in estimating corporate taxes was that the Crandon mine would be operated on a "stand alone" basis. That is, Exxon would conduct mining in Wisconsin through a business separately incorporated from the parent company. If this were true, corporate tax due the state would be based only on Wisconsin operations.

However, if Exxon chose to operate the project under its own corporate umbrella, the mine's state income tax liability could vary from the amount due on a "stand alone" basis. This is because the mine's income or loss would be calculated together with the parent company's, and losses or gains

elsewhere would be combined with losses or gains in Wisconsin. While the choice in accounting is up to Exxon for corporate tax purposes, this is not the case with net proceeds tax, which is calculated only on Wisconsin mining activities.

Net Proceeds Tax Estimates - The state of Wisconsin and certain local study area jurisdictions could receive revenue derived from Exxon's net proceeds tax payments to the state. The estimates of net proceeds tax revenues developed by the Wisconsin Department of Revenue are based on a 1984 forecast of metals prices (zinc, copper, gold, lead, and silver) with the following underlying assumptions. First, the mine is assumed to operate continuously with no slowdowns or interruptions. Second, the mine is assumed to extract, on the average, 7,700 tons of ore per day, beginning with the massive (zinc-rich) and ending with the stringer (copper-rich) ore. Third, extracting, processing, and mine operating costs are assumed to be those cited in a July 1985 study of the Crandon project undertaken for Exxon by the mining engineering firm of Pincock, Allen, Holt, Inc. Fourth, assumed transportation costs for concentrates, mine investment outlays, mine life of 29 years and a 30-month construction schedule, and data on ore grades provided by Exxon would be actual.

The Mining Investment and Local Impact Fund would receive 60% of the estimated $118 million net proceeds tax payments, or about $71 million. Approximately one-third of this amount would be used to make the mandated first dollar payments to local municipalities, while the remainder presumably could be used as discretionary funding to mitigate the negative impacts of mining in the region. Table 3-53 shows the net proceeds taxes paid by Exxon depending on metals prices. The amount of net proceeds taxes paid would depend on mine profitability, which is directly related to the price of metals. Obviously, changes in metals prices, or changes in any of the assumptions used to calculate net proceeds tax would change the estimates. Table 3-53 also includes the construction period payments which would be paid by Exxon to the Mining Investment and Local Impact Fund.

In the base case scenario (metals prices 100% of predicted) net proceeds taxes would be paid in the first year following construction ($1.30 million), and in the second year, $5.31 million would be paid. Sixty percent of each of these would be transferred to the Mining Impact Fund. These amounts, combined with the continuing construction period payments, would be sufficient to pay the first dollar payments to the five municipalities each year and pay Forest County the additional amount due. After the second year of operations, the $5.31 million also would be sufficient to repay most of the State of Wisconsin loan to the Mining Impact Fund if that had a higher priority than reducing Exxon's total credit for construction period payments. By the following year, 1993, when an estimated $6.32 million in net proceeds tax would be paid, there would be, for the first time, a large amount of money available for discretionary use by the Mining Impact Board in mitigating negative impacts. This money could be available for jurisdictions with mining-related costs that had not benefited from the project's increased assessed valuations or received construction period payments. Included are numerous townships near the project area (e.g., Ainsworth, Elcho, Monico, Schoepke, etc.); the Rhinelander and Antigo areas; the Antigo, Rhinelander and Elcho school districts; and Oneida and Langlade counties.

During the stringer ore phase of the project, anticipated net proceeds tax revenues would decline substantially for a period of eight years and then increase to slightly more than $1 million for three years. This might not pose a problem because the net proceeds tax collected between 1993 and 2006 would average over $6 million per year.

For metals prices at 80% of the predicted scenario (Table 3-53), during construction and the first three years of operation, there would be payment only of the mandated construction period payments. Not until 1995 would there be sufficient net proceeds tax to pay back the state loan, provide for first dollar payments, or allow the Mining Impact Board to distribute discretionary money to mitigate negative impacts of mining. The 80% level of metals prices is close to the September 1986 price level for zinc and gold. Later in operations (2007-2012), there would be a period of six years when no net proceeds tax would be paid, and during the final thirteen years (during copper-rich ore mining phase), there would not be sufficient net proceeds tax during any year to pay the entire first dollar payments. Under these circumstances, municipalities might have to absorb any mining-related costs. For the stringer ore phase of the project, under the 80% scenario, an interrupted or terminated schedule may have a greater probability than continued operation.

During mining, 40% of all the net proceeds tax would be paid into the Badger Fund. This would amount to an estimated $45 million over the project duration ($14 million after project year 10) if

metals prices were at 100% of those predicted. Currently, no distribution of the principal in the Badger Fund has been established by the Legislature.

About 60% of the gross value of the ore would be derived from zinc, assuming metal prices (Table 3-54) would be as predicted by Chase Econometrics, Inc. Copper would account for about 25% of the total gross value, while the remaining 15% would come from silver, gold and lead in that order. The bulk of the zinc would be produced in the first phase of mining, while the bulk of the copper would be mined in the second phase. The relatively low value of copper is shown by the substantially reduced net proceeds tax estimates for the second mining phase. For the other four estimates of net proceeds tax collections, the metals prices listed in Table 3-53 were varied between 80% and 120% of the base case estimates. Clearly, the price of metals is the primary factor in determining net proceeds tax, which is an indicator of profitability.

Table 3-54 also illustrates the disparity between metals prices predictions for 1990 and beyond, with today's metals prices, particularly for zinc. Zinc prices would have to increase by 27% (from $.44 to .56 per pound) to reach the base case scenario. However, zinc prices can change rapidly, as illustrated by its 26% increase from $.35 to $.44 cents per pound in the summer of 1986. The actual and anticipated price of metals would be a key determinant in the decision to begin mine construction as well as in later profitability.

Two other factors, construction costs and operations costs, would affect the potential profitability of the proposed mine. Construction costs paid by Exxon would have little direct effect on the net proceeds taxes because construction costs are not used in calculating the tax. Construction costs, however, would affect the rate of return on investment, a critical factor influencing the decision to proceed with the project.

Operations costs would have a direct effect on the net proceeds tax collections. For example, if operations costs were 15% greater than anticipated, net proceeds tax collections would decrease about 19%, and if operations costs fell 5%, net proceeds taxes would increase by 6%. Operating costs and construction costs are readily predictable, in comparison to metal prices. Thus, they were not varied in the net proceeds tax estimates.

Table 3-53

Estimates of Net Proceeds Tax and Mining Impact Board Payments by Year[1]

Estimates Based on Metals Prices as a Percentage of Predicted Values[2]

Year[3]	80 Percent	90 Percent	100 Percent	110 Percent	120 Percent
1987	.000	.000	.00	.000	.000
1988	.72	.72	.72	.72	.72
1989	.71	.71	.71	.71	.71
1990	.70	.70	.70	.70	.70
1991	.45	.45	1.30	3.98	6.94
1992	.45	1.49	5.31	7.85	10.40
1993	.45	3.70	6.32	8.64	10.61
1994	.48	4.13	6.06	7.23	8.20
1995	6.48	8.32	9.39	9.21	10.70
1996	5.40	6.01	7.18	8.85	10.51
2006	3.26	4.76	6.27	7.78	9.28
2007	.00	.06	.27	.67	1.19
2008	.00	.13	.44	.92	1.46
2009	.00	.15	.51	1.03	1.59
2010	.00	.17	.55	1.09	1.73
2011	.00	.13	.47	.98	1.60
2012	.00	.00	.16	.54	1.10
2013	.06	.24	.66	1.26	1.89
2014	.08	.33	.81	1.44	2.08
2015	.14	.51	1.08	1.71	2.38
2016	.18	.61	1.20	1.85	2.55
2017	.26	.73	1.33	2.00	2.72
2018	.00	.00	.09	.20	.41
TOTAL	58.27	86.62	118.42	151.54	186.93

[1] In millions of 1985 dollars. From Wisconsin Department of Revenue, 1986.

[2] Estimates for 1988-1993 include construction period payments which would be paid by Exxon.

[3] Years 1988-90 would be construction. Only selected years shown.

Table 3-54
Metals Prices Used in Net Proceeds Tax Estimates in 1985 Dollars[1] and Current Metals Prices

Year[3]	Zinc	Copper	Silver	Gold	Lead
Projected Prices[2]					
1990	.56	.85	12.71	444	.36
1991	.52	.83	11.68	409	.33
1992	.54	.86	12.60	441	.34
1993	.56	.96	12.45	436	.36
1994	.56	1.00	13.04	456	.38
1995	.55	1.09	12.91	452	.35
2000	.55	1.16	13.02	455	.39
2005	.56	1.24	13.30	466	.41
2010	.56	1.35	13.60	476	.46
2015	.56	1.47	13.89	486	.46
2018	.56	1.55	14.06	492	.47
Current Prices[4]					
1986	.44	.60-.66	5.62	411	.23

1 From 1984 Chase Econometrics estimates. Prices inflated to 1985 dollars by Department of Revenue.
2 Zinc, copper, and lead in dollars per pound; silver and gold in dollars per Troy ounce.
3 Representative years used to show trends. All years would be during the mining operations phase.
4 Current prices for September 9, 1986.

Mining Impact Board Payments to Municipalities - Table 3-55 shows the amounts, timing and recipients of payments from the Mining Investment and Local Impact Fund. Payments by the Board are made only to municipalities and tribes, not individuals. Permit period payments already have been made. Construction period payments would begin following initiation of construction by Exxon. First dollar payments, dependent on mining profitability, could begin as early as project year 4, although more likely would begin in project year 5 or later depending on metals prices. The Townships of Nashville and Lincoln and the two Native American tribes could receive up to $3 million each through the project duration if the project were initiated and the metals prices were as predicted. Under similar conditions, Forest County could receive up to $11.7 million for mining-related impacts.

Table 3-55
Mining Impact Fund Payments to Municipalities[1]

Municipality	Permit Period Payments 1983-86	Construction Period Payments for Project Year[2] 1 2 3 4-6	First Dollar Payments Project Year[3] 4-31
Nashville Township	4	1 1 1 1 each year	1 each year
Lincoln Township	4	1 1 1 1 each year	1 each year
Sokaogon Chippewa	4	1 1 1 1 each year	1 each year
Forest Co. Potawatomi	4	1 1 1 1 each year	1 each year
Forest County[4]	0	3 3 3 0	1 + 2.5 each[5] year

1 Numbers indicate mandated payments to municipalities in $100,000 increments which would be adjusted annually for inflation. Discretionary funds also could be available to these and other municipalities based on fund availability and mining-related impacts.
2 The anticipated construction period is 30 months; however, construction period payments can be made for up to 3 years after concentrate production begins.
3 First dollar payments are dependent upon Exxon paying net proceeds tax to the state, 60% of which goes to the Mining Impact Fund. Net proceeds tax payment depends on profitability of mining, and is not expected to be paid immediately.
4 Construction period payments are up to $300,000 annually reduced by any taxes paid to the county by Exxon on improvements to the land.
5 Forest County is eligible to receive an additional $250,000 annually if sufficient net proceeds taxes are paid.

Sales Tax Revenues - Consumer purchases subject to sales tax were estimated on the basis of earlier calculations relating to personal income and consumption. Total state sales tax revenue from increased personal consumption during the project operation phase is estimated at $150,000 per year, or $4.35 million for the project duration.

IMPACTS TO PUBLIC SERVICES AND FACILITIES

This section provides additional discussion of public service and facility requirements and certain nonmonetary effects of the project. The costs associated with the new public facilities and services identified here would be above and beyond jurisdiction costs shown earlier.

Under the impact scenario, Forest County is the only jurisdiction requiring a new capital facility. An updated sheriff's department, particularly a new jail is projected. This deficiency could likely be tolerated under the without-project scenario, but poses approximately $1 million in additional costs under the impact scenario. The Forest County Sheriff's Department also would require between $500,000 and $800,000 per year for additional vehicles and personnel during the construction phase to serve the additional population in the Townships of Crandon, Nashville, and Lincoln, as well as the increased traffic in the project vicinity.

Attributing the entire cost of these new facilities to the proposed Exxon project is not realistic. Eventually the facilities would require replacement/expansion under the without-project scenario. Under the impact scenario, however, the need for replacement/expansion comes much sooner and thus is triggered by the project. No matter how the attribution is made, the current taxpayers would be responsible for the additional costs, and tax levels of the affected municipalities would be adjusted accordingly.

HUMAN SERVICES IMPACTS

Increased costs would be incurred at the county level for statutorily required human services (e.g., mental health, alcohol and drug abuse, social services, youth services), as well as increased costs for nonstatutory services (e.g., public health, emergency medical services, senior services and school health programs). The average per capita cost factors used to estimate future costs under both the without-project and impact scenarios are derived from prevailing (baseline) standards and levels of expenditures. Any deficiencies or unmet needs reflected in the existing per capita cost factors, therefore, have been carried forward and reflected in the projections of future public costs as well.

The following overview of human service impacts of the project is not inclusive of all human service requirements, but identifies some of the prominent program and service needs which are reflected in the costs portrayed earlier.

Medical Services - In Forest County, the number of doctors, nurses, dentists, and optometrists is below standard, and there is no hospital. The project could stimulate growth in the medical area. Emergency medical services, with two ambulances each in Nashville and Crandon, would be requested more frequently under the impact scenario. Although there would be a medical vehicle stationed at the Exxon project site, the long distance to Rhinelander would occupy the vehicle during an emergency, and capacity easily could be overwhelmed with a multiperson accident.

Mental Health - Under the impact scenario, the Northwoods Guidance Center in Rhinelander and its satellite office in Crandon would require a case manager, and clerical staff support. Current needs of the Langlade Health Care Center in Antigo would be increased under the impact scenario.

Social Services - The Forest County Department of Social Services would require two additional social workers, and the Langlade County Department of Social Services would require one additional social worker and additional facility space under the impact scenario. The Oneida County Social Services Department would require additional funds for institutional care and would require two new social workers, two social service aides, and one additional support staff member under the impact scenario.

Public Health Services - The Oneida County Nursing Service would require two additional nurses and one full-time counselor and increased funding for its maternal-child health program under the impact scenario.

SCHOOL DISTRICT IMPACTS

Public School Enrollment - Estimates of the school-aged population were derived for each school district in the local study area. To account for private school enrollment and nonenrollments, the projections were derived by reducing school-aged population by 10 percent.

Table 3-56 shows the projected school-aged population increases for the Crandon, Elcho, Antigo, and Rhinelander School Districts. Public school enrollment in the without-project scenario is projected to decrease over the next 30 years, then increase slightly. Under the impact scenario, enrollments would rapidly increase through the three year construction period. This increase is projected to be 40% for the Crandon School District, 12% for Elcho, and 8% each for the Antigo and Rhinelander School Districts. Enrollment for each year of the 29-year operations period is estimated to be lower than during the construction phase. During the first year of operations, school enrollments are projected to be 30% above without-project projections for the Crandon District and 7% or less for the other three districts.

Table 3-56
Public School Enrollment Projections by School District

District:		Crandon		Elcho		Antigo		Rhinelander	
Mine Phase	Year	Without Project	Projected Increase	Without Project	Projected Increase	Without Project	Projected Increase	Without Project	Projected Increase
Preconstruction	1986	939	6	456	1	2919	4	3104	4
Construction	1987	924	78	449	12	2878	42	3072	54
Construction	1988	916	189	444	28	2854	108	3058	133
Construction	1989	904	353	438	52	2820	215	3032	252
Operations	1990	903	264	437	38	2822	205	3045	198
Operations	2017	813	263	381	38	2617	204	3168	198
Operations	2018	813	251	381	36	2622	197	3190	188
Closure	2019	814	166	381	26	2627	150	3211	126
Closure	2020	815	96	381	16	2632	94	3233	74
Closure	2021	815	41	381	7	2637	45	3256	31
Closure	2022	816	10	380	2	2643	15	3279	8

Source: From Denver Research Institute, 1986. Only representative years shown.

TRANSPORTATION SYSTEM IMPACTS

Highway Transportation Impacts - Increases in traffic volume are dependent upon growth in population and employment. Because the majority of population growth would occur in the Rhinelander, Crandon and Antigo municipal areas, traffic increases would be spread over the road network in the study area (Fig. 2-13). Most of the traffic increases would be associated with the direct employment at the mine/mill site by the daily commuters and by the delivery of equipment, reagents and supplies during project construction and operations. Consequently, the traffic increases would be most noticeable in the immediate vicinity of the mine/mill site.

Roadway segments providing the most direct routes between residential locations and the mine/mill site would receive the bulk of traffic increases. These include U.S. Highway 8 between Rhinelander and County Trunk Highway (CTH) S; State Highway 55 from Argonne south through Crandon to CTH T; CTH's T, TT, A, and US Highway 45 between Antigo and the project site; and CTH's B and K linking Highway 55 with Pelican Lake and Elcho, respectively.

Based on existing traffic volumes and forecasts of with- and without-project traffic volumes DOT prepared a worst case traffic capacity analysis. The only roadway segment which is projected to experience over-capacity during construction is STH 55 from the mine access road to Crandon. This would occur during peak traffic (shift changes) during summer months in the third year of construction, when staff needs at the mine would be highest.

Elevated traffic levels and temporary vehicle lines could occur during shift changes, particularly at the intersection of STH 55 and the mine access road, the intersection of CTH S and US 8, the Crandon area, and at the intersection of highway 55 and CTH's K, B and T. Before and after shift changes, lines of vehicles may be waiting at stop signs awaiting access onto the busier highways. Temporary, minor increases in traffic levels in the City of Crandon would result from vehicles passing through as well as project employees seeking food, fuel, and other services and amenities. Increased traffic on State Highway 55 may increase the probability of vehicle-pedestrian accidents, particularly at Mole Lake. During the spring and summer months, from May through September, background traffic levels are normally elevated. The addition of mine/mill traffic, during shift changes would cause an approximate 10% increase in the congested peak hour traffic levels on STH 55 between the mine access road and Crandon. Snow and icy road conditions in the November through March period would slow traffic movement even though background traffic levels would be lower.

During the operations period, Highway 55 between the mine site and Crandon, and CTH S, are forecast to be at or slightly over-capacity in the peak summer months during shift changes. During these periods, in the City of Crandon and at nearby intersections there could be temporary lines of cars and slow moving traffic. Traffic levels, however, would be slightly less than during the third year of construction.

Highway 55 in the mine area has average dimensions for a state trunk highway (2-eleven foot lanes and 3 foot shoulders); however, 59% of the section between Mole Lake and Crandon is marked no passing, indicating a twisting course with some low hills. The Critical Accident Ratio between Mole Lake and Crandon is high (1.38), implying a high probability that the accident rate is attributable to an assignable cause or causes, most likely the nature of the highway. The section of STH 55 between Crandon and the south Forest County line has an accident rate of 553 accidents per 100 million vehicle miles. Assuming that the present rate remains the same, the number of accidents occurring on this section would increase as a result of mine-generated traffic. Given this assumption, it can mathematically be determined that a maximum one year increase of up to 19 accidents could occur during the third year of construction, and that a maximum of 4 additional accidents could occur during each year of the 29 year operations phase. It is generally the case, however, that when traffic increases on low volume roads, the rate decreases. In this situation a rate decrease would result in an accident increase below the maximum predicted above, using the accident rate formula. Thus, it is likely there would not be an increase in the number of accidents in the Forest County portion of Highway 55.

In the remainder of the local study area and along major highway corridors beyond the study area project-related traffic would not result in measurable changes to accident rates or numbers.

In addition, there would be increased levels of traffic associated with the increased secondary business activity in the area. The increased population filling these jobs, however, would be dispersed throughout the local study area.

Rail Transportation Impacts - The project-related level of rail shipments would consist of 18-20 rail car loads of concentrates leaving the facility daily and about 8 rail car loads of reagents and supplies entering the facility each week. The reagents which could be delivered by rail are listed in Chapter 1. In total there could be an increase of up to 7,000 loaded rail cars per year moving to and from the site. More than 90% of them would be zinc, copper and lead concentrates.

The average amount of rail traffic each year is about 12 million miles in Wisconsin. The current trend is a decrease in annual rail miles. Each year in the state there are about 60 derailments. The number of incidents where toxic materials are released is very low. According to national figures, about 7.5% of railroad incidents result in the release of hazardous materials. With the projected increase in shipments by rail, there would be no significant increase in the probability for an incident to occur. However, while the probability of an incident may not change, the consequences of a release of some reagents (i.e., toxic or hazardous) could have a significant impact on an environmentally sensitive area.

Impacts to Forest County Highway Department - Based on projections of Forest County highway needs, Forest County's road department would need approximately $1 million per year for two to three years during the construction period for heavy equipment replacement and about $300,000 per year for additional personnel. The additional personnel would be for additional planning, engineering, construction and maintenance needs. Forest County's highway equipment is old and in need of replacement, and the project would hasten replacement need. However, not all replacement costs would be attributable to the project. Approximately $500,000 would be required to rebuild CTH S from State Highway 55 to U.S. Highway 8.

IMPACTS TO PUBLIC WATER SERVICE

The water supply systems of the cities of Crandon, Antigo, and Rhinelander plus the Elcho Sanitary District #1 have sufficient capacity to accommodate anticipated population growth associated with the mine.

IMPACTS TO SEWAGE TREATMENT FACILITIES

Construction of the mine/mill could impact municipal sewage treatment systems in two ways. The most important impact would be the increased population. Population increases in the local study area would change the loading to the municipal sewage treatment facilities of Crandon, Antigo, Rhinelander, and Elcho. The with-project municipal population projections are used as reasonable representations of sewer service area populations and potential treatment plant loadings. Secondarily, sanitary sewage from the construction crews, particularly during the first six months, might be treated in local wastewater treatment plants (e.g., Crandon). The maximum amount of undigested sanitary wastes which would require disposal would be about 3,500 gallons per week (from 700 employees). No agreements have been reached on where disposal would be permitted. Should the City of Crandon be unable to accept the wastes, it would have to be taken elsewhere. The Laona and Wabeno treatment plants, however, probably would be unable to accept these wastes due to limited capacity and operating problems.

After the on-site sewage treatment plant is in operation, there would be some undigested sewage which would have to be disposed off-site. The sewage treatment plant would be unable to treat all the wastes from the construction workers. Portable toilets and trailers with multiple toilet units and holding tanks would be located in areas where there would be no permanent sanitary facilities. The maximum amount of undigested sanitary wastes which would require disposal would be 4,000 gallons per week (1,000 employees, each generating 4 gallons per week of sewage).

Once Exxon's on-site sanitary sewage treatment plant is in operation, periodic disposal of waste activated sludge would be required. The sludge would contain inorganic materials, highly inert organic solids, and volatile solids. Disposal at a wastewater treatment plant is not considered acceptable because of the highly inert nature of the sludge. Approximately 2,000 - 3,000 gallons per month of sludge would have to be disposed. Procedures in Chapter NR 204, Wisconsin Administrative Code, guide sludge disposal (landspreading), and if followed there would be acceptable impacts to the environment.

City of Crandon - The City of Crandon's population is projected to rise from 2,024 in 1985 to a maximum of 2,297 in 2016. Sewage flow to the treatment facility in 1984 averaged 152,000 gallons per day. Using the daily per capita flow of 75 gallons, sewage flow could be expected to rise to about 172,275 gallons per day by 2016. Although this projected maximum average daily flow would be well below the design level of 260,000 gallons per day, seepage from the cells receiving the final effluent currently have diminished. Land is available for construction of additional seepage cells or sewage treatment capacity if required. Due to the diminished seepage cell capacity, the Crandon treatment facility may require additional treatment capacity, whether population increases due to the Exxon project are realized or not.

City of Antigo - The City of Antigo's population is projected to increase from 8,929 in 1985 to a maximum of 10,401 in 2017. Sewage flow to the treatment plant in 1984 averaged 1.4 million gallons per day. Using the daily per capita flow of 157 gallons, average flow in 2017 would be expected to be 1.6 million gallons per day, well within the plant's design capacity of 2.47 million gallons per day. Some additional operation and maintenance cost would be incurred due to the increased loading.

City of Rhinelander - The City of Rhinelander's population is projected to increase from 7,975 in 1985 to a maximum of 8,111 in 1989. Sewage flow to the Rhinelander treatment plant averaged 1.45 million gallons per day in 1984. Using the daily per capita flow of 182 gallons, sewage flow in 1989 is projected to reach 1.47 million gallons per day. This slight increase in loading would be expected to have no impacts other than a small increase in operational costs. Even if the work/school day population would increase significantly due to population increases in surrounding townships, the associated sewage flow increase should not be large enough to necessitate capital improvements to the existing treatment facility.

Elcho Sanitary District No. 1 - The Town of Elcho's population is projected to increase from 1,077 in 1985 to a maximum of 1,109 in 2019. Sewage flow to the Elcho treatment facility in 1984 averaged 45,000 gallons per day. Using the daily per capita flow of 41 gallons, average sewage flow could be expected to rise to 46,800 gallons per day. Elcho School District enrollment of children living outside the Sanitary District also would increase flow to the sewage treatment facility. As Elcho's sewage treatment capacity is already stressed in wet years, system replacement or upgrading would be necessary, even if only a small increase in Elcho's population is ultimately realized.

UTILITY IMPACTS

Electric Service Impacts

The Exxon project could add 30 megawatts (MW) to both the summer and winter peak loads in Wisconsin Public Service Corporation's (WPS) "Upper Western" area. If the Exxon load is added, the timing and need of other transmission projects in the area would be affected.

Transmission system improvements are planned to eliminate potential power outages along specific lines at times of peak loads. To aid in planning the improvements, the existing system is modelled to reflect future peak load levels. During modeling, specific lines are taken out of service to see if electrical problems arise elsewhere in the transmission system. If such problems are found, additions to the transmission system are designed to solve them.

Black Brook-Venus Line - A new 32 mile transmission line is planned to connect the Venus substation to the Black Brook switching station, located west of Antigo (Fig. 3-15). The line would be built to 345 kV standards but initially would be operated at 115 kV. Conversion to 345 kV operation would occur after the construction of the planned Venus to Plains line. The potential addition of the Exxon project, however, may affect the timing and need for the new Black Brook-Venus line. The peak load levels produced at the mine and mill complex are key factors affecting the need for the line.

WPS states that the Black Brook-Venus line would be needed when the Upper Western area peak load reaches 195 MW. At this load level, low voltage problems would develop in the Upper Western area's transmission system if the southern half of the Aurora Street-Venus 115 kV line has an outage. The addition of the proposed Black Brook-Venus line would eliminate these low voltage problems. The 195 MW peak load level is forecast to be reached during the winter of 1989, if the Exxon project is developed as planned. Without the Exxon load, the 195 MW level should not be reached until the winter of 1992 at the earliest. Depending on the projected growth rate used, the Black Brook-Venus line could be delayed to 1993 or beyond. The Exxon load thus advances the need for the Black Brook-Venus line by at least 3 years.

The utility previously applied for Public Service Commission (PSC) approval to construct a Black Brook-Venus line. The application was subjected to extensive staff review and hearings because the environmental impacts of the various routes were a major issue in the case. In 1980 the PSC granted WPS authority to construct a line significantly different in design and route from that proposed. WPS elected not to construct the authorized line. A new application to the PSC would be necessary before a Black Brook-Venus line could be built.

Venus-Plains Line - Another future line affected by the Exxon load is a planned 345 kV line between the Venus substation and the Plains substation near Iron Mountain, Michigan. Initial planning indicated the line would be needed in the early 1990's. Present planning, however, indicates the line is not needed until after the year 2000. The need for the line depends on electric load growth in the WPS Upper Western area and parts of the Upper Peninsula of Michigan. The addition of the Exxon load, however, would affect when the line is needed. The Exxon impact on the timing of this line is difficult to evaluate at this time.

Crandon Distribution Support - WPS is tentatively planning to tap the Venus-Exxon transmission line to provide distribution support for the Crandon area. A 115/24.9 kV distribution substation would be built at the line's closest approach to the City of Crandon in the early 1990's. Crandon is presently supplied with electric power by a 24.9 kV distribution line from the Venus substation. If the 115 kV line to the mine is not built, WPS presently has no plans to change the way Crandon is served.

Radio Frequency Noise - Radio Frequency (RF) noise is a by-product of electricity transmission. The effect is directly related to the voltage level of the transmission line and the distance the line is from receiving antennas. RF interference produces annoying background noise on radios or fuzzy pictures on TV sets. The WPS had a RF Noise study done of transmission line routes between the Venus substation and the mine site. The studies measured the level of existing signals from radio and television stations. The report concluded the proposed route along U.S. Highway 8 should be acceptable for the proposed 115 kV transmission line. Further testing may be required after the transmission line is in operation to insure RF interference is not a problem.

Natural Gas Service Impacts

The mine/mill would use about 165,000,000 standard cubic feet of natural gas annually. This gas would be supplied from a transmission pipeline of ANR Pipeline Company. This transmission pipeline currently has sufficient capacity to supply Exxon gas demand well into the future. No additional natural gas facilities beyond the specific extension into the project site, should be needed to meet mine/mill natural gas needs.

Residents and businesses along the lower pressure sections of the natural gas line also would be eligible for natural gas service. The lower pressure section of line is along Airport Road, south of State Highway 55. Natural gas service is currently not available in this area. Service would not be available to customers along the high-pressure portions of the natural gas line north of State Highway 55.

IMPACTS TO SOLID WASTE DISPOSAL SITES

Prior to completion of the on-site landfill during the construction phase, refuse at the mine site would be collected periodically and disposed at a nearby landfill. An estimated 120 tons or 260 cubic yards of refuse would be hauled to an off-site landfill prior to the availability of the on-site facility. Refuse from the remainder of the construction, all of the operations, and all of the closure phases would be landfilled at the Exxon site. It is unknown where the initial refuse would be disposed, but potential sites include the City of Antigo facility or the Oneida County landfills if they would have sufficient capacity. The managers of these landfills would have to approve Exxon's use, however. The impact of disposal would be to reduce landfill site life by less than 1 percent at these facilities. Development related to the proposed project, such as an increase in population, would result in a greater quantity of solid waste requiring disposal. The impacts on the site life of a landfill of the increased population are shown in Table 3-57.

There are 50 licensed solid waste disposal sites presently receiving wastes in Forest, Oneida and Langlade Counties. Eleven sites are located in the local study area (Table 3-57). The licensed solid waste disposal sites can be divided into two categories: those which have a plan approval under Chapter NR 180, Wisconsin Administrative Code (Solid Waste Management), and those which do not have a plan approval.

Landfills with a plan approved under Chapter NR 180 have specified capacities which govern the site life. Landfills without approved plans are older facilities "grandfathered" into the program or landfills approved under previous administrative codes which did not require the same degree of protection. All of these landfills would be closed by 1999. Most of the nonapproved landfills and some of the approved sites have exemptions which allow for open burning of waste and reduced covering frequency. These exemptions are allowed based upon site conditions and the population of the service area for each site.

Increasing the waste volume entering a nonapproved site in which open burning occurs would result in an increase potential for groundwater contamination and/or an increase in airborne contamination due to the burning.

If the population in the landfill service area exceeds 2,500 people, the exemptions which allow for open burning and reduced covering must be rescinded. Stopping the practice of open burning would reduce air contamination, while elimination of the covering exemption would increase the costs of operating the site. The lack of burning plus more frequent covering would use the remaining capacity of these sites at a faster rate. Increasing the volume of waste entering an approved site would shorten the site life at these facilities as well.

Forest County has 13 licensed solid waste disposal sites, five of which are located in the local study area. The City of Crandon has the only project area landfill with an approved plan. An 8.5% population increase is projected for the City of Crandon, and a corresponding decrease in the site life would be expected. The other four landfills in the project area are nonapproved sites. Population projections for the service areas of these sites indicate no expected change in existing status regarding burning and covering exemptions.

The six active landfills in the balance of Forest County consist of a modern, approved site for the Township of Laona and five additional nonapproved sites. Population projections indicate the five nonapproved sites would not change status for the burning and covering exemptions. The life of the Township of Laona site would be decreased to the extent the population increases in the landfill service area.

In Oneida County, there are 20 licensed solid waste disposal sites receiving municipal waste. Three of the landfills are located in the Rhinelander area. In the Rhinelander area, only the Oneida County landfill is a modern, approved site. The service area for this facility includes much of the county. The landfills for the Townships of Crescent and Newbold are nonapproved sites. The Oneida County landfill would have a reduction in site life corresponding to the increase in population in the service area. The projected population changes due to the Exxon Project in the Townships of Crescent and Newbold would change the status of the burning and covering exemptions. Both townships (Newbold first, later Crescent), however, are projected to increase over the 2,500 population maximum allowed under Chapter NR 180 without the Exxon Project. As a result, the burning and covering exemptions would be lost even if the mine/mill is not constructed, although at a later date.

There are seven licensed solid waste disposal sites in the remainder of Oneida County. The Township of Sugar Camp (South Site) is a modern, approved facility. The other six are not. One of these sites, the Township of Schoepke site, receives only stumps and brush. All of the seven sites have exemptions to allow for open burning and reduced covering. The projected population increases for the balance of Oneida County would not result in a change in the status of the existing burning and covering exemptions. The life of the Township of Sugar Camp South Landfill would be decreased by the percentage of population increase which occurs in the service area.

In Langlade County there are 18 licensed solid waste disposal sites, three of which are located in the local study area (Table 3-57). Both of the Township of Elcho landfill sites are nonapproved facilities; the Enterprise site does not have an open burning exemption while the Post Lake site does. Both sites have exemptions for reduced covering. The third landfill is the City of Antigo landfill which has a remaining site life of one to three years.

The projected population increases indicate the Township of Elcho landfills would not require a change in the existing operations. The existing City of Antigo landfill will close at or just after the earliest possible start of the proposed project. The City of Antigo has submitted a feasibility study to the DNR for a new solid waste disposal site, and the impact on the new site of the mine/mill would depend upon the design and operations of the new landfill.

The balance of Langlade County has 12 licensed solid waste disposal sites. All but two of these sites are nonapproved landfills with open burning and reduced covering exemptions. The two exceptions are the Township of Peck and the Langlade County Forestry Department landfill which do not practice open burning. The projected population increases would not affect the operations of these sites.

Table 3-57
Landfills in the Local Study Area

Name	Licensed Acreage	Remaining Site Life[1]	Service Area 1985 Pop.[2]	Service Area Impact Pop.[3]	Impacts[4]
Forest County					
City of Crandon	7.7	6 years	2,062	2,297	SL
Crandon Township	2.0	Until 1999	634	651	N
Lincoln Township	3.8	Until 1999	611	683	N
Nashville - North	40.5	Until 1999	750/2	816/2	N
Nashville - South	5.0	Until 1999	750/2	816/2	N
Oneida County					
Oneida County[5]	21.0	11 years	19,416	ca. 21,500	SL
Crescent Township	9.1	Until 1999	1,829	2,733	B, C
Newbold Township	3.0	Until 1999	2,376	3,336	B, C
Langlade County					
City of Antigo[6]	20.1	1-3 years	8,725	10,372	SL
Elcho - Enterprise	5.0	Until 1999	1,081/2	1,142/2	N
Elcho - Post Lake	5.0	Until 1999	1,081/2	1,142/2	N

1 Calculated from 1986
2 DOA population estimates for January 1, 1985
3 Projected population during mid-operations, year 2016, from Denver Research Institute.
4 Impacts: SL - Reduction in site life
C - Exemption for covering removed
B - Exemption for open burning removed
N - No change in operations
5 In addition to the City of Rhinelander, serves Pine Lake, Three Lakes, Pelican, Woodruff, Lake Tomahawk, Monico, Schoepke, Piehl, and Little Rice.
6 Serves the City and Townships of Antigo, Ackley, and Rolling.

IMPACTS TO GOVERNMENT STRUCTURE

Despite the potentially significant impacts in certain parts of the study area, it is not anticipated that structural changes in governmental operations would occur (e.g., changing from volunteer to full time fire departments or from septic tanks to centralized sewage facilities) due primarily to the project. Project inmigrants would probably ascribe to a philosophy of local governance similar to prevailing views. The most diverse values would likely occur during the construction period, particularly if members of the work force inmigrate from communities outside the Great Lakes region. Inmigrant work force members during the operations phase, however, are expected to come predominantly from other parts of Wisconsin, Michigan, and Minnesota, and thus the potential for conflicting social and political values appears low.

IMPACTS TO SOCIOCULTURAL ENVIRONMENT

SOCIOCULTURAL IMPACTS

The project is likely to create a slight shift in the area's occupational structure. Along with the predominance of mining and construction activities, trade and other services are expected to increase in relative importance. The importance of existing retail trade centers in the study area, including Rhinelander, Antigo, and ultimately Crandon, also would increase.

The attraction of higher paid jobs during the construction period of the project could result in higher public service (and private sector) employee turnover rates in the study area. High turnover rates would be associated with the project operations work force, particularly in the early years of the operations phase, and this would contribute to higher transience in the study area labor force. Of concern to many of the employers is the potential for wage inflation and loss of employees to the project. According to 1984 study area employment data and wage estimates, large wage differentials are likely to exist between project and non-project jobs. Significant wage inflation, however, may be dampened due to the large supply of unemployed and underemployed in the study area. The loss of some skilled workers to project jobs would occur. This turnover, coupled with expected turnover of project jobs, could be disruptive for study area employers and for public agencies serving the dependents of work force families.

The absolute level and rate of population growth induced by the project would be the major determinants of social change in the study area. The current sense of community familiarity and a prevailing atmosphere of informality may be transformed somewhat, not because of the aggregate size of the new study area population, but because of a potential new demographic composition.

As the project developed and development-related growth occurred, the quality of public education could be enhanced due to the increased assessed value and school tax revenues paid to the Crandon School District. Mining impact funds also could be apportioned to other school districts.

An Exxon-sponsored survey of 778 people in the study area revealed that permanent residents, seasonal residents, and visitors view the project differently. While most visitors stated that the project would have little impact on their plans to visit the area, seasonal residents were more likely to suggest that there was potential for negative effects. Permanent residents generally expect the project to have positive effects on their communities, particularly with respect to employment opportunities, wages, and increased opportunities for trade and services.

Public meetings involving study area residents have exhibited a discernible difference in attitude between seasonal residents and the permanent residents. The seasonal residents focus, for the most part, on the project's potential disruption of the rural character of the area and the potential for environmental damage. Although permanent residents also were concerned with natural environmental issues, they were more favorably disposed to the project's potential economic benefits.

IMPACTS TO TOURISM AND RECREATION

The local area within a several mile radius of the mine is served by recreation and tourism-based businesses. These include resorts, taverns, restaurants, and retail establishments which handle supplies and equipment for hunting, fishing, boating, sailing, camping, snowmobiling, hiking, and swimming. Project development would reduce water-based activities and waterfowl and upland game hunting in the area to be developed. Project-generated noise could reduce the desirability of summer outdoor recreation activities and lake use near the project, particularly for Oak, Little Sand, Duck, Deep Hole and Ground Hemlock Lakes. Some individuals participating in these outdoor activities, however, probably would shift their activities to nearby areas rather than stop altogether. Tourist use of summer cottages in the local area, particularly around nearby lakes such as Ground Hemlock, Rolling Stone Lakes and Lakes Lucerne and Metonga, also could be expected to be reduced as a result of increased competition with project workers for cottages.

The same could be true for summer cottages and homes more distant from the project, such as those on Pickerel Lake and Upper and Lower Post Lakes. In general, the negative effects of the project on tourism include the reduction of recreational desirability due to the industrial presence in the area and the number of project workers occupying housing previously devoted to vacation use. Offsetting these impacts would be the local recreational needs of the inmigrants. On balance, it is anticipated that tourism and recreation in the vicinity of the project would not be significantly impacted.

Tourism and associated outdoor recreational use in the larger region, particularly the remainder of Forest and Oneida Counties and associated with the Wolf River in Langlade County, is very significant to the economics of the region. The project would not have significant impacts to wildlife populations, aesthetics, or air quality in this region, thus the existing levels of hunting, hiking, trapping, camping, nature study and other outdoor activities would not be impacted. Similarly, the project's proposed discharge to Swamp Creek, a tributary of the Wolf River, would be at levels less than those which have known short-term or long-term toxicity to fish, other aquatic life, and humans who would consume the fish. Therefore, there is no predicted reduction in fishing activity or other water quality based activities such as canoeing, boating, rafting or kayaking on the Wolf River. The perceptions of those attracted to and using the area are predicted to remain unchanged, and the economic benefits of tourism are projected to remain unchanged or increase slightly due to the increased regional population.

IMPACTS TO ARCHEOLOGICAL FEATURES

No adverse impacts to the identified cultural resources would occur due to construction, operation, or closure of the mine/mill, MWDF, utility corridors , access road, rail spur, and pipelines. The identified archeological sites east and northeast of Oak Lake (eligible for the National Register of Historic Places) are on private parcels not affected by the project.

AESTHETIC IMPACTS

The analysis of aesthetic impacts is limited to the off-site visual aspects of the proposed project. Section NR 132.17, Wisconsin Administrative Code, regulates the location, design, painting, maintenance, and screening of the facilities to insure visual compatibility of the facility with the surrounding area. Since the screening of the proposed facility would be partially dependent upon the surrounding forest, any unplanned removal of the forest by natural occurrence or human activity could increase the visual impact of the facility.

Mine/Mill Surface Facility - Visual screening of the mine/mill surface facility consists of well-stocked northern hardwood pole timber with some areas of medium-stocked aspen and mixed hardwood poles. The west exhaust raise and exhaust fan would be surrounded by a stand of well-stocked aspen saplings with further screening along Sand Lake Road by northern hardwood pole timber. A minimum of 200 feet of undisturbed forest would remain between Sand Lake Road and the closest portion of the mine/mill site perimeter fence. Mine/mill structures not exceeding the height of the forest canopy (approximately 60 feet) should, therefore, be reasonably well screened from all off-site ground level viewpoints.

Both the headframe (155' high) and the concentrator building (approximately 100' high) would extend above the height of the surrounding forest. The headframe and concentrator would be painted and would be rough textured to minimize reflectivity and of a color compatible with the surrounding background.

Possible viewpoints include surrounding hilltops, lake frontages, fields, or right-of-way openings with vistas toward the headframe. Many viewpoints would be screened by hills and/or forest cover.

Aesthetic Impacts of Mine Waste Disposal Facility - The proposed tailings pond embankments would rise above the surrounding landscape and provide screening for activities within the ponds. The exterior of the bank would be effectively screened by surrounding hills and trees.

Aesthetic Impacts of the Power line - The preferred power line route would have a visual impact along U.S. Highway 8. There is presently a 24.9 V distribution line along this route. The new line would consist of 75-foot single wooden poles spaced 350 feet apart with three steel side arms. The existing 24.9 KV distribution line would be underbuilt on the new poles. The new construction would increase the visual impact because of the larger poles and additional wires.

The preferred power line route would cross the Wolf River at the Highway 8 bridge, where the existing 24.9 K power line crosses. The Exxon transmission line would look essentially identical to the existing line, although it would be taller, and the aesthetic impacts would be low.

Where the power line route goes cross country, between Highway 8 and the Exxon access road, it would create a new opening through primarily forested lands. About seven or eight residential and recreational units located near CTH B, Gliske Creek, and the Highway 55 crossing may have a view of the power line depending on pole alignment. Pole alignment has not yet been determined. Gliske Creek is a trout stream, and construction techniques which would leave low brush along its banks would decrease the impacts at the crossing.

The final segment would parallel the proposed access road from Highway 55. Power line structures and clearing would add to the visual impacts of the access road as described below.

Aesthetic Impacts of Access Road and Electric Power line - The access road and electric power line from Highway 55 to the mill would be completed during the first 14 months of construction. The only segment of this corridor visible from Highway 55 would be across an open field to the forest edge, a distance of approximately 3,200 feet. The bridge and power line crossing at Swamp Creek would be visible to persons using the stream at that location. Upon project termination, the bridge and power line would be removed and the roadway reclaimed if no alternative uses had developed.

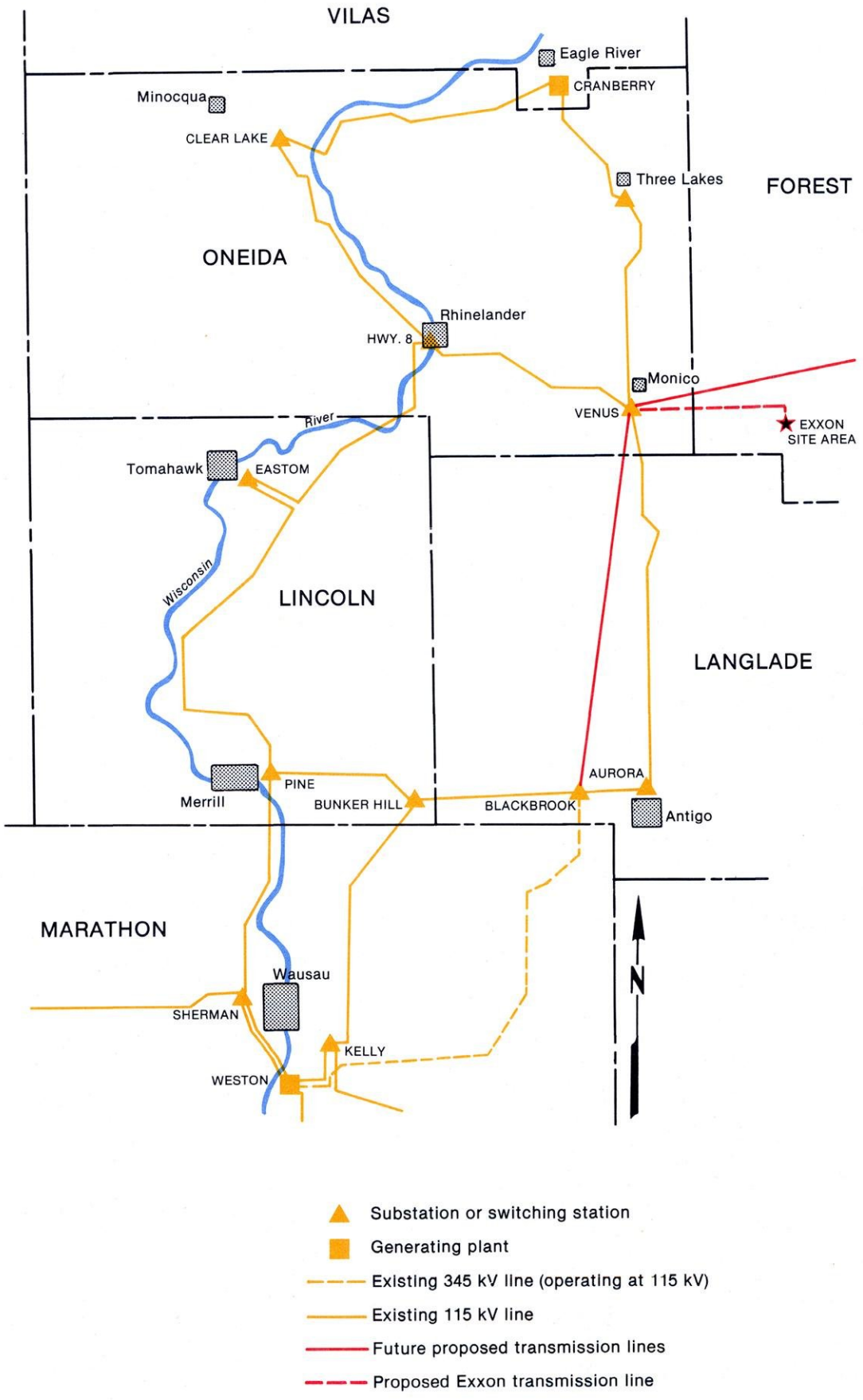


Figure 3-15. Proposed Regional Electric Transmission Lines

Aesthetic Impacts of Rail Spur and Siding - The proposed rail spur intersects the Soo Line in an open field adjacent to Keith Siding Road. This intersection would be visible from the road and from two residential units. After crossing this field, the spur enters a wooded wetland area where the siding would be located. The spur and siding then cross a second open field for a distance of approximately 500 feet. This field also is contiguous with Keith Siding Road, and rail cars traveling through or parked on the siding would be visible at this location. Plantings on the north side of the tracks in these two open fields would assist in the mitigation of these visual impacts. A vegetative screen to the height of the rail cars, however, would take a number of years to develop.

Other potential viewpoints include a view of the bridge crossing Swamp Creek by persons using the stream and the road crossing at Berry Lane.

Most visual impacts would be eliminated upon completion of reclamation except for grass covered openings where forests once existed. These openings eventually would revert to woody vegetation if left undisturbed.

Aesthetic Impacts of Wastewater Discharge Pipeline Corridor - Construction of the wastewater discharge pipeline would occur during project years one and two. Disturbance of the right-of-way to a width of up to 50 feet followed by trenching, pipe laying, trench backfilling, leveling, and reseeding would occur. The pipeline outfall at Swamp Creek would be the only exposed structure. Viewpoints for the grassed over right-of-way would include the Sand Lake Road and Highway 55 road crossings. Persons navigating Swamp Creek would observe the pipeline outlet and stone riprap placed to control erosion. Upon termination, no disturbance of the right-of-way would be required since the pipe would be plugged and left in place. The outlet structure, however, would be removed and the site reseeded. The right-of-way eventually would be invaded by native woody species unless disturbed by further human activity.

IMPACTS TO NATIVE AMERICAN TRIBES

SOCIOCULTURAL IMPACTS

Both the Forest County Potawatomi and the Sokaogon Chippewa tribal members retain a close affinity with the land and waters on the reservation. Their traditional cultural beliefs, religious ceremonies, and practices reflect this unity. Because of these beliefs, ceremonies and traditions, the Native American people consider themselves very rich to be a part of the natural diversity. Issues of traditional versus new values, money economy versus subsistency, taking from the land or being part of it would involve personal decisions as well as tribal concerns. Issues related to the project could become the chief divisive issue among the tribal members. The concerns would be difficult to quantify or remedy, but would be carried with the tribe even after the mine had closed.

TRIBAL GOVERNMENT AND FINANCE

The tribes rely heavily on government funds, and because these funds do not provide a continuous or secure funding base, there is no guarantee tribal government would be able to sustain current levels of services to tribal members. If the mine is developed, the Forest County Potawatomi and Sokaogon Chippewa populations could grow as tribal members migrate into the area seeking work. This population growth would place additional demands on tribal government, administration and services. The complexities of the interactions with Exxon, other local jurisdictions, and the State also would increase the demands on tribal government.

Both tribes currently are receiving payments from the Mining Investment and Local Impact Fund Board (MIB) in the form of annual block grant permit period payments of $100,000 (indexed). Similar payments would be made to the tribes if construction is initiated. Construction period payments would continue through project construction and up to three years following concentrate production. After that, they would be eligible for first dollar payments from the net proceeds tax when mining becomes profitable. If the tribes received annual $100,000 payments during the construction and operation phases, each could receive about $3 million in mandated payments if the mine were profitable. Table 3-55 indicates the mandated payments the tribes and other municipalities could receive during the project.

In addition, the tribes would be eligible for discretionary grants from the MIB (if funds were available) during the project. Some of the following mining-related impacts could be mitigated with the mandated annual payments. The impacts, however, are very difficult to quantify in monetary terms. Therefore, the following analysis of impacts does not attempt to indicate which impacts could or could not be mitigated with the MIB payments, either mandated or discretionary.

IMPACTS TO NATIVE PLANT GATHERING

Both the Sokaogon Chippewa and the Forest County Potawatomi use a large number of the native and adventive (introduced) plant species for food, medicine, and art. They have expressed concern about the impact of the mining operation on these plant resources.

Of the many species reportedly used, only two species are believed to be restricted to specific areas within the environmental study area. One of these species is wild rice (Zizania aquatica), an especially important plant to the Sokaogon Chippewa, which is restricted in the environmental study area primarily to Rice Lake on the Mole Lake Reservation. The other species is bur oak (Quercus macrocarpa), used as a food, dye, and medicinal plant, which is restricted in the study area to two or three small groves on the Exxon property.

Exxon has not proposed a policy on public use of company controlled land that is not fenced. Some of these lands have been described as traditional gathering grounds by the Native Americans. This land could be available for gathering of bur oak products and other more widely distributed plants. Should Exxon have a restrictive public access policy, or should tribal members feel unwelcome on Exxon lands, then these lands would not be available for traditional gathering purposes. Alternative areas would need to be found to gather all species formerly collected on Exxon lands. Due to the widespread distribution of all species, except bur oak, the local alternate sites should be found easily. Alternative bur oak collection sites, however, would be more distant (within sixty miles).

Contamination of wild food plants with heavy metals from windblown ore/tailings dust is not expected to be a problem. Air emission modeling indicates project-related heavy metal inputs would be considerably less than existing background levels. A dust suppression program to minimize dust coming from project activities would likely be a permit condition. Analysis of soil, plant, and animal elements for heavy metal contamination is planned by Exxon to confirm expected conditions.

The important wild rice resource of Rice Lake would not be adversely impacted by the mine activities. Surface construction activities, located two and one half miles upstream from one of Rice Lake's inlets (Swamp Creek), would have erosion and runoff controls. Runoff would be intercepted by a network of sedimentation ponds prior to reaching Swamp Creek. Water discharged from these sedimentation ponds would have water quality limits determined by state water quality standards. Treated mine water, which could have sulfate concentrations potentially injurious to wild rice, would be discharged below Rice Lake. Stringent design criteria for the MWDF would prevent tailings leachate from altering surface waters more than existing natural variability.

Mine dewatering would slightly reduce the flow in Swamp Creek. Because Swamp Creek is only one inlet supplying water to Rice Lake, and there is a lake level control at the lake's outlet, a reduction in Swamp Creek flow would not be expected to adversely affect wild rice. High water levels, especially during wild rice germination and establishment (floating leaf stage) in May and June, are potentially much more threatening to wild rice than are low levels. Since Exxon has agreed to mitigate Swamp Creek flows during low flow conditions to within natural flow variation, there would not be adverse impacts to Rice Lake and Swamp Creek biota.

IMPACTS TO THE FOREST COUNTY POTAWATOMI

Population Impacts - Anticipation of jobs at the Crandon project could increase the migration of the Forest County Potawatomi back to the reservation. Migration of both former residents and tribal members who have never lived on tribal lands may occur as these people seek project-related jobs. In addition, some Potawatomi who would otherwise migrate out of the local study area may choose to remain.

Respondents of the household survey were asked if they had any relatives who are now living off tribal lands who might return to seek employment at the project. Thirty-eight such individuals were identified. All of them were in their working years, between the ages of 16 and 64. Twenty-five of the potential returners were male and 13 were female. The majority lived in Wisconsin, and were employed in the construction trades and as laborers. An average of 2.7 family members per worker would be associated with each potential migrant, and thus there is a potential for as many as 101 persons to return to the Forest County Potawatomi community. A survey of 69 off-reservation tribal members also provided information on project-induced migration. Twenty-seven respondents under this survey said they would seek project employment. With an average of 2.8 family members per worker and assuming all returned to Forest County, there is an identified potential for 75 additional people as return migrants. This could mean a total inmigration of 176 people to or adjacent to reservation lands.

A major constraint to population growth on tribal lands is the lack of adequate housing. Many returning tribal members would have to seek housing off tribal lands. Other project-induced population growth in the study area also would affect the Potawatomi as competition would increase for housing, goods, and services in communities adjacent to tribal lands.

Economic Impacts - Economic impacts to the Forest County Potawatomi would result primarily from: 1) continued payments from the Mining Impact Board as previously detailed; 2) employment income from those hired directly by Exxon or indirectly by increased regional economic activity; 3) migration of Potawatomi's to the reservation hoping to secure employment in the area, thus increasing demands on tribal services and resources, and 4) changes in the level of tribal business activity (cigarette sales, bingo, excavating, firewood sale).

There are a number of constraints to integrating the Potawatomi into the Crandon project work force, even though fifty-three percent of those surveyed indicated they would apply for a job at the mine. Sixty-four percent of the persons aged 25 and over who live on or adjacent to tribal lands have less than a high school education which is the minimum educational level in Exxon's hiring guidelines. Even if hiring policies would be conditionally waived, the Potawatomi's would be at a competitive disadvantage compared to other local residents. In addition, most people have unskilled and semi-skilled job experience with training in occupations as laborers, precision craftsman, and administrative support personnel. A very small proportion of the respondents were licensed or certified in a trade. Tribal members who reside outside of the local study area may have a competitive advantage over the resident group. Their education levels were higher and they were more frequently licensed or certified in a trade.

Another constraint to employment at the mine is transportation. Many of the potential employees do not own vehicles. In addition, the Potawatomi would need to be alerted to Exxon's hiring schedule so they could participate in the hiring process.

It is impossible to forecast how many Potawatomi would be employed at the mine or for how long, but without aggressive measures to integrate them into the project work force, the level of employment could be low. Exxon has indicated it intends to pursue a comprehensive training program which could be very important to the Potawatomi looking for mine/mill related employment. Employment at the mine could be influenced by attitudes about working underground. Those who would gain employment at the mine, whether temporary or for a longer term, would receive higher wages compared to the prevailing wage rates, which in Forest County are among the lowest in the state. A sustained income from mine/mill employment could be of considerable benefit, particularly if the wage earner was one of the nearly one-third of the tribe living below the U.S. poverty level or if the wage earner was one of the 68% of the Potawatomi unemployed.

Regional economic activity would be stimulated by the proposed project, and some indirect jobs would be available to the Potawatomi. Many of these jobs would be in the construction area or as laborers, maintenance, clerical or operators. Some of these would be of a temporary nature. Long-term employment opportunities, however, probably would be comparable to existing Potawatomi participation in the area's labor force, which is relatively low.

The recently formed Forest County Potawatomi Excavating and Construction Company could realize business opportunities during the construction phase of the project. The firm should be able to bid with minority status, and it has journeymen, heavy equipment operators, and qualified diesel engine mechanics. Revenue from bingo games, cigarette sales, and firewood sales probably would increase due to increased business activity during the construction and operation periods.

Housing Impacts - Housing occupied by Forest County Potawatomi both on tribal lands and in the immediate vicinity is substandard. Although limited funds are available for improvement, upgrading the housing stock has been difficult. Limited family incomes and the resulting unwillingness of lending institutions to mortgage homes on tribally-owned land contribute to the substandard condition of the housing stock and constrain the ability to acquire new and/or adequate housing. Added difficulties occur because of the isolation of housing units spread over an 11,000 acre area of tribal lands and poor access roads.

The development of the mine/mill could worsen the housing conditions of the Forest County Potawatomi. Based on the household survey, only 16 of 92 Potawatomi residences would have adequate room to accommodate a person or family who returned for project-related employment. More than one-half of the homes are mobile homes or trailers. In addition, homes already are crowded, housing on the average 4.1 persons, while the national average is 2.7 persons per home. Thirty-one residences would have great difficulty accommodating additional people, and forty-five (49%) would have no room for additional people. The possibility of upgrading and adding to the present housing stock is very limited. Construction period and first dollar payments made to the tribe, if the project proceeds, would help offset increased costs to the tribe, and could be used to improve housing conditions. The tribe also could apply to the MIB for discretionary grants.

Other Impacts - Law enforcement services for the Forest County Potawatomi are provided by the Forest County Sheriff's Department. With project development and a substantial population increase predicted to move into the project area, however, the Sheriff's Department would likely have a large increase in the number of emergency and routine calls. Nearly one-half of the Potawatomi interviewed stated law enforcement response time was bad or very bad. Thus, unless improvements could be made, law enforcement service to the Potawatomi could worsen.

Additional crowding of the Potawatomi by returning reservation members would impact the existing tribal capacity for provision of services. An additional burden would be placed on waste removal, health and human services, tribal administration, and related services.

Increased population in the project area and increased enrollment in the Crandon School District could result in increased tension between the Potawatomi and the dominant white culture.

Closure - Impacts of mine/mill closure can only be described in qualitative terms. To the extent that Potawatomi had been employed directly with the mine/mill, employment would end. Unemployment compensation would be available to those formerly employed. This would make the transition somewhat easier, but the benefits would be temporary. Overall employment including some of the indirect employment would be reduced economic activity, reduced expenditures, and less need for services.

Business activities of the Potawatomi such as the cigarette sales, bingo games, logging and firewood sales, excavating, as well as any other developed during the project, probably would be impacted by lower sales. Following project closure, or when the stream of net proceeds taxes would stop, the tribe would no longer receive the $100,000 indexed, annual first-dollar payments from the MIB. The tribe, however, would be eligible for funds from the MIB through its discretionary grant program if sufficient funds were available.

The impacts of project closure on population and housing are difficult to predict, and depend on a number of variables. A reduction in population could occur through migration of the newly unemployed to other areas to look for jobs. If that occurred, it would reduce overcrowding in housing. The Potawatomi are somewhat mobile as evidenced by past trends. If housing conditions improve during the project, however, there would be less incentive for unemployed tribal members to leave the reservation.

IMPACTS TO THE MOLE LAKE SOKAOGON CHIPPEWA

Pre-Construction Impacts - The discovery of the orebody has already resulted in impacts for the Sokaogon Chippewa. Tribal authorities report that a number of tribal members have returned to the reservation in anticipation of jobs. The return of tribal members to the reservation has put additional strain on already limited reservation housing, and attempts are being made to develop additional housing. A number of families are sharing living quarters. Their return to the reservation also has increased the demand on tribal health care delivery systems. Further increases and demand for reservation medical services could result in decreased quality of care.

The area east of the reservation and south of Swamp Creek traditionally has been a good location for the collection of wild plant foods and medicinal plants. Much of this resource already has been lost because tribal members feel unwelcome on Exxon-controlled property.

Sociocultural Impacts - Many reservation residents have and would continue to experience some degree of psychological stress in their attempts to cope with the possibility of development of a large mining operation so near their homes. This distress centers on their perception of possible negative consequences to Rice Lake and the impact the mine could have on traditional life styles and customs. Responses to questionnaires indicate a feeling of helplessness in dealing with potential mine development, worry about increased traffic on State Highway 55, and concern for the long-term quality of drinking water. About half of the Sokaogon Chippewa indicated they would not be interested in working at the mine.

Construction Impacts - The construction phase of the Crandon project would bring changes to the reservation and the tribal inhabitants. An influx of construction workers and their families into the local area, particularly to areas just east of the reservation, would be disruptive. Once construction of project facilities had begun, additional tribal members would be expected to migrate to the reservation in search of jobs. There is no way of predicting the exact number, but tribal authorities feel, in total, an influx of over 100 individuals could occur. The influx of a group this large into the small population base would affect many aspects of reservation life. The housing shortage on the reservation would be worse, and housing close to the reservation would be expensive and in short supply. More families would need to share homes than at the present time. An additional burden would be placed on waste removal, health and human services, tribal administration, and related services.

It is difficult to predict how the construction phase of the project would affect the Sokaogon Chippewa in terms of opportunity for employment. Tribal members lack relevant work experience, education, and skills necessary for employment at the construction site. The Sokaogons' reluctance to work underground would be another constraint. The majority of the reservation residents have indicated no desire to work at the mine. This suggests the mine would not be enthusiastically viewed as a source of employment, even though approximately one-third of the tribal members surveyed did indicate they would be interested in job training if offered. The hiring policies of Exxon and its contractors would be instrumental in affecting the number of Sokaogons hired. Those who would be employed, either temporarily or permanently, would earn higher wages than otherwise possible, and hiring would reduce the very high level of unemployment. Exxon's entry level wage rate would be substantially higher than the prevailing rate in the region and would provide an economic boost to those hired.

Increased congestion and more crowded housing conditions may have health consequences for reservation inhabitants. There also would be a greater likelihood of serious accidents involving pedestrians and traffic on Highway 55. Car and truck traffic to and from the Elcho and Antigo areas would pass through the Mole Lake Reservation.

Increased demand may be experienced at the tribally owned grocery store. The tribe's bingo operation also would probably have increased business due to the greater numbers of people in the area. The tribe's construction company expects to bid on construction work related to the project, and other tribal enterprises may be developed on the reservation during the construction phase of the project.

Social life on the reservation would be impacted by the overall population growth induced by the project and by the increased levels of traffic, noise, dust, and human activity in proximity to the reservation. An increase in internal dissension between tribal members may occur particularly between those who may work at the mine and those who do not. Social life may exhibit a greater dependency on the "money economy" and more conspicuous displays of wealth in contrast to the traditional customs, and this division of life styles could be viewed as particularly troublesome.

An inmigration of large numbers of white workers and their families could make the Sokaogon Chippewa even more of a minority. Racism could become more pronounced rather than diluted, and increased pressure on the land may cause further loss of wild animal and plant food resources. Traditional customs in the Sokaogons' sense of community may be threatened. Increased crowding on the land and more intense utilization of resources by newcomers in the vicinity of the reservation could degrade the reservation environment.

Off-reservation Treaty Rights - The Sokaogon Chippewa have certain hunting and fishing rights to public lands within the ceded territory in northern Wisconsin. Recent court cases have recognized these rights in general terms, although the scope of these rights continues to be defined by the courts. The proposed sale of 880 acres of Forest County land to Exxon would result in a loss of those rights on that land. The land proposed for sale (Fig. 1-3) includes about 3/4 mile of Hemlock Creek and is nearly completely forested. No lakes are included within the land proposed for sale.

Within the nine townships surrounding the Mole Lake Indian Reservation, there are more than 28,400 acres of publicly owned land, including county forest land and state ownership. The sale of 880 acres would reduce the amount of public lands within the surrounding townships by 3%. In addition, there are extensive holdings of public land within the Nicolet National Forest, the boundaries of which are within 10 miles to the north of the reservation and 8 miles to the east. The overall impact of the loss of hunting rights to the 880 acres would be minimal, as thousands of acres of similar forest lands would be available, and access to Hemlock Creek could be gained from alternate sites.

Operations Impacts - Several constraints limit the number of mine-related jobs available to reservation residents during the operation phase of the project. Most Sokaogon do not wish to work underground, and the lack of education and experience may limit their participation in other jobs in the absence of an effective training program. If there was an effective training program, an aggressive hiring effort aimed at Native Americans, and relaxation of some educational requirements, more Sokaogon Chippewa could be hired. Those positions most likely filled by reservation residents are clerical, warehouse, operators, maintenance, and mill laborers. Those who would obtain employment at the project would probably receive substantially increased wages compared to the prevailing wages.

The tribe's bingo enterprise would likely increase in popularity. The tribe's construction company, if successful in obtaining long-term project-related work, could become an important economic enterprise. Similar to the construction phase, increased traffic along Highway 55, noise, and increased human activity in the area during operations would be an adverse impact on reservation residents. There would be increased crowding in reservation housing to the extent that returning tribal members secure project-related employment.

Since the reservation is situated near the proposed mine access road, the Sokaogon Chippewa could choose to capitalize on the possible economic opportunities. They could supply a variety of service, food, and leisure business needs following mine development.

Closure - Closing the mine/mill would impact the Chippewas, although the description of those impacts is qualitative and more speculative. Chippewas employed directly at the mine/mill would be laid off. While unemployment compensation for those formerly employed would make the transition somewhat easier, the benefits would be temporary. Overall employment as well as economic activity would be reduced because of fewer people, reduced expenditures, and less need for services.

Following closure and reclamation at the project site there would be less vehicular traffic, reduced noise, dust, and congestion in the vicinity of the reservation. Fewer vehicles would travel Highway 55 through the reservation, and the potential for pedestrian-vehicle accidents would be reduced.

Business activities of the Chippewas such as the cigarette sales, bingo games, grocery store, excavating, as well as any other developed during the project, would probably have lower sales. Following project closure, or when the stream of net proceeds taxes to the state would stop, the tribe would no longer receive first-dollar payment from the Mining Investment and Local Impact Fund Board. The tribe would, however, be eligible for funds from the Mining Impact Board through the discretionary grant program if sufficient funds were available.

The impacts of project closure on population and housing are difficult to predict, and depend on a number of variables. A reduction in population could occur through migration of the newly unemployed to other areas. If that occurred, overcrowding in housing would be reduced. The Chippewas are somewhat mobile as evidenced by past trends. If housing conditions improve during the project, there could be less incentive for unemployed tribal members to leave the reservation.

IMPACTS TO THE MENOMINEE RESERVATION

The Menominee Reservation is located south of the project on State Highway 55. The far northern border of the reservation is within a 45-minute drive of the project site. Approximately 4,000 tribal members live in the reservation, mainly in Keshena and Neopit. Keshena, location of the tribal headquarters, is near the southern border of the reservation.

Social and economic impacts to the Menominee Reservation from the proposed project are anticipated to be minimal. The inmigrant population attracted by the project is projected to live closer to the mine site, and therefore, population-related impacts such as housing effects, school district costs, and costs to local municipalities would not accrue to the reservation. The increased economic activity stimulated by the project would occur primarily in the Crandon, Rhinelander, and Antigo urban areas. The reservation does not have the authority to tax any aspects of the project, and would receive no mandated block grant payments from the Mining Impact Board. For these reasons, the reservation was not included in the area of significant socioeconomic impact delineated by the socioeconomic study area.

The most likely socioeconomic impact of the project on the Menominee Reservation would be from possible employment opportunities. If tribal members would choose to interview at the project and would qualify for employment at the mine, some tribal members might commute to the project for work. Employment would result in wage and benefits, but the overall level of employment at the mine may be low due to the long commuting distance and time between the project and the Menominee population areas.

Impacts to Recreation and Tourism - As previously discussed in the "Impacts to Swamp Creek and the Wolf River" and "MWDF Seepage Impacts on Surface Water Quality" sections, there are no significant short-term or long-term impacts predicted to occur to the Wolf River which would impact fish or other aquatic animals or persons that consumed fish. This includes no significant changes in heavy metals, no change in Wolf River water temperature, and no reductions in river flow in the reservation. In addition, air quality impacts to the reservation would not be noticeable or measureable. Therefore, existing fishing, activities in the reservation are not projected to decrease due to the project. Due to the expected increased population in the region, it is possible that tourism and outdoor recreational use would increase slightly.

Transportation Impacts - Transportation impacts in Menominee County could result from increased automobile and truck traffic associated with the project. However, the vast majority of project-related workers are predicted to live within Langlade, Forest, and Oneida Counties or commute from outlying areas. Project-related automobile traffic in Menominee County is expected to be negligible.

There would be a maximum of about 17 trucks per day carrying supplies and reagents or for services purposes driving to and from the project site daily during construction. An estimated 30% of these (5) would be from the south. A conservative assumption would be that all southerly truck traffic would pass through the reservation. Therefore, during the maximum impact period, an estimated increase of 10 trucks per day (half of the material and supply vehicles would be empty) could pass through the reservation. This anticipated increase in project-related traffic through the Menominee Reservation is negligible. As a result, no measurable changes in the number of traffic accidents or accident rates are predicted.

CLOSURE IMPACTS

The previous sections on socioeconomic impacts concentrated on impacts during the construction and operations phases of the project. Many of the tables, however, indicated projected impacts during the closure phase as well. Refer to the tables on population changes, employment, housing demand, public service and facilities costs, changes in assessed valuations, and school district costs and enrollments. In addition, closure impacts specific to the Native American tribes are discussed in those sections.

After the completion of mining activities, the income and employment from the project would cease to exist. Since the specific socioeconomic conditions which might exist in the study area some 35 years hence (assuming uninterrupted operation of the project), are not known, only some of the general tendencies which could accompany closure are discussed. The following discussion assumes mine/mill closure is the only significant economic event occurring in the study area at the time of project termination. Except where otherwise noted, the discussion is intended to apply to closure at any time during the project operation phase.

Many individuals employed directly by the project or in a business significantly dependent on the population and income effect of the project, most recent inmigrants, and some longer-term residents would probably choose to leave the study area rather than remain and attempt to secure alternative employment. Reduced demand, as well as income, for goods and services would reduce employment in those sectors which had previously expanded to accommodate the increased population. Reduced demand for housing and land would result in temporarily depressed property prices at a time when many residents searching for employment elsewhere would be seeking to sell their homes. Housing vacancies would rise and demand for new housing would fall.

In addition to the private sector effects, closure would similarly affect the provision of public services and the collection of public revenues. The public service and facility system which had previously expanded to accommodate the impending inmigration of a substantial number of new residents would have to adjust to a revised future of reduced demand. These processes of expansion and contraction however, are not necessarily symmetrical. For example, where the construction of a public service system could be tolerated at less than full prevailing standards to avoid the prospect for future excess capacity, closure would entail an excess capacity due to the sudden departure of substantial numbers of people. The reduction and elimination of this excess would occur over a period which would depend on the specific timing of closure (as well as the lead time after announcement of closure). Personnel hired to increase public service capacity would probably be laid off over this period. Alternatively, if personnel were not laid off, their retention could represent maintenance of excess capacity pending increased population from other sources, or a form of increased service standards. As an example of the kind of excess capacity which would accompany closure, a school district, informed of the immediate departure of a significant number of students, might be compelled by the existence of employment agreements to maintain a staff level to accommodate the previous level of enrollment. In this case, as in many other similar situations, it is probable that the excess capacity would last for some time (e.g., for the balance of a school year) after project closure.

The implications of a reduced tax base and revenues on public services should be considered. First, the sales tax revenue due to direct, indirect, and induced project purchases would decline. Later, the net proceeds taxes, corporate income taxes (if any at the time of closure) and individual income taxes from departing residents would cease to accrue to the state. The assessed value of the project property would decrease in an amount which could depend on the specific timing and other conditions surrounding closure (e.g., if closure occurred after the full production term (29 years), the reduction in assessed value would be less than if the project ended in mid-production). Property taxes accruing to local jurisdictions would similarly diminish. Finally, the assessed valuation of residential, commercial, and other property in the study area may diminish due to reduced demand occasioned by the project's departure. The combined effects of these reductions in the tax base, together with the potentially lagged reduction in service levels, could be an increase in tax rates to the remaining residents of the study area, in a magnitude and duration which would depend on the specific circumstances of closure. Tax base reductions in Lincoln Township, Forest County, and the Crandon School district could be very substantial.

The specific circumstances which would influence the severity and duration of closure impacts are primarily the timing of the closure in the operations sequence (and therefore in the level of public services and revenues resulting) and the lead time between announcement and closure. If the project operated for the full production term or if there were announced a future closure well in advance, the affected individuals and jurisdictions could anticipate the kinds of effects described above, and could thereby adjust their actions accordingly, resulting in significantly diminished and foreshortened negative impacts; these potential mitigation actions are described below.

The private markets which had previously expanded or diversified in reaction to the project could adjust for impending closure by a gradual reduction in capacity (e.g., employment attrition). Reductions in housing and land values could similarly be minimized through anticipation and gradual adjustment of demand, rather than the sudden and disruptive decline associated with unexpected closure.

As with the private adjustments, the severity and duration of the public sector cutbacks could be minimized with adequate advance notice, largely through employment attrition and acceptance of temporary reductions in standards to avoid future excess capacity.

The revenue implications of closure, even where anticipated in advance, are less subject to adjustment and mitigation due to the nature of the projected stream of net proceeds taxes. As shown in Table 3-53 the level of taxation is "kinked" at the twelfth year of operation (i.e., at the exhaustion of the zinc-rich orebody) with significantly lower tax revenues from the mine resulting after that time. If closure occurred before the twelfth year of operation (during massive ore mining), the loss of potential taxes would be significantly greater than the loss which would result after that time (e.g., during stringer ore mining). In the case of other tax revenues, the anticipation of closure would permit adjustment of revenue expectations parallel to service level adjustments so as to minimize the adverse effects of rises in tax rates.

This description of closure impacts should be considered in light of the relative influence of the project on the study area. Where impacts are described, their severity should vary in proportion to the relative significance of the project on the affected area. Thus, for example, the fiscal effects of closure on Forest County would be expected (in most cases) to be greater in both absolute and relative terms than the effects on Oneida County. Similarly, most impacts would be more significant in the townships of Lincoln and Nashville in relative terms than they would be in the Township of Ainsworth. Finally, it should be recognized that the overall influence of the project on the study area (as measured by relative employment or population share) could be characterized as minor to moderate. Therefore, as with other socioeconomic effects, the effects of closure on the study area's socioeconomic condition are not expected to be more than minor to moderate.

SUMMARY OF FISCAL AND ECONOMIC IMPACTS

Based on the previous analyses and on the stated assumptions, the overall or "net" fiscal and economic impacts of the project are not expected to be substantially adverse. That is, the sum of all the identified costs would be compensated by the corresponding revenues and other benefits. This summary is based on the assumption of project construction, operations, and closure as proposed by Exxon. During this period, some sectors and governmental entities (i.e., cities, counties, towns, tribes), could be impacted with greater costs than revenues while others could be impacted with greater revenues. In addition, a sector or municipality might experience net costs during a particular project phase or for successive years, followed by net gains in the next project phase or years.

The significant positive and negative effects of the project which would impact the local study area include: 1) labor costs (employee benefits) and expenditures (local and state purchases) during construction, 2) direct (mine/mill) and indirect (project-induced) labor costs during operations and closure, 3) materials and supplies purchased during operations, 4) increased assessed valuations from private, industry, and project-related sources and property taxes paid to local municipalities and the Crandon school district, 5) statewide effects such as corporate income tax and sales tax, which indirectly benefit the local area, 6) identified costs to municipalities and school districts to provide necessary services to Exxon and the project-induced population, and 7) Mining Impact Board payments to municipalities and a portion of net proceeds taxes paid to the state.

Under some other scenarios of mine development and operation, and under other definitions of "economic impact" the conclusion of net fiscal and economic impacts is less clear. The worst case, in fiscal terms, would occur if mine construction were terminated at peak employment, thereby minimizing collection of project-related taxes. Under this scenario, the increased public service and facility costs would have been incurred simultaneously with the inmigration of the construction work force; however, the corresponding revenue stream would be significantly diminished. First, no net proceeds taxes would be collected, since no mine operations would have commenced; likewise, no corporate income taxes could be collected. The sales taxes associated with the inmigrant construction work force would be correspondingly reduced, as would any increases in assessed valuation due to the construction of additional residential and commercial structures. However, the construction of even part of the facility would result in increased economic activity in the study area to the extent that materials and services were purchased locally. Also, the constructed improvements at the mine site would result in significantly increased valuation in the taxing jurisdictions. Nonetheless, it is probable that, if the project were terminated at the peak construction phase, the project would result in "net substantial adverse economic impact."

The most likely scenario for early mine closure would be after the massive (zinc-rich) ore had been mined. Table 3-53 indicates a sharp reduction in profitability as identified in net proceeds tax estimates, between years 2006 and 2007. The latter year would be the first scheduled year of mining the stringer (copper-rich) ore. Under certain economic conditions, Exxon could choose to temporarily suspend or terminate operations at that time.

Early mine closure after the massive ore phase would result in cessation of wage income (direct and indirect) to workers, elimination of most of Exxon's local purchases for supplies and services, reduction of economic activity stimulated by the project, and substantially reduced or no corporate income, sales and net proceeds taxes paid. All of these impacts would be identical to those which would be expected to occur at scheduled project closure. However, if this were a project suspension, property taxes would be paid by Exxon until after closure and until it disposed of the land.

In addition, there would be at least two fiscal differences between closure after 16 years of operation and closure after 29 years of operation: 1) by the end of year 16, about 90% ($106 million) of the total net proceeds taxes estimated for 29 years of operations would have been paid, because the massive ore is more valuable than the stringer ore at current prices; and 2) total assessed value of the mine/mill facility (Table 3-49) is higher earlier in the operations period, resulting in the greatest impact on local tax reduction early in the project, although it would be significant throughout the project.

While the greatest costs of the project to municipalities are in the final year of construction, the greatest revenues from the project accrue shortly thereafter. Overall revenues from numerous sources (e.g., construction wages and purchases, operations wages and purchases, property taxes, net proceeds taxes) soon would be greater than costs based on the assumptions previously stated. In addition, because tax benefits to local communities and net proceeds taxes would be greater early in the project, it is expected that closure after the zinc-rich ore was mined would not result in net significant adverse economic impacts.

Therefore, under the most likely (the proposal) and mid-term closure scenarios of project development, the conclusion is that, given the prevailing assumptions, all available and credible evidence suggests that the project would not result in significant adverse economic impacts.

CUMULATIVE MINING IMPACTS

POTENTIAL MINING OF NEARBY OREBODIES (CUSTOM MILLING)

If the mine/mill is developed, two nearby massive sulfide orebodies may be developed with the ore custom milled at the Exxon site. Such agreements would eliminate the heavy financial burden of constructing individual milling facilities and would avoid the need for separate tailings ponds.

The Mole Lake deposit, about five miles west of the Crandon orebody, is beneath the Mole Lake Indian Reservation. According to a 1982 U.S. Geological Survey (USGS) news release, six borings were made near Bishop Lake by the USGS for the Bureau of Indian Affairs. The borings were as much as 1,100 feet deep and all encountered mineralized rock. Copper is the most abundant metal, but zinc, lead, and silver also are present. According to the 1982 news release, no further studies of the occurrence were planned by the USGS, and any future exploration or mining would be at the discretion of the Mole Lake Tribe.

The other occurrence is the Noranda orebody located about 20 miles northwest of the Exxon site on the Pelican River in Oneida County. Information presented by the company in 1976 indicated the Noranda deposit has about 2.2 million tons of ore averaging 4.5% zinc and one percent copper. Noranda stated the deposit was too small to develop independently but would consider the use of the Exxon mill at Crandon. Noranda has continued to be active in metallic mineral exploration in Wisconsin, but has not proceeded with the development of the Pelican River deposit.

It is not possible to predict the likelihood of developing one or both of these deposits by using the Exxon mill to concentrate the ore. Exxon has indicated such an arrangement might necessitate changes in the ore concentrating processes to accommodate the different ore characteristics. Exxon has not expressed interest in such arrangements but circumstances could alter that position in the future.

If custom milling was sought, Exxon would have to change their solid waste operating license as well as their mining and reclamation plans and plan of operation. Such a change could be considered a modification of the mining permit and a hearing might be requested if five or more interested persons would petition the DNR. Further, Wisconsin Administrative Code Section NR 182.05(1) states the license for the tailings ponds would be issued for the design specified in the determination of site feasibility. If Exxon later chooses to ask for an increase in design capacity to accommodate tailings from outside ore, the feasibility review process would be reopened, and public hearings could be held.

EFFECT ON MINING IN WISCONSIN

If Exxon successfully obtains the necessary permits and approvals, other companies with metallic mineral orebodies may be encouraged to go forward with their permit applications. The world market situation for copper and zinc, however, would probably be the determining factor as to whether applications for other orebodies would be submitted. The two orebodies for which applications are most likely include the Kennecott copper deposit near Ladysmith in Rusk County and Noranda's Pelican River deposit in Oneida County. Both of these orebodies are very small compared to the Crandon orebody. Several other metallic mineral occurrences are known but none appear to be likely candidates for permit applications.

Exploration activity in Wisconsin may increase if Exxon obtains the required permits, but world metal markets have more influence on the amount and type of exploration activity than any other factor.

If Exxon's permit conditions are extremely stringent, a dampening effect on exploration activity and permit applications for other orebodies may occur. Such a situation is possible, but each deposit is unique and permitting requirements would be determined on a site-specific basis. Therefore, possible permit conditions relating to the Exxon project would have little relevance to other potential mining activities.

RISK ASSESSMENT

Section NR 132.07, Wisconsin Administrative Code, requires that a risk assessment of possible project hazards be prepared and submitted as part of the mining plan. In addition to identifying the various risks, appropriate contingency measures also must be identified for each risk. For purposes of satisfying the code, for an occurrence to constitute a risk, the occurrence must result in a release of contaminants or other deleterious material to the accessible environment. Thus, the risk for an event is a measure of the frequency of occurrence and resultant consequences, with the primary factor being the resultant consequences. For example, if an event had a high recurrence level but posed no environmental threat, the risk of that event would be low.

The approach employed was to base the risk assessment on the judgment of engineers, historical data for related industries and semi-quantitative techniques. Events with potential environmental effects judged to have occurrence probabilities of 10^{-2} per year (e.g., 1 occurrence in 100 years) or greater are classified as high. Those with projected probabilities of 10^{-4} per year (e.g., 1 occurrence in 10,000 years) or smaller are classified as low, and significantly consequential events that fall in between 10^{-2} and 10^{-4} are termed moderate. Following are the various risks and the appropriate contingency measures:

ON-SITE REAGENT SPILLS

During the life of the project, many different reagents would be delivered, stored, handled, and used during ore processing. Small reagent spills and leaks would occur quite frequently over the life of the project. On-site reagent spills could result in locally hazardous working conditions, they could present a potential threat to the environment, and they would be costly and disruptive. As an overall practice, reagent storage, delivery systems and handling systems/procedures are designed to prevent spills and leaks. Project facilities are designed so that spills or leaks are contained, thus facilitating cleanup. These factors combined with the judgment and observations of experienced industry personnel indicate on-site reagent spills with resultant environmental impacts would be a low probability event.

Project facilities would be designed with curbs, concrete floors, and other containment and recovery features to contain spills. Further, the groundwater contingency plan and the federal spill prevention counter-measure and control (SPCC) plan would specify handling and cleanup procedures. In the event of a spill, the following general steps would be followed: 1) The person observing the spill would briefly assess the situation, and report the spill to proper personnel; 2) The area of the spill would be secured; 3) Using trained personnel and designated procedures, the spilled material would be recovered to the extent possible, and unusable material would be disposed at an approved site; 4) An investigation would be conducted to determine the cause of the spill, and what if any, measures should be taken to prevent future occurrences.

FUEL SPILLS

As with reagent handling areas, the fuel storage area is designed to contain any spilled material. Fuel tanks would be surrounded by containing berms and underlain by an elastomeric membrane liner so that large volume spills due to rupture of a fuel storage tank would present no threat to surface or groundwater. Therefore, this assessment focuses on small quantity spills which are more likely to affect the area. These spills could result from leaking pipes and hoses or careless handling.

Prior to construction of the fuel storage tank and berms, spills would be absorbed into the soil. The effects of such spills would be short-term localized contamination of soil and emission of fuel vapors. Long-term effects would not result because contaminated soil would be removed and disposed in accordance with the SPCC plan.

During operation, fuel would be handled only at the fuel station and the lined fuel storage area. A fueling station would incorporate modern dispensing equipment, hard-surfaced drives, curbs, and sewers. Minor spills would be cleaned using absorption material or would be flushed to the storm sewers and then to the industrial wastewater treatment system. In the event of a tank rupture or other major spill at the fuel storage area, spilled fuel would be contained within the berms and the fuel would be pumped to a tanker truck for disposal or to a reprocessor as appropriate.

Given the proposed handling precautions, fuel spills would be a low risk event. Further, the proposed cleanup measures would minimize to the extent possible, long-term effects.

ON-SITE CONCENTRATE SPILLS

Three concentrates (zinc, copper, and lead) would be produced and handled on the mine/mill site. Spills of concentrate could occur as a result of conveyor malfunctions or train accidents. Both of these occurrences are low recurrence rate events. Further, the concentrate is an insoluble solid amenable to cleanup, and impacts of a spill would be temporary and very localized mainly due to the mechanical disturbance associated with cleanup. Also since the concentrate is a valuable material, recovery of a spill would be expected in a timely fashion. The low rate of occurrence and the minimal resulting impacts make on-site concentrate spills a low risk occurrence.

The methods used for recovery of concentrate would depend on the extent of the spill. Minor spills would be cleaned up using shovels and wheelbarrows, while recovery of major spills would involve the use of front end loaders and trucks.

MWDF LEACHATE CONTROL SYSTEM FAILURE

The two control systems (the bottom liner/underdrain and reclamation cover) are designed to minimize the seepage of leachate into groundwater. Failure or inadequate performance of either of these systems would result in increased seepage from the MWDF and greater potential for groundwater contamination. Depending on the duration and extent of increased seepage and the quality of the seepage, a long-term effect could result. Increased levels of sulfate and total dissolved solids in groundwater are the most likely impacts . Combining the natural characteristics of the site and engineering features of the facility, seepage of contaminants off-site resulting in significant groundwater quality degradation as a result of a leachate control system failure is felt to be a low probability low risk event. Monitoring of the MWDF to determine the amount of seepage would be conducted throughout the operation. If increased seepage should occur or appear imminent, the evaluation and assessment procedures detailed in the contingency plan would be implemented. The appropriate remedial responses are presented in the groundwater contingency plan and summarized in Chapter Four (Alternatives). The actual corrective action would be determined after conducting a thorough assessment of the problem.

EMBANKMENT FAILURES

A failure of a tailings pond or reclaim pond embankment could result in a serious but reversible impact to large areas of land. The ponds are designed to withstand concurrent severe, natural conditions. The proposed revegetation and maintenance of the outer slopes would minimize erosion, thus adding to slope stability. Side slope grades, construction controls, soil characteristics, and runoff control all limit the potential for slope failures. For these reasons failure of an embankment is a low probability occurrence and also poses a low level of risk.

In the case of a major embankment failure, the immediate response would be to take whatever measures are necessary to ensure public safety. After that, the affected area would be restored and reclaimed using methods appropriate for the given situation. In the case of a minor embankment failure or leakage through the embankment, the affected area would be repaired immediately and additional construction or design modifications initiated in order to prevent further problems.

SUBSIDENCE

Surface subsidence could present a potential source of risk during all phases of the project. If subsidence would occur the effected area should be limited to the surface area directly over and/or adjacent to the mine. The two main processes of subsidence would be overburden consolidation and rock failure within and around the mine. Evaluation of the mining methods and studies on the characteristics of the bedrock, backfill, and overburden indicate the maximum possible surface subsidence would be less than six inches. The predicted maximum possible subsidence is within allowable limit for conventionally designed buildings. There should be negligible effect on topography and land use considering the irregularity of the existing land surface and variability in thickness of the glacial overburden. Thus, subsidence is viewed as a low risk event. If significant subsidence would occur such that surface impacts result, the affected area would be reclaimed in accordance with section NR 132.08, Wisconsin Administrative Code.

LEACHING FROM THE ABANDONED MINE

After mining, salvageable and potentially toxic material would be removed from the underground workings. Groundwater interceptor drillholes, backfill delivery boreholes, and fuel supply pipelines would be grouted. Following these activities, the mine would be allowed to flood.

Under different geologic conditions, such as those encountered in southwest Wisconsin, flooding of an abandoned mine and the surrounding areas could result in groundwater contamination. Groundwater quality and flow data collected during baseline studies, however, indicate there is only a very small vertical hydraulic interaction between the orebody and the overburden. This situation is not expected to change significantly after mining, since the mining process would not result in major bedrock fracturing or leave large unfilled areas after mining. Thus, the post-mining groundwater regime should be essentially similar to pre-mining conditions. Contamination of the glacial aquifer is not expected to present a risk. However, if contamination would result from the mine, the approach specified in the groundwater contingency plan would be followed and the appropriate remedial action would be developed and implemented.

TAILING PIPELINE FAILURES

A buried high density polyethylene (HDPE) pipeline would be used to transport tailings slurry to the MWDF. In determining the appropriate pipeline specifications, the physical properties of HDPE such as resistance to corrosion and abrasion, friction pressure loss and installation methods were evaluated. The pipeline is designed to operate for the duration of the project without replacement. These design considerations combined with the proper installation, flow pressure monitoring, and periodic inspections should limit leakage and allow rapid identification of leaks. Damaged sections of pipline would be excavated, contaminated soil would be removed and new sections of pipe would be installed. If a leak would occur, the impacts should be confined to the area immediately around the leak. Therefore, the risk of a significant failure of the tailings pipeline is judged to be low.

MINE/MILL FIRES

Operation of the mine requires the use and storage of certain combustible materials. Unlike some other sulfide mines, there is no potential for combustion of the ore, waste rock or backfill. Therefore, fires which might occur underground should be of short duration and confined to limited areas. Based on records from all types of copper, lead, and zinc mines, it is estimated that the maximum frequency of mine fires is 0.2 fires per year or one fire every five years.

In accordance with Mine Safety and Health Administration requirements, appropriate precautionary and mitigation measures would be incorporated into the planned mine operation. Installation of fire suppression systems, widespread distribution of fire extinguishers, availability of larger fire fighting units and employee safety programs should minimize the risk and provide a rapid response to extinguishing the fire.

Mill fires also could occur, but the risk of a major fire are judged to be low. The probability of an unanticipated surface fire is less than one fire over the life of the project, and the duration of such fire would be less than four hours. An on-site fire control vehicle using Exxon personnel would be used to contain or extinguish small fires. To control a large fire outside assistance might be required.

FOREST FIRES

Forest fires present a risk during the project. The potential for a fire to start off-site is always present and independent of the existence of the project. Fires also may start on-site and spread to the surrounding area. The potential for fires along the railroad and access road corridors would be minimized by controlling the presence of undesirable vegetation. If a fire would occur, fire fighting equipment and personnel would be available to ensure prompt response. If a major fire would occur on-site, the large amount of cleared land surface associated with the project might act as a fire break, thus impeding the spread of the fire off-site. The occurrence of a major forest fire is a low risk event.

ACCIDENTAL EXPLOSIONS

Underground mine development and operation requires the use of explosives. An accidental ignition of explosives and blasting supplies stored and handled on-site would present a hazard to personnel in the vicinity. The greatest hazards would be from falling debris or fires. Transportation, storage and use of explosives would be in strict compliance with state and federal regulations. Historical data from the mining industry indicate such an occurrence would be a very rare event. Considering the siting, design, and operating factors, the risk of an accidental detonation is low.

WATER TREATMENT SYSTEM FAILURE

Monitoring programs are designed to ensure that treated discharge water would meet specified standards. If the system malfunctioned and the water did not meet standards, the water would be diverted to the reclaim ponds while the system was repaired. The longest predicted duration of shutdown due to either planned or unplanned events is three weeks.

The reclaim ponds are designed not to leak but would be equipped with a leak detection/collection system. Therefore, if leaks would occur, they would be detected, and a contingency plan would be implemented. This contingency plan would be similar in approach to that for the MWDF. The most likely remedial action would be to drain the leaking pond and repair the liner. Removal of one of the ponds during repair would necessitate operational changes in order to maintain the normal level of production.

It is anticipated there would be occasional planned and unplanned shutdowns of portions of the treatment system. However, due to frequent monitoring and in-line testing of the treatment system and operational contingencies, failure of a component of the treatment system does not present a significant threat to the environment.

AIR POLLUTION CONTROL SYSTEMS FAILURE

Several air pollution control systems would be incorporated into the project facilities. The normal airborne emissions would be only a few percent of allowable regulatory limits. As a result, if one or more of these systems were to malfunction or fail, considerable margin exists so that operations could continue during repairs. Thus, no off-site impact in violation of the regulatory limits is foreseen, and this occurrence is consequently judged to be a low risk event. A malfunction prevention and abatement plan for credible failures of air pollution control systems would be contained in the air permit. This plan details how the air pollution control systems would be regularly evaluated to determine if the systems are functioning and being maintained properly.

EROSION CONTROL STRUCTURE FAILURE

Failure of structures used to control erosion and drainage would result in localized erosion and sedimentation. Due to the relatively small volume of water handled by these facilities and their design and maintenance features, no long-term off-site impacts would result. It is expected that regular maintenance of temporary structures would be required as long as they are in use. The permanent structures should require minimal maintenance and are designed to accommodate a 25 year, 24-hour storm event. Failures of erosion control structures would be corrected by rebuilding the structure, regrading, and revegetating any washed-out areas. Such failures are viewed as low risk occurrences.

NATURAL PHENOMENA

Natural phenomena such as earthquakes, tornadoes, extreme wind conditions, and extremely high precipitation events are relatively rare. Project facilities have been designed with certain margins of safety so that such occurrences would result in minimal damage, as discussed above. Thus, these natural events are low risk occurrences.

REAGENT CHARACTERISTICS AND EMERGENCY RESPONSE PROCEDURES

The following list of reagents (see Table 1-5) are proposed for use in the ore flotation and water treatment processes. They would be shipped by truck or rail to the site, stored, and used as previously indicated. A risk index or hazard analysis for each reagent is not available. However, the reagents' characteristics and required emergency response procedures if a spill occurred are presented.

Sulfur Dioxide- A nonflammable gas which can explode when exposed to intense heat. It is potentially harmful when ingested, varying from irritation to lethal. Skin contact is harmful. Contact with water and intense heat may cause flash back and explosion. The emergency response procedures in the event of a release are to evacuate an area within 1/4 mile and approach the area with self-contained breathing apparatus and protective clothing. Large amounts of water with diking to prevent runoff would be used around the spill area while the container is being repaired.

Copper Sulfate- A strong irritant and toxic if ingested. It is flammable and would produce a bluish smoke when on fire. It is also soluble in water. The response is evacuate the spill area and approach up-wind with self-contained breathing apparatus. The spill area should be diked to avoid further contamination while container repair operations are conducted.

Sodium Cyanide- A poison which is harmful when ingested, inhaled, or comes in contact with the skin. A cloud of gas, dust, or smoke will form when released from container. If ignited it could become flammable gas and burn with explosive force. The area should be evacuated up to 1/2 mile, and self-contained breathing apparatus and a chemical suit or splash suit should be worn. Large amounts of water should be used to cool container tanks, and a dike should be set up to handle further contamination.

Polypropylene Glyco Methyl Ether- A liquid which is flammable and can explode when exposed to intense heat. The response in the event of a spill or release is to dike the spill area and conduct patching operations. Large amounts of water should be used to cool container if it is located near a fire. Responders should also use self-contained breathing apparatus near the spill area.

Sodium Sulfide- A flammable solid which is potentially harmful when ingested, breathed, or in contact with skin. It is spontaneously combustible and will easily ignite when released near a heat source. In a hydrated or solution form it could cause frostbite when in contact with compressed liquid gases. The response should be evacuate spill area and approach container with self-contained breathing apparatus and chemical suit. The spill area should be diked and large amounts of water used to cool tanks near a fire or used on the fire.

Xanthates- These are salts and xanthic acid which are minor irritants. They are soluble in water and are a moderate fire risk. The response should be to dike area and use protective clothing such as a splash suit.

Zinc Sulfate- This will burn and can produce a poisonous gas. It could cause burns to skin and eyes. The response procedures are to approach the spill area with self-contained breathing apparatus and a chemical suit. A dike should be set up to prevent further pollution. Water should be used only if the container is in or near fire.

Starch- A carbohydrate polymer which is white, amorphous, and tasteless. It is harmless by itself.

Sodium Dichromate- A noncombustible liquid which has a violent rupture potential when container is exposed to intense heat. It can be toxic when breathed, ingested, and touched. Since it is a rapid oxidizer it presents a serious fire hazard when it is in contact or mixed with fuels or any combustible material. Response procedures include the use of self-contained breathing apparatus and a chemical suit. If exposed to fire, blankets of water should be used, otherwise a dry chemical should be used to suffocate the spill area.

Sodium Silicate- (water glass) A noncombustible, nontoxic substance.

Activated Carbon- A flammable and combustible material which can be ignited by heat, sparks, or flames. It may burn rapidly with a flare effect, produce poisonous gases, and burn the skin and eyes as well as posing a pollutant effect. Response procedures include the use of self-contained breathing apparatus and protective clothing. Large amounts of water should be used when the material is in or near fire.

Methyl Isobutyl Carbinol- A flammable liquid which has a violent rupture potential when containers are exposed to intense fire. Its smoke or vapors are toxic. A vapor cloud will travel along the ground and settle in low places, where the potential of flashback and explosion exists. Response procedures involve self-contained breathing apparatus and using water in low areas, followed with diking the spill area. As in all incidents which have potential for explosion, the area should be evacuated.

Lime- Lime can be toxic and flammable and will erupt or burn violently when in contact with water. When ignited a flammable gas is released which travels on the ground and settles in low places producing the potential for flashback and explosion. Lime can be handled by removing it from water; otherwise, a chemical spray can be used until clean-up and recovery operations begin.

Caustic Soda- This is toxic and corrosive. Contact with water may cause a violent reaction, fuming, or fire. If it is ignited a flammable gas could be produced having a potential for flashback or extensive fire. Response should include the use of dry chemical foam and self-contained breathing apparatus.

Soda Ash- A nontoxic, noncombustible material used as a pH modifier.

Sulfuric Acid- A corrosive liquid which will burn skin, eyes, or lungs. Contact with water may cause violent reaction, fuming, or burning. Sulfuric acid may ignite producing toxic vapors and a flammable gas. Response should include the use of self-contained breathing apparatus and a chemical suit. The spill area should be evacuated and a dike set up to abate pollution.

Ferric Sulfate- This material will burn but not ignite readily. It can produce a poisonous gases. Response should include the use of self-contained breathing apparatus, protective clothing, and the use of a dike to handle the spill area.

Sodium Hexametaphosphate- Is soluble in water and insoluble in organic solvents. It is used to soften water, inhibit corrosion and prevents precipitation of slightly soluble scale-forming compounds. Commonly called "calgon".

Flocculant- A substance that induces an aggregation of suspended particles to form small clumps. Exxon may use an organic flocculant such as polyacralamide, a water soluble, solid material. When it burns it can produce noxious fumes. The response to a release is use of protective clothing. If the tank is on fire the responder should approach upwind using large amounts of water and dike the area to prevent runoff. An evacuation of the area should be conducted a minimum of 1/2 mile radius.

CHAPTER FOUR
ALTERNATIVES TO THE PROPOSED PROJECT AND THEIR ASSOCIATED IMPACTS

IMPLEMENTATION AND PROJECT SCOPE ALTERNATIVES

NO ACTION

The no action alternative is abandonment of the project by Exxon. The environmental impacts of a no action situation are essentially those impacts presently occurring or those that would occur under the existing land use and predicted trends without mining. Exxon's existing employees would likely leave the Rhinelander area, and Exxon would close its Rhinelander office. Exxon might sell the land and mineral rights, or consider other options. If no action is taken on the project, all the drill holes would be permanently abandoned and the sites regraded and revegetated. The drill sites would eventually revert to forest species. Permanently abandoning the drill holes could allow Exxon to secure the release of its exploration bond.

A no action alternative would have fiscal implications for the Local Investment and Mining Impact Fund Board (MIB) and the State of Wisconsin. During the permitting period (1983-1986), the Fund paid $100,000 annual block grants to Lincoln and Nashville townships and two tribes (Mole Lake Chippewa and Forest County Potawatomi) in the vicinity of the mine. The source of the funds was through loans authorized by the legislature based on the assumption that the loans would be repaid after mining began. Without a mining project, there would be no immediate source of revenue to the MIB for loan repayment.

PROJECT EXPANSION OR REDUCTION

In general, there is an optimum rate of ore removal for a given orebody. The most important factor influencing ore removal is whether the orebody can be mined by surface methods (open pit or strip mining) versus underground methods. For an underground mine, orebody characteristics such as size, shape, orientation, maximum depth, degree of weathering, and ore grade and distribution influence the method of ore removal while the production rate is limited by the ore hoisting capacity of the production shaft(s). Expanding the size of the main shaft or increasing the number of production shafts to increase production would be expensive. Moreover, the mill facilities also would have to be upgraded otherwise there would be little benefit to this alternative.

Mine/mill production must provide a satisfactory economic return. Though an increase in production over the proposed rate is possible, a significant increase seems unlikely. An accelerated production rate would speed up some of the predicted impacts (e.g., tax generation, tailings leachate generation). Significant metals price changes could result in changes of the rate and amount of massive and stringer ore removal as well as changes of the estimate of ore reserves.

Long-term reductions in the rate of ore removal and processing could occur under certain economic and marketing conditions. Mining companies have reduced production in order to retain key employees while they wait for the end of adverse market conditions. Short-term causes include a breakdown of one or more ore processing elements, transportation problems, fires or other reasons. These possible interruptions are alleviated by surge storage areas for the ore or the concentrate (coarse ore storage building, concentrate storage and the preproduction ore storage pad) so that at least part of the process could continue. Fixed costs, such as mine pumping, would continue even if the mine were temporarily closed. A temporary reduction in operating rate would not significantly alter the environmental impacts other than extending the impacts over a longer time period and delaying final reclamation. Staffing, taxes and other socioeconomic impacts would depend on the severity and longevity of the reduced production.

The life of the mine might be extended if greater ore reserves were discovered. In general, metallic mines have a lower grade but a greater tonnage of ore than expected. If this occurs, some changes in permits, such as the solid waste license, would be necessary to account for the increased volume of

tailings. Environmental impacts would be much the same as presently predicted, but they would extend over a longer period and the return of the area to a non-mining condition would be delayed.

Another alternative is the processing of ore from other nearby orebodies in addition to the Crandon deposit. The implications of this alternative ("custom milling") are discussed in the Cumulative Impacts section of Chapter Three.

An unlikely alternative is a shortened mine life due to lower than anticipated ore reserves. Due to the large number of drill holes (over 200) penetrating the orebody, the extensive assays performed, and the large amount of geological analysis of the orebody, it seems more probable that the ore reserves might be greater than anticipated. This is especially true because the bottom of the orebody has not been completely defined. Such definition by surface drilling is difficult and expensive. The customary method is to drill from underground mine openings as the mine is developed.

A variation of the shortened mine life alternative is the closure of the mine after the massive ore phase. This could occur if the anticipated economic return on metal concentrates to be produced during the stringer ore phase is less than desired by Exxon. If the project were terminated after the massive ore phase (project year 19), the impacts would be lessened. The 24,500,000 ton stringer orebody would be left intact. Approximately 150 acres would not be covered because tailings pond T4 and the last cell of the landfill would not have to be constructed. Of this total about 15-18 acres would be wetlands. Electric power, natural gas, and liquid fuel consumption would be cut by 30 to 35 %. Noise and traffic levels would return to pre-mining conditions about 13 years sooner. Return of the land to forestry and recreational uses would be hastened by early mine closure.

The groundwater drawdown caused by mine inflow would be slightly smaller and of shorter duration than if the project had continued. In addition, the amount of leachate seeping from the tailings would be reduced by about 30% because only three tailings ponds would have been built. Discharge of treated process and mine intercept waters to Swamp Creek would cease in year 19, and mitigation of surface waters would end several years after closure.

A variant of the massive ore only mining scenario is massive ore mining with removal of select portions of the stringer orebody. This variant clearly depends on the relationship between anticipated revenues compared to anticipated expenses. If select portions of the stringer orebody were mined, the impacts would range between the proposed 29 year mine life (massive and stringer) versus a 16 year mine life (massive only).

DELAY MINE DEVELOPMENT

Given the present low prices for zinc and copper as well as the projected price trends, it may not be profitable to develop and operate the Crandon orebody for some time. A delay in mine development could occur following the Master Hearing even if the necessary permits were issued. One of the permit conditions, however, could be a time limitation within which construction must begin or the permits would be voided. A delay would provide more time for incorporation of new technologies which could increase environmental protection. A negative aspect, however, could be that baseline data might become outdated if data collection is discontinued. Depending on the length of the delay, new baseline data may have to be collected and interpreted.

SITING ALTERNATIVES

Provisions of the mining permit include locational criteria for mining-related facilities. These criteria include avoidance of sensitive areas such as archaeological or historical sites, scientific areas, parks, locations within 1,000 feet of a lake or 300 feet of a river or stream, within 1,000 feet of a roadway, or within wetlands (to the extent possible). These criteria were used in the screening of alternative locations for mining-related facilities.

MINE/MILL

To provide access to the underground mine, the mine surface facilities must be located near the orebody. Given the orientation of the deposit and the proximity of Little Sand Lake, the headframe and mine surface facilities are situated in the only viable location.

The mill facilities need not be located in the immediate vicinity of the mine, but the impacts are less at the proposed location than at an evaluated alternate location northeast of Duck Lake. Greater environmental impacts would result at the Duck Lake location because of greater land disturbance due to facilities duplication and the need for additional facilities not required for a combined mine/mill site. Facilities such as access roads, the railroad spur, power lines, water supplies, wastewater discharge pipeline, sanitary waste systems, parking lots, sedimentation basins, and various service buildings would be duplicated or extended. Additional facilities would include a road or conveyor system for transporting ore to the mill, and pipelines for transporting backfill to the mine and mine water to the water treatment system. The siting of the MWDF also might change if the mill were moved to the Duck Lake site. In addition to the greater land disturbance due to the duplication of facilities, the creation of additional facilities would increase project energy usage. These factors make separate sites for the mine and mill facilities economically and environmentally less desirable.

MINE WASTE DISPOSAL FACILITY (MWDF)

Alternative sites for the MWDF were evaluated based on the following criteria: least overall adverse environmental impact, minimum use of wetlands, minimum site visibility, and least impact to surface water and groundwater. In addition, both industry practice and state regulations favor disposal locations in the same watershed as the mine/mill, tailings pipelines as short as possible yet not crossing wetlands or streams, and minimal drainage area above the disposal site. Exxon's MWDF siting studies, given the siting criteria, gave preference to: (1) a confined site design, (2) an upland area with maximum separation between tailings and groundwater, (3) close proximity to the mill, (4) avoidance of lake and stream crossings, and (5) maximum use of site soils as building materials. This siting procedure led to the selection of the upland location, site 41 (the proposed MWDF location), as the best disposal area.

Siting Studies

Dames and Moore, an Exxon consultant, used preliminary information from the early project design to examine potential disposal sites within 12 miles of the mine (Fig. 4-1). Soil borings from approximately half of the identified sites were used to establish baseline characteristics. The alternative MWDF sites (Table 4-1) were separated into three series based on different site designs.

Table 4-1
Characteristics of Potential Tailings Sites

Site Number	Distance from Mine (miles)	Area (acres)	Estimated Storage[1] Capacity (yd^3) (million)	Disposal[2] Technique
1	1.4	300	12	1
2	2.8	350	22	1
3	2.1	250	4	1
4	2.0	600	15	1
5	1.2	200	4	1
6	2.4	500	19	1
7	5.9	650	10	1
8	4.8	650	22	2
9	6.0	250	10	1
10	3.6	350	13	1
11	4.1	150	7	1
12	5.0	200	7	1
13	5.9	600	7	1
14	7.1	300	10	1
15	6.4	100	1	1
16	6.3	350	9	1
17	6.4	250	5	1
18	7.6	250	4	1
19	7.2	500	15	1
20	3.9	450	8	1
21	2.2	200	1	1
22	4.2	300	7	1
23	7.4	450	15	1
24	6.1	600	20	1
25	3.5	200	4	1
26	6.4	200	5	1
27	5.2	200	2	1
30	2.3	600	22	2
31	3.9	1,000	22	2
32	6.6	650	22	2
33	6.8	500	22	2
34	8.1	650	22	2
40	1.3	650	22	2
41	1.6	650	22	2
42	3.6	650	22	2

[1] Conservative volume estimate; could be greater by increasing average depth. Required disposal volume is 22 million yd^3

[2] 1 = Tailings Dam
2 = Earthen Embankments

Sites 1 to 27, with the exception of site 8, are conventional tailings dam sites. A tailings dam would use native soils and coarse tailings or waste rock to block off the lower end of a natural depression or valley. The finer tailings would be dumped behind the dam, thus filling the valley. Only two sites (2 and 8) had sufficient capacity to contain all of the expected waste volume. Site 8 would completely enclose a large wetland with confining dikes, thus it is unacceptable. Sites 1, 2, 4, 6 and 22, are unacceptable because they block major wetland outlets. Multiple sites would be required if the smaller, drier sites were used to minimize impacts on wetlands and streams. Therefore, most valley-fill sites are too small and environmentally unacceptable because they are occupied by wetlands or streams. Moreover, these sites were located at widely varying distances from the mill, thus increasing transportation and operation costs. Containing and treating leachate from these sites would be difficult.

Sites 30 to 34 are located on broad expanses of glacial outwash. Major disadvantages of these sites are the shallow depth to groundwater and the highly permeable soils. The need for soil borrow areas to build the dikes and the final cover would increase the overall impact of a disposal facility on these sites. These sites have sufficient volume to hold the tailings and would not block streams or occupy large areas of wetlands. These sites would be at or below the mill elevation making gravity or low pressure pumping of tailings possible.

Sites 40 to 42 are drumlin uplands at or above the mill elevation thus eliminating the advantage of gravity flow systems. The soils consist of well-consolidated, moderate to low permeability silty sands (glacial till) and provide the greatest separation between the ground surface and the water table. These sites also minimize transport distances, eliminate most wetland crossings by pipelines, and do not interfere with major surface watercourses. The upland locations have the best soils for constructing dikes and liners, greater potential for deeper excavations, and decreased need for borrow areas. Sites 40 to 42 have only minor confining topographic features, however, and upland sites with earthen embankments (the proposed design) are more expensive than valley fills in terms of construction and material costs. This cost however, is offset by pipeline rights-of-way, construction, and operation costs for distant sites. The drumlin sites closest to the mine/mill are west and east of Little Sand Lake, sites 40 and 41, respectively. Other upland areas are more distant, for example, west of Lake Metonga, between Lakes Metonga and Lucerne, and north of Lake Lucerne.

Only relatively subtle differences exist between the two best upland sites, sites 40 and 41. Both sites would be close to the proposed mill and would meet the "least overall environmental impact" requirement. Site 41, however, has less permeable soils, provides more separation from groundwater, is approximately the same distance from the mill, and has less need for a soil borrow area. Site 41 is consistent with administrative code requirements emphasizing the location of the MWDF within the same drainage area as the mine/mill. By locating the MWDF where surface water impacts and drainage area disturbances are minimal, direct environmental disturbances would be minimized.

Alternative arrangements of the tailings ponds at site 41 were considered to reduce wetland disturbance. These arrangements, however, would have greater surface area and drainage basin disruption with consequent erosion and siltation impacts compared to a compact site which would cover some wetlands.

MINE REFUSE DISPOSAL FACILITY (MRDF)

Some alternative on-site locations for the landfill could be utilized. Advantages of the proposed location are the depth to groundwater and leachate attenuating capacity of the underlying till soils. The proposed location, however, confines the MWDF and reclaim ponds. This location also may interfere with efficient transport of soil materials between the MWDF and the construction support area. The landfill site might be a convenient borrow source or storage location for soil stockpiles. Landfill interference with MWDF construction and operation could be eliminated if one of the following alternative sites was utilized:

1. The wooded area north of the preproduction ore storage pad would be close to the mill and the source of all refuse except for air curtain destructor wastes from MWDF clearing and grubbing operations. The soils in this area are suitable for landfill siting. This location is close to the water treatment plant for leachate treatment.

2. A location west of the reclaim ponds would be suitably isolated (greater than 1,000 feet from both Duck and Skunk Lakes) and the soils are acceptable. This site is covered by till soils and has a depth of approximately 50 feet to groundwater. This location would be easily accessible from both the mill and the MWDF by a side road extending from the haul road. Leachate could be pumped to the treatment plant by a small-diameter pipe along the haul road pipeline corridor.

The two alternative sites, however, would cause more land disturbance and require more monitoring wells.

RECLAIM PONDS

During the MWDF siting process, the reclaim ponds were assumed to be located with the MWDF so a separate siting analysis was not performed. The most effective alternative sites for the reclaim ponds would place them near the mill or between the MWDF and mill. Over 90% of the water pumped to the reclaim ponds comes directly from the tailings thickeners.

Sites between the mill and the MWDF are limited by the presence of Little Sand and Skunk Lakes, wetlands, and the proposed haul road and rail corridors. A location between these facilities would allow gravity flow from both the mill and the MWDF, thus reducing pumping costs. The groundwater table in this area, however, is between 15 to 20 feet below the ground surface and would complicate construction activities. In addition a considerable portion of the Skunk Lake drainage area would be utilized, resulting in disruption of the natural drainage patterns and water flows.

A location north of the mill has adequate acreage and offers potential savings in pumping costs. If this location were chosen, some redesign of the preproduction ore storage pad would be required. Impacts include less runoff/recharge to Swamp Creek and the loss of about 10 acres of conifer swamp. A location near the mill would reduce construction, capital, and operation costs but increase the potential risks to water quality in Swamp Creek.

A slight eastward shift in location of the reclaim ponds (and MRDF) would reduce the impacts to wetland F-15, the bur oak site. It is not expected that such a shift would reduce the volume of soil available for MWDF construction.

ANCILLARY FACILITY SITING ALTERNATIVES

Preproduction Ore Storage Pad

Alternative locations for the preproduction ore storage pad would have greater environmental impacts. A location near the mill, especially the proposed location, is accessible to the haul road, minimizes haul distances, minimizes the total acreage disturbed, and facilitates leachate pumping to the wastewater treatment system. Another advantage would be the availability of waste rock when mine backfill is needed. This pad could be used to store mining equipment or act as surge storage for ore and concentrates if needed. These needs would be best met if the pad were close to the mine/mill.

Haul Road and Pipeline Corridor

Five alternative routes were evaluated for the haul road and tailings/reclaim water pipelines corridor from the mine/mill to the MWDF (Fig. 4-2). Route 3 is nearly identical to route 2 and is not shown on Figure 4-2. Consideration was given to route length, topography, wetland disturbance, potential for wildlife disturbance, and proximity to Sand Lake Road and Skunk Lake. While route 2 is the proposed route, the others are viable alternatives (Table 4-2).

Table 4-2
Alternative Tailings/Reclaim Water Pipeline and Haul Road Corridor Characteristics

Route	Total Length[1] Feet	Area of Wetlands Affected[2] Acres
1	4,400	0.4
2	3,830	0.6
3	3,830	0.6
4	4,370	0.4
5	4,670	0.0

[1] Length from mine/mill area to reclaim pond
[2] Corridor width of 100 feet assumed.

The topographic features for all routes are similar. Routes 2 and 3 (3,830 feet) are the shortest while route 5 (4,670 feet) is the longest. The area of wetlands disturbed by the various alternatives is approximately the same with the exception of route 5, where there would be no wetland disturbance. The maximum area of wetland affected would be 0.6 acre. The wetland crossing for routes 2 and 3 would be in an area of wetland previously filled for drill pad access.

Route 1 would be adjacent to Skunk Lake for several hundred feet, while routes 2, 3, 4 and 5 would be sufficiently separated from Skunk Lake to minimize lake disturbance. Wildlife impacts associated with the alternate corridors would be similar except for potential effects of route 1 on waterfowl use of Skunk Lake. Route 4 would be adjacent to Sand Lake Road for approximately 125 feet while Route 5 would require relocation of approximately 1,000 feet of Sand Lake Road. Relocation of the Sand Lake Road segment would require approval by the Town of Nashville and, might disturb or pass adjacent to a wetland contiguous with Little Sand Lake. The exact placement of the relocated Sand Lake Road segment would depend upon the buffer distance needed between the road and route 5. The potential for increased noise levels and fugitive dust emissions to Little Sand Lake would be greatest for route 5.

Railroad Spur

The railroad spur would be used to ship concentrates and receive equipment and bulk supplies. Aerial tramways and belt conveyors were considered as alternatives but rejected as less suitable. These alternatives required additional land disturbance, duplication of facilities, and greater energy consumption than the proposed railroad spur.

Six alternative corridors were studied between the Soo Line (three miles to the northeast) and the mine/mill site (Figure 4-3). The proposed alternative (corridor D) would result in the fewest impacts from environmental, construction, and operational standpoints. Locational criteria included minimizing wetland and stream crossings, total route length, and encroachment on sensitive environmental areas. In addition, the railroad spur must have gradual curves and a grade of one percent or less. Table 4-3 summarizes characteristics of the alternative rail corridors. Corridor lengths range from 2.2 to 2.9 miles. Alternatives A and F would have the greatest potential impact on major streams because more bridges or culverts would be required. With additional bridge construction, more soil disturbance, erosion, and siltation in streams would be expected. Alternatives A, B, and E would intrude on an environmentally sensitive wetland. Alternative C would pass close to an environmentally sensitive spring pond and a wetland. Alternative C also would require a large earthen cut in the steep-sided drumlin west of Hemlock Creek to meet the required grade.

Distances to osprey and eagle nests are considered acceptable except for corridor A (0.13 miles to an osprey nest). An eagle nest 0.4 miles north of corridor C blew down in 1984 and it is not known whether the eagles will rebuild in the same location. In severe winters with deep snow, deer congregate in the wetlands along Swamp Creek. Alternatives A, B, and E would encroach on more of the Swamp Creek deeryard than the other corridors. None of the corridors however, are expected to have significant adverse impacts on deer yarding. Other wildlife impacts (such as to upland habitat), and impacts on forest resources and air quality would be similar among the various alternatives.

No human residences would need to be removed along any of the corridors. Corridors D and F are the closest to a residence (0.1 mile); corridor C is the farthest (approximately 1 mile). Approximately 0.3 mile of each corridor, except C, would be visible from Keith Siding Road. Planting a buffer strip of trees between the road and railroad spur might be desirable to mitigate noise and visual impacts. About six recreational cabins are located between 0.1 and 0.5 miles from the proposed rail corridor D. All corridors have similar overall potential for noise disturbance of cottage users except C which is approximately one mile from the nearest cottage.

The corridors would cover approximately five acres of agricultural land except corridor C which would not cross agricultural land. Corridors B, C, and D would intersect Berry Lane, a town road, while corridors A, E, and F would cross no public roads.

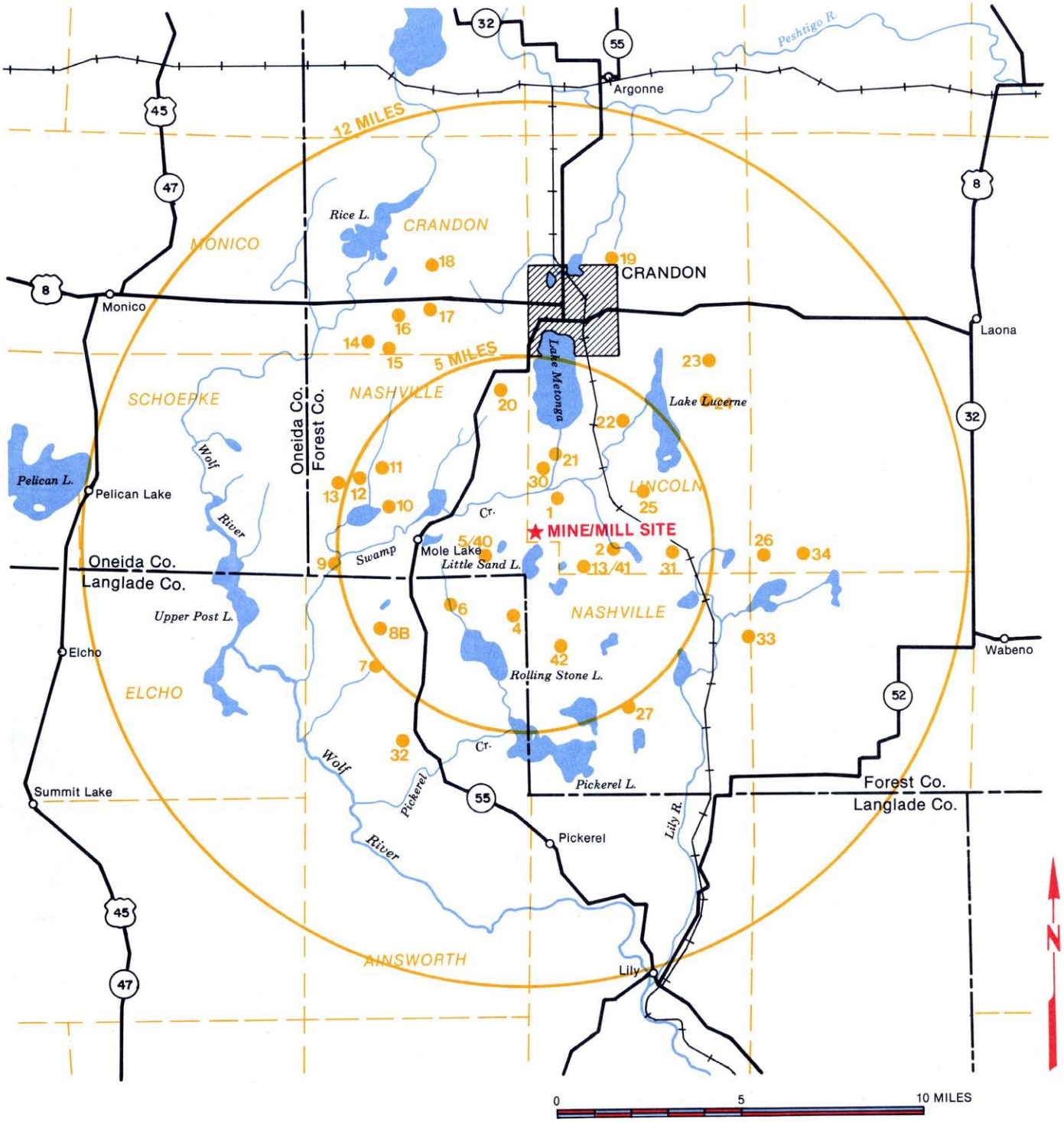
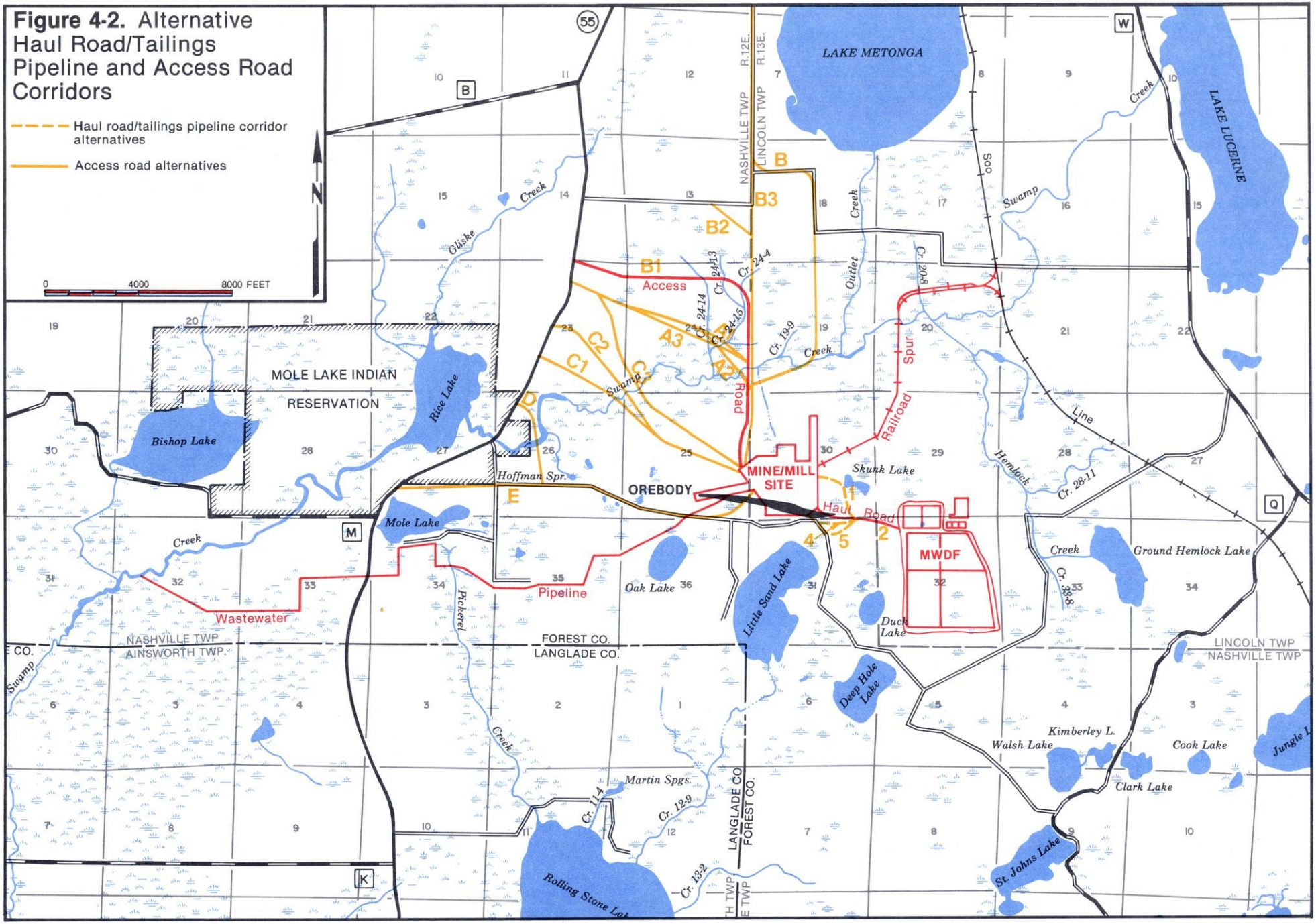


Figure 4-1. Alternative MWDF Siting Locations


Figure 4-2. Alternative Haul Road/Tailings Pipeline and Access Road Corridors
Haul road/tailings pipeline corridor alternatives
Access road alternatives
N
0
4000
8000 FEET
LAKE METONGA
LAKE LUCERNE
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
B
B3
B2
B1
Access
C2
C1
C3
A3
A2
A1
D
E
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Hoffman Spr.
OREBODY
MINE/MILL SITE
Haul Road
Railroad Spur
MWDF
Skunk Lake
Duck Lake
Oak Lake
Little Sand Lake
Deep Hole Lake
Ground Hemlock Lake
Kimberley L.
Walsh Lake
Cook Lake
Clark Lake
St. Johns Lake
Rolling Stone Lake
Martin Spgs.
Pipeline
Wastewater
Gliske Creek
Pickerel Creek
Hemlock Creek
Swamp Creek
Outlet Creek
Cr. 24-4
Cr. 24-13
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
Road
Line
SOO
FOREST CO.
LANGLADE CO.
AINSWORTH TWP.
NASHVILLE TWP
LINCOLN TWP
NASHVILLE TWP
LANGLADE CO
FOREST CO.
55
B
M
K
Q
W

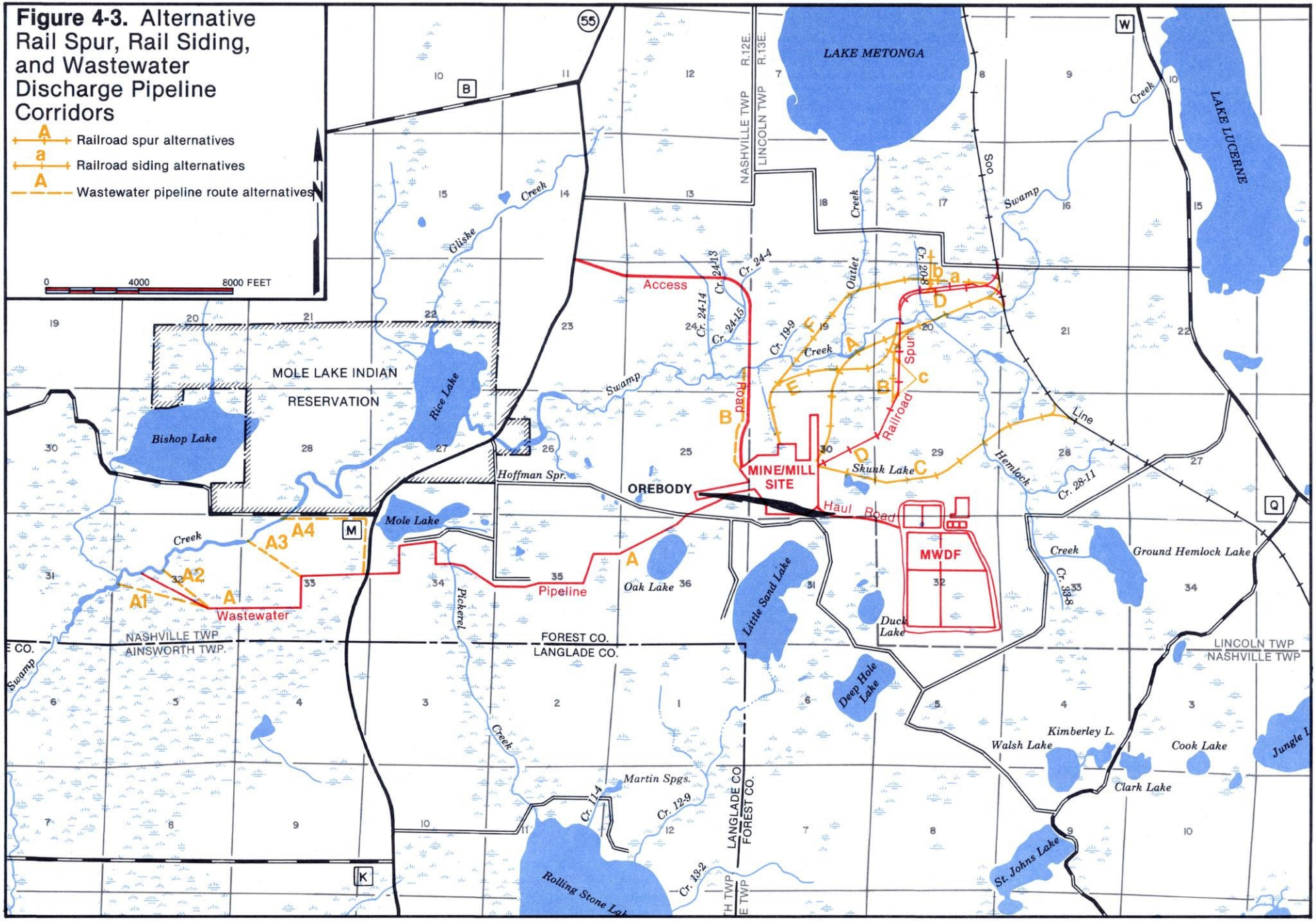

Figure 4-3. Alternative Rail Spur, Rail Siding, and Wastewater Discharge Pipeline Corridors
A Railroad spur alternatives
a Railroad siding alternatives
A Wastewater pipeline route alternatives
0 4000 8000 FEET
N
LAKE METONGA
LAKE LUCERNE
MOLE LAKE INDIAN RESERVATION
Bishop Lake
Rice Lake
Mole Lake
Oak Lake
Little Sand Lake
Deep Hole Lake
Duck Lake
Skunk Lake
Ground Hemlock Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Rolling Stone Lake
Martin Spgs.
Hoffman Spr.
Oliske Creek
Pickerel Creek
Swamp
Outlet
Soo Line
Hemlock Creek
NASHVILLE TWP
LINCOLN TWP
AINSWORTH TWP.
FOREST CO.
LANGLADE CO.
R.12E.
R.13E.
Access Road
Railroad Spur
Haul Road
Pipeline
Wastewater
MINE/MILL SITE
OREBODY
MWDF
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
A
A1
A2
A3
A4
B
C
D
E
a
b
c
55
B
M
K
Q
W

Table 4-3
Alternative Rail Corridor Characteristics

Route Characteristic	Alternative A	B	C	D (Proposed)	E	F
Overall Length (Miles)[1]	2.4	2.4	2.2	2.7	3.0	2.9
Stream Crossings (Name of Stream)	3 (Swamp Cr.)	1 (Swamp Cr.)	1 (Hemlock Cr.)	2 (Swamp Cr., Cr. #20-8)	2 (Swamp Cr.; Cr. #20-8)	3 (Outlet Cr.; Swamp Cr.; Cr. #20-8
Wetlands Affected (acres)[2]	7.0	5.7	6.0	3.1	6.7	5.9
Closest Eagle (E) or Osprey (Os) nest (miles)	0.13(Os)	0.37(Os)	0.40(E)[3]	0.37(Os)	0.35(Os)	0.45(Os)
Intrusions to Sensitive Areas	Wetland #01	Wetland #01	Wetland #F15 Spring pond complex tributary to Hemlock Creek	---------	Wetland #01	---------
Agricultural Lands (acres)[2]	4.8	4.8	0	5.4	4.8	5.6
Nearest Residence (miles)	0.2	0.2	1.1	0.1	0.2	0.1

[1] Length measured from Soo Line Railroad mainline to mine/mill site perimeter.
[2] Wetland and agricultural acreages based on 100-foot wide corridor.
[3] Nest blown down in 1984.

Rail Siding

A siding is needed for rail car delivery, pickup, and temporary storage. The siding would consist of three sets of parallel tracks, each 3,250 feet long, adjacent to the railroad spur. Three alternative locations were considered along the proposed railroad spur (Sidings a, b, c, Fig. 4-3). Characteristics of the three alternative siding locations are summarized below:

Table 4-4
Alternative Rail Siding Characteristics

Characteristic	Siding Alternatives (Using Rail Spur Corridor D) a (proposed)	b	c
Sets of Tracks (excluding main spur)	3	5	3
Wetland Intrusion[1] (acres)	0.8	0.5	0
Streams Crossed	#20-8	-	-
Nearest Residences (miles)	0.1	0.3	0.9
Nearest Town Road (feet)	750	490	2,360
Agricultural Lands[1] (acres)	1.1	2.0	0

[1] Using a 49-foot average width for siding alternatives a and c and 66-foot for siding alternative B.

The area immediately north of the mine/mill site also was evaluated for a siding. Traffic congestion, wetland intrusion, and Soo Line preference for a siding closer to its own tracks are problems with the location.

Siding alternatives a and b would intrude on 0.8 and 0.5 acres of wetland respectively, while siding alternative c would have no direct wetland intrusion. Because of the existing topography, siding alternative c would need extensive earth work to meet the grade criterion. This would create the potential for erosion into an environmentally sensitive wetland. Siding alternative c also is the farthest from the Soo Line tracks. The landowner adjacent to siding c would require three private crossings of the siding for access and timber harvest. Siding alternative b would have the greatest impact on agricultural land (2 acres) while alternative c would have none. The proximity of siding alternative b to the town road might have the potential for increased vandalism.

Exxon considered trestles for the alternative a siding to minimize wetland impacts. Fill with culverts was selected because of switching and accessibility problems expected with a trestle design.

Access Road

Twelve alternative corridors were considered for the access road to the mine/mill site (Fig. 4-2). Table 4-5 summarizes the features of each corridor. Since Exxon does not have condemnation powers to acquire right-of-way, the final alternatives are limited to corridors with willing sellers or existing access. Locational criteria included existing traffic patterns, route length, wetland and stream crossings, earthwork requirements, safety, social impacts, and availability of right-of-way. The design standard for the access road alternative routes was a vehicle speed of 50 miles per hour. None of the alternatives would require relocation of any residences. Alternative B1 is the proposed access road corridor.

Table 4-5
Alternative Access Road Corridor Characteristics

	Alternative											
	A1	A2	A3	B	B1 (Proposed)	B2	B3	C1	C2	C3	D	E
Overall Length[1] (miles)	2.4	2.4	2.4	3.2	2.9	2.3	2.1	1.9	2.1	2.1	0.7	0.8
Number of new stream crossings	3	3	3	2	5	3	3	1	1	1	1	0
Wetlands affected[2] (acres)	5.4	4.5	3.2	0.2	3.2	3.6	4.0	3.8	2.8	3.3	2.6	1.2
Approximate number of residences within 0.1 mile[3]	2[5]	2[5]	2[5]	6	0	0	1	1[5]	3	2[5]	22[6]	15[7]
Approximate number of seasonal cabins and cottages within 0.1 mile[3]	0	0	0	10	0	0	0	0	0	0	0	19
Agricultural lands[2] (acres)	8	8	8	1	6	3	3	7	3	9	2	0
Closest eagle or osprey nest[4] (miles)	0.8	0.8	0.8	0.6	0.8	0.8	0.8	0.9	0.9	0.9	2+	1+

1 Length from State Highway 55 to mine/mill site perimeter except that alternatives D and E go from Highway 55 to Sand Lake Road, while alternatives B, B2 and B3 go from Airport Road to the mine/mill site perimeter. Corridors B and C2 include approximately 1.5 and 0.2 miles, respectively, of town roads that would probably need upgrading.

2 Based on 100-foot corridor width. Acreages for alternatives D and E do not include 0.6 acres of wetlands that might be affected if existing Sand Lake Road were widened.

3 Includes dwellings along existing roads that would be traveled as part of the corridor (i.e., Sand Lake Road for alternatives D and E, Sherman Lane for C2, Keith Siding Road and Swampy Lane for B).

4 Does not include nests west of Highway 55 (near Rice Lake and along Swamp Creek).

5 One residence is on Highway 55.

6 12 of these are west of Highway 55, Village of Mole Lake.

7 Nine of these are along Highway 55, Village of Mole Lake.

Exxon rejected the use of existing roads because a new and safer road was desired. Upgrading the existing Sand Lake Road was considered but the increased traffic at its intersection with State

Highway 55 would be a safety problem. Upgrading the intersection for safety purposes might require removal of several recently constructed homes on the Mole Lake Reservation, changing Highway 55's horizontal alignment, and/or relocating Highway 55's Swamp Creek culverts. The Wisconsin Department of Transportation supports only the A alternatives, B1 (the proposed route), and C3 for safety reasons.

The following impacts decreased the feasibility of various alternative corridors: intrusions into sensitive wetlands (A1, A2, A3); safety and social factors (D, E); longer length (B); and land for the C corridors cannot be purchased. The A corridors and corridor C3 would have the most impact to agriculture while E would not affect agricultural lands. Of the remaining corridors (B1, B2, B3), B1 (the proposed corridor) would have the least wetlands intrusion and shortest travel distance between Highway 55 and the mine site.

The greatest proportion of mine-related traffic on Highway 55 would be from the north, the Crandon and Rhinelander areas, rather than from the south. Some workers, material, and supplies, however, would originate from the south and west (Antigo, Merrill, Wausau), particularly during construction. If the access road were developed from the south or corridor E was selected, mine-related traffic to and from the north on Highway 55 would probably use the existing Sand Lake Road. This would increase safety problems at the Sand Lake Road-Highway 55 intersection. Safety problems also might occur to a lesser extent at the Highway 55 intersection if corridor D were selected.

For the proposed corridor (B1), there would be no entrance to the mine/mill site from Sand Lake Road. Mining-related traffic coming from the south on Highway 55 would pass through the Village of Mole Lake northward to the junction of alternative B1 and Highway 55. Traffic from the north would not pass through Mole Lake. An increase in traffic through the Village of Mole Lake would be expected regardless of where the access road was built. Traffic through Mole Lake would probably be less using the proposed corridor rather than developing a south access road or selecting alternatives D or E. Any access road location could influence the location of future developments (i.e., residential, mobile home courts, businesses, etc.) and local traffic patterns.

Alternatives D and E would have the shortest lengths of new construction (excluding those portions of the Sand Lake Road requiring upgrading) while corridors B and B1 would have the greatest length of new construction. Construction costs for the various alternatives were not estimated but generally would be proportional to roadway length and number of stream crossings.

Alternative B1 would have five stream crossings, with all streams, except Swamp Creek, having small or intermittent flows. Some erosion and consequent siltation to streams would be expected during construction. The A alternatives would cross two unnamed streams with natural reproduction of brook trout. Bottom soils are firmer at the B1 crossing of Swamp Creek than at A, C or D. Minor impacts to water quality and vegetation may occur from road salt, oil, and other common highway runoff contaminants regardless of the route selected.

Similar air quality and noise impacts would be expected for the various corridors. Dust potential during construction would be greatest along the longest alternatives with alternatives B, D, and E located closest to the most homes and cottages. B1, the proposed route, has the least number of nearby residences. Water sprinkling should minimize problems during construction.

Impacts to upland wildlife and vegetation generally would be proportional to the length of uplands each route traverses. No known eagle or osprey nests are close enough to any of the access road alternatives to disturb nesting activity. An osprey nest 0.6 mile east of corridor B is the closest, except for the Rice Lake and Swamp Creek eagle nests west of Highway 55. Impacts to the winter deer concentration areas along Swamp Creek would be greatest with the A and C corridors, but no alternative would have unacceptably high impacts.

Electric Transmission Line

All of the alternative routes start at the existing Venus substation near Monico and end at a new Exxon substation on the mine/mill site. The termination point at Exxon is fixed at the location of the electrical load to be served. The origination point is the nearest existing transmission substation. Starting a line at the next closest transmission substation would require a line at least 10 miles longer than the proposed line.

All alternatives follow the proposed Exxon access road (corridor B1) from Highway 55 into the project site. The intersection of the access road and Highway 55 thus becomes the functional endpoint for the alternate routes. Any major change in the access road location could significantly alter the siting of the transmission line.

There are four major areas limiting alternative transmission line routes (Fig. 4-4). The first is the Mole Lake Reservation. The utility (Wisconsin Public Service Corporation) does not have the right of eminent domain over these lands so property cannot be condemned for right-of-way. Any transmission line route over reservation lands would need the voluntary cooperation of the tribal community. The second constraint is the Crandon Airport. The surrounding lands are zoned with maximum height limitations to keep aircraft flight paths clear of obstacles. Any line in the zoned area would have to comply with the height restrictions, effectively limiting how close the line could come to the airport. Lake Metonga is the third siting constraint. It is not practical to construct a transmission line over a lake of this size. The last major constraint is the City of Crandon. While it is possible to route a line through the city, avoiding it is desirable.

The utility provided information on the proposed route and seven alternate routes. These routes consist of various combinations of east-west and north-south route segments (Figure 4-5). The routes are combined into three groups, the "North;" "Center" and "South" routes. The shortest route is 16.4 miles long ("South A"), while the longest is the proposed route ("North A") at 18.3 miles (Table 4-6).

Table 4-6
Corridor Sharing on Alternate Transmission Routes

Route	Total Length (Miles)	Existing Trans-Line	Shared Corridors (miles) Highways	Town/Private Roads	Total
North A (Proposal)	18.3	0.4	9.0	3.2	12.6
North B	18.0	0.4	8.0	5.7	14.1
Center A	16.9	0	0	3.0	3.0
Center B	16.8	0	0	3.3	3.3
Center C	16.6	0	0	5.7	5.7
South A	16.4	2.4	0	3.5	5.9
South B	16.7	2.4	0	3.3	5.7
South C	16.7	2.4	0	3.5	5.9

Corridor right-of-way width is partially dependent on the type of structure used. The two "North" routes would use single pole wood structures for their entire length. The six "Center" and "South" alternatives would use single pole structures only along the Exxon access road. The remainder of these routes would consist of H-frame structures. H-frames use two wooden poles to support a horizontal crossarm from which the conductors are suspended. In general, H-frame structures are wider, but shorter, than single pole structures. H-frame structures require wider cleared rights-of-way than single pole structures. In addition, a new line built next to an existing line or road could use at least a portion of the existing right-of-way thus resulting in a narrower right-of-way than a line built cross-country. Table 4-7 gives new right-of-way requirements for combinations of these two types of structures.

Table 4-7
New Right-of-Way Width Requirements

Type of Right-of-Way	Single Pole	H-Frame
New, No Shared Corridor	80 feet	100 feet
Along Existing H-Frame	65 feet	65 feet
Along U.S. Highway 8	-	-
Along County, Town Roads	42 feet	57.5 feet
Along Exxon Access Road	80 feet	-

The routes vary considerably in their degree of corridor sharing. Corridor sharing consists of building a line on or next to an existing linear right-of-way, such as a road, railroad track, or existing transmission line. While the existing right-of-way is generally widened to accommodate the new line, the width of the extra clearing is generally less than the width needed if a completely new right-of-way were cleared. All routes would share the proposed Exxon access road for a distance of about three miles. This segment is included in the "Town and Private Road" category. Table 4-6 summarizes the corridor sharing potential.

The two "North" routes, including the proposed route, have the greatest potential for corridor sharing. About two-thirds of their total length would be along other rights-of-way. The largest stretch of corridor sharing would be along U.S. Highway 8, about eight miles for "North B" and about nine miles for the proposed route. No additional right-of-way for the line would have to be acquired along U.S. Highway 8, since existing utility easements and the highway right-of-way would adequately accommodate the new line.

The three "South" routes would share corridors for about one-third of their lengths. This comes primarily from the Exxon access road (three miles) and 2.4 miles along an existing transmission line which runs southward from the Venus Substation. The "Center C" route also would corridor share along about one-third of its length. This comes from following the Exxon access road and following a town road for about 2.7 miles. The other two routes "Center A" and "Center C" utilize shared corridors for only about one-fifth of their lengths. This is almost entirely along the Exxon access road. The remaining four-fifths of these routes entails new cross-country rights-of-way.

The total amount of additional right-of-way required for each route is calculated by using structure type, length of corridor sharing, and right-of-way (R-O-W) width requirements for each route (Table 4-8).

Table 4-8
Total New Right-of-Way Requirements

Route	Acres of New R-O-W
North A (Proposal)	89
North B	84
Center A	198
Center B	195
Center C	180
South A	179
South B	183
South C	182

Cost Comparisons - The capital costs to the utility for the alternate transmission line routes range from about $3.5 million to about $4.2 million (1987 dollars). The most expensive is North A, the proposed route. Table 4-9 lists the estimated costs for each route and compares the cost of each alternative to the cost of the proposed route.

The two North routes include a cost of $570,000 to underbuild (i.e., construct on the same poles beneath the proposed line) the existing distribution line on the transmission line along U.S. Highway 8. This amount represents most of the cost difference between the two North routes and the other six routes.

Table 4-9
Cost Comparison of Alternate Transmission Routes
(1987 Dollars)

Route	Cost	Cost Compared to North A
North A (Proposal)	$4,220,000	-
North B	$4,153,000	$ -67,000
Center A	$3,665,000	$-555,000
Center B	$3,633,000	$-587,000
Center C	$3,590,000	$-630,000
South A	$3,493,000	$-727,000
South B	$3,567,000	$-653,000
South C	$3,568,000	$-652,000

Impact Comparison - The various alternate transmission line routes differ substantially in their impacts to natural resources. They have less significant differences in their effects on existing human developments. The differences between the alternate routes are discussed below, with an emphasis on how the proposed route compares to the alternate routes.

Forests - All transmission line routes would involve clearing forests on the right-of-way. Trees and tall shrubs would be removed to eliminate potential contact between vegetation and the line's conductors. Regrowth of cut vegetation and new growth would be periodically recleared, about every five years.

Many of the forest lands in this region are periodically logged for lumber and pulpwood. Right-of-way clearing removes that land from future lumber and pulp production. The two "North" routes would involve clearing the fewest acres of forest lands, 77 acres for the proposed route and 68 acres for "North B." The three "Center" routes and the three "South" routes would require clearing about twice as many acres, ranging from about 136 to 170 acres. The affected forests can be grouped as upland forests (aspen-birch, northern hardwoods) and lowland forests (swamp conifers). Table 4-10 shows the number of acres of upland and lowland forests to be cleared on each route. In all cases, three-fourths or more of the forest to be cleared would be upland forest.

Table 4-10
Forest Clearing on Transmission Line Routes

	Type, Acres		Ownership, Acres		Total Forested Acres
	Lowland	Upland	Private	Commercial	
North A (Proposal)	5	72	53	24	77
North B	13	56	57	12	69
Center A	27	142	61	108	169
Center B	34	133	86	81	167
Center C	30	112	63	79	142
South A	25	111	83	53	136
South B	24	125	96	53	149
South C	40	112	90	62	152

The forests along the routes are owned by a combination of private and commercial forestry enterprises. None of the forest lands are in county, state, or federal ownership. A breakdown of private vs. commercial ownership is shown in Table 4-10. The least private ownership is along the "North" routes (53-57 acres). The "Center" routes have an intermediate level (62-86 acres) of private ownership and the "South" routes have the most (83-96 acres). The "North" routes have the least commercial ownership (12-24 acres), while the "Center" routes have the most (79-108 acres). The "South" routes have an intermediate level of commercial ownership (53-62 acres). In summary, the "North" routes would require clearing significantly less forest lands than any of the "Center" and "South" routes.

Wildlife - The major impact of a new transmission line on the wildlife of the region would result from habitat changes on the right-of-way. Clearing the right-of-way in forested areas would change the primary vegetative cover from trees to grasses and shrubs. Animals which live in the forest types removed from the right-of-way would lose suitable habitat, lowering their populations in the area. Species inhabiting grasslands and shrublands would benefit, as more habitat would be created by the right-of-way clearing. The two "North" routes would involve the least change of forest to grass/shrub habitats (69-77 acres). About twice as much forest to grass/shrub conversion would occur with the "Center" and "South" routes (136 to 169 acres). The "North" routes would thus have the least impact to wildlife populations resulting from habitat changes.

All routes would cross a winter deer yard bordering Swamp Creek along with the proposed Exxon access road. The impact to the deer herd would be lessened by selective treatment (minimized clearing) of conifer trees, which provide winter cover and food along this section of right-of-way. No other deer yards are crossed by any of the routes.

Two bald eagle nests have been recorded in the vicinity of Rice Lake, at distances of about one-half to one mile away from all routes. A new line along any of the routes would not affect these nests. Another bald eagle nest was located close to Gliske Creek, near all routes. This nest was active in 1981 but could not be found in 1982. It probably blew down. No other endangered or threatened species are known to inhabit areas along any of the routes.

The waterbird collision mortality potential of the routes is discussed in the Wolf River section. The potential impacts of the routes on trout fisheries and other aquatic organisms is discussed in the Surface Waters section.

Wetlands - There are extensive tracts of wetlands between the Exxon project site and the Venus substation site. Many of these wetlands are associated with the area's lakes, rivers, and streams. The various transmission line routes differ greatly in how much wetland would be crossed.

Almost all of the wetlands crossed by the routes consist of forested habitat, primarily various swamp conifers. The acreage of forested wetlands which would be cleared along each route is shown in Table 4-10 (under "Lowland"). The "North" routes would involve clearing the least forested wetlands (5 acres for "North A," 13 acres for "North B"). The "Center" and "South" routes would involve clearing larger areas of forested wetlands, ranging from about 25 to 40 acres. The low acreage of forested wetlands cleared along the "North" routes is the result of the extensive corridor sharing with Highway 8. While the highway crosses many large wetland tracts, the existing built-up highway right-of-way is wide enough to accommodate a transmission line without additional clearing or filling of wetland areas.

Impacts to the wetlands could be minimized along all routes by limiting construction activities to winter when the wetland soils are frozen. Small alterations to the right-of-way centerline may be necessary to avoid or limit impacts to small, important wetland areas, such as those bordering Gliske Creek.

Wolf River - All routes require a crossing of the Wolf River. The Wolf River is a natural resource of major importance. Because of its undeveloped natural beauty, many recreation activities occur on or near the Wolf River. The possible transmission line crossing locations differ greatly in their impact to the river's values.

The two "North" routes would cross the river at the Highway 8 bridge. The three "Center" routes would make their crossing at a point about one mile south of Highway 8, while the three "South" routes would cross about three miles south of the highway. The two "North" routes cross the river at an existing heavily developed crossing. The Highway 8 bridge is a large structure. The existing 24.9 kV power line from the Venus substation to Crandon crosses the river next to the bridge. The Exxon transmission line would replace the 24.9 kV crossing with a new line that would look essentially identical to the existing line, although it would be taller. The visual character of this stretch of the river would remain essentially as it currently is.

The three "Center" routes would create a new crossing of the river. The river banks at this point are undeveloped, with no buildings or roads nearby. High wooded banks are located on the east side of the river, while the west side is covered with open marshland in front of lowland forests. A river crossing here would place an obvious man-made intrusion into a long stretch of undeveloped river.

The three "South" routes would cross the river in a somewhat more developed section of the river. The half-mile wide planning corridor of these routes includes two sections. The upper section has forest lands bordering the river, while the lower section is open fields. A town road crosses the river at the upper edge of the planning corridor. A crossing in this stretch of river could be made to roughly blend into the existing land use patterns by routing it along the woodland-open field border. The conductors suspended over the river would still be a visual intrusion to anyone boating on the river.

There are large areas of wild rice beds bordering the river at a number of locations south of Highway 8. Waterfowl feed in these wild rice beds and fly along the river between them. New overhead wires crossing the river could result in collision deaths to these birds. The river crossing of the "Center" routes has the most potential for collision mortality, the "South" crossing has a lower potential, while the "North" crossing at Highway 8 has the least.

Constructing a new crossing of the river could cause siltation to the river from erosion. The potential for this is minor at the "North" crossing as the construction would take place in open fields with a well-established grass cover. The "Center" crossing would have to be carefully constructed to avoid erosion of the steep, wooded east bank. The removal of the trees and shrubs on the east bank, along with the use of vehicles on the newly opened right-of-way, could result in erosion problems. The siltation potential of the "South" crossing depends on whether suitable ground cover is present to help limit erosion at the location of the right-of-way crossing.

In summary, the "North" crossings have the least potential for bird collisions, river siltation, and visual impact for people using the river.

Other Surface Waters Impacts - There are a number of streams located between the Venus substation and the Exxon project site. A new transmission line crossing these streams could affect their water quality and their aquatic life. The alternate transmission routes differ in the number of streams crossed. In addition to the Wolf River, all routes also would cross Swamp and Gliske Creeks. Table 4-11 shows the major streams crossed by the transmission line.

The streams could be affected by transmission line crossing in two major ways. First, clearing the right-of-way and constructing the line could result in stream siltation from soil erosion. The siltation could degrade the quality of the stream bottom habitat for organisms living in the stream. The second impact results from cutting tree and shrub cover at the stream edge. The removal of trees and shrubs could increase the amount of sunlight reaching the stream, raising the water temperature. Many aquatic organisms, including trout, require cold water temperatures. The increase in water temperature, however, would be very small and is not predicted to impact populations of these organisms.

Table 4-11
Major Streams Crossed by Transmission Line Routes

Route	Wolf River	Swamp Creek	Gliske Creek	Logan Creek	Unnamed*	Stockley Creek	Mud Creek
North A (Proposal)	x	x	x				x
North B	x	x	x				x
Center A	x	x	x				
Center B	x	x	x	x	x		
Center C	x	x	x		x		
South A	x	x	x		x	x	
South B	x	x	x	x	x	x	
South C	x	x	x	x	x	x	

* Unnamed creek in Sections 15 and 16, T35N, R12E

Scientific/Natural Areas - None of the routes pass near any recognized scientific areas or natural areas. There are also no natural areas specifically identified by the Department of Natural Resources as having local, county or state-wide significance.

Recreation - The major recreational impact of a new transmission line would be the visual degradation of the natural character of the Wolf River. The wild and undeveloped nature of the Wolf River is an important factor influencing canoeing and other boating uses. The "Center" routes would have the most impact, the "North" routes the least. Another potential recreational impact is the degradation of trout populations and the fishing activities these populations support. A new transmission line may increase hunting activities. Clearing forests on the right-of-way and conversion to grass/shrub cover would provide additional habitat for some game species, including deer and ruffed grouse. The increase in game animal cover would be greatest on the "Center" and "South" routes, least on the "North" routes. No parks, public hunting grounds, or other specifically designated properties would be crossed by any of the routes.

Residences - All routes would pass near some residences. The primary effects on these residences would be the visual impact of a new transmission line and possible interference with radio and television reception. A new line along all alternate routes would be visible to residences near where the line crosses Highway 55 (the same location for all routes.) Also, a line would be visible to a small number of residences where the routes cross Highway B (three different crossings). The existing Venus substation and the proposed Exxon substation location are not near any homes.

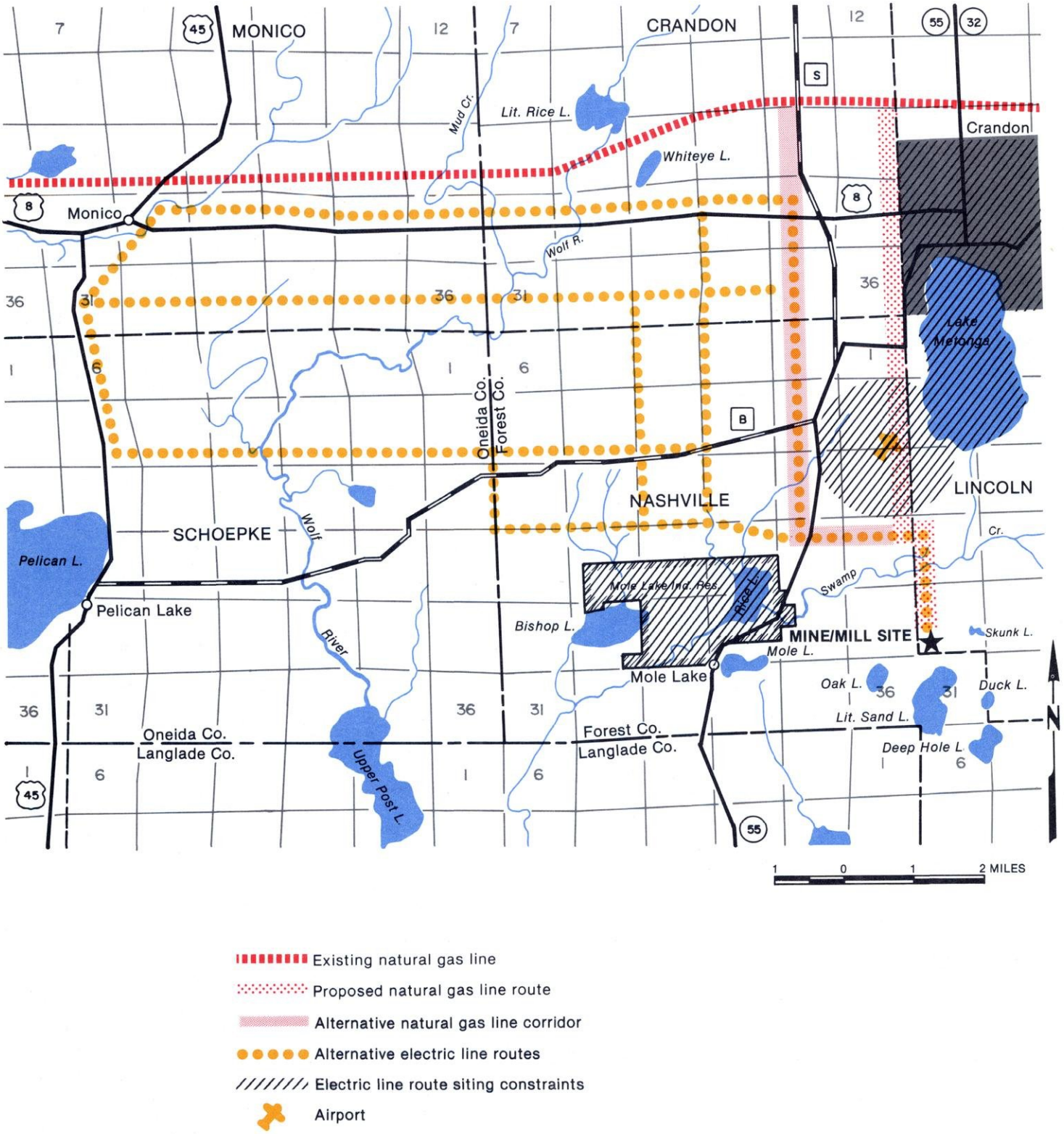
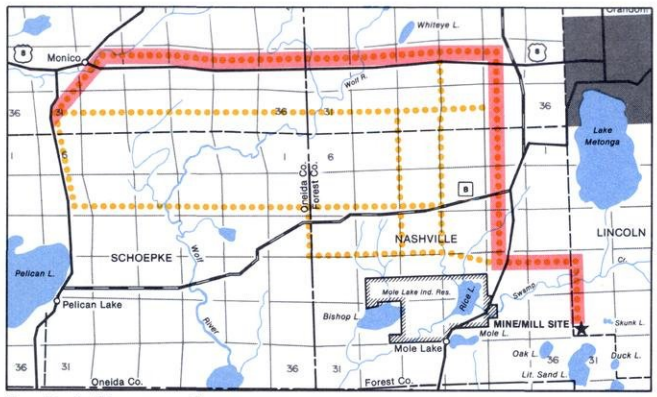
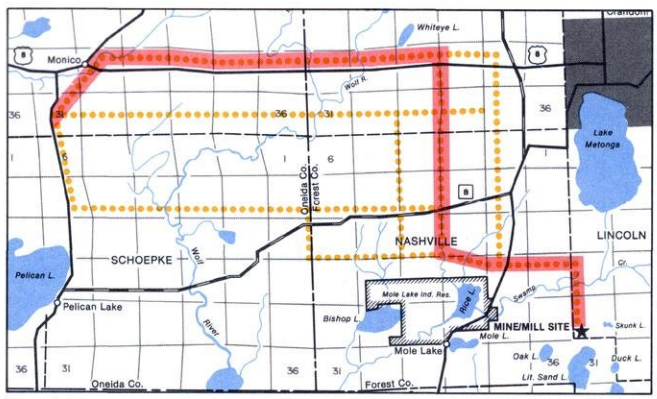


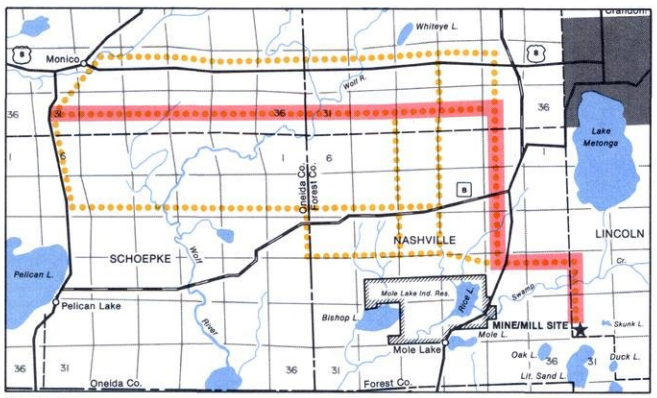
Figure 4-4. Alternative Electric Transmission and Natural Gas Line Corridors with Identified Siting Constraints



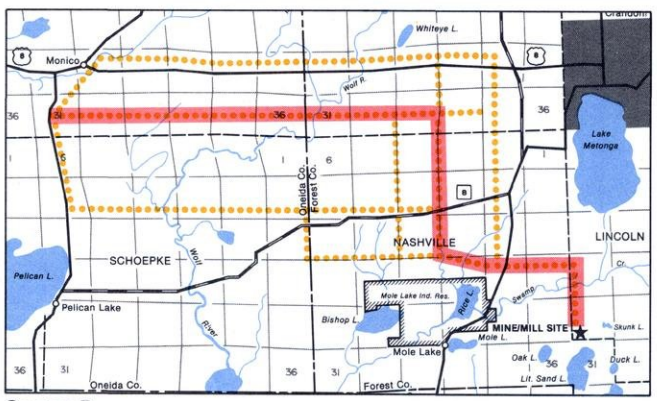
North A (Proposed)



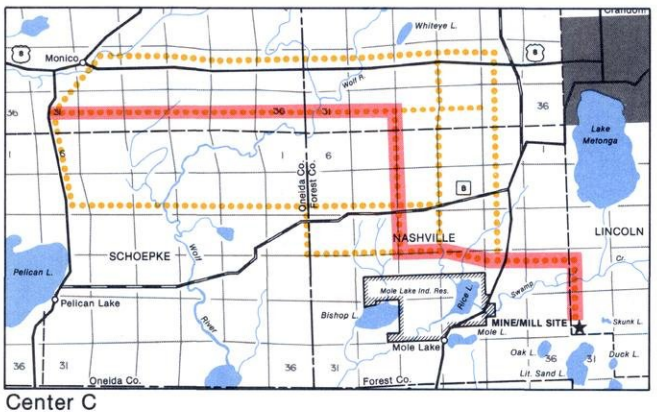
North B



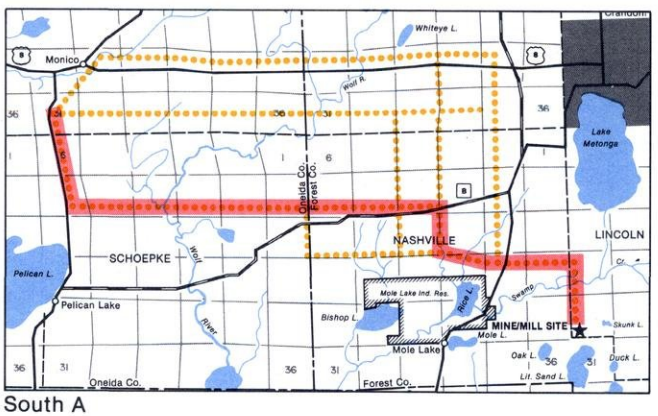
Center A



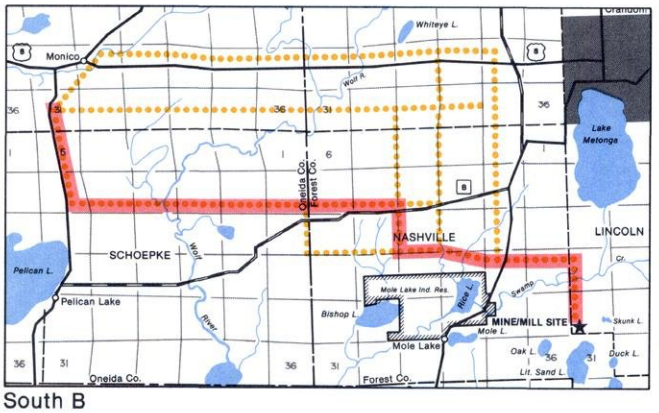
Center B



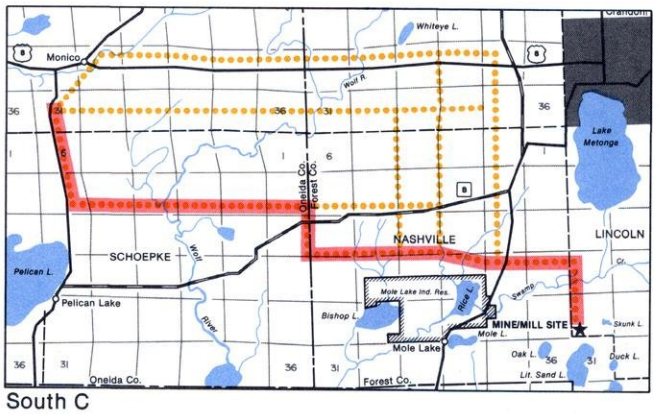
Center C



South A



South B



South C

Figure 4-5. Alternative Electric Transmission Line Routes

The three "Center" and three "South" routes would pass near a few residences. These routes run essentially cross-country through woods and away from roads or other developments.

The two "North" routes would involve a line built near a much larger number of residences. These routes follow Highway 8 for 8-9 miles. These lines would pass near 25 ("North B") or 27 ("North A") homes along Highway 8. A new line along Highway 8 would replace a somewhat smaller existing line of similar design. A larger line would add to the visual impact of the existing condition, however, this additional impact should be minor compared to the visual impact of the existing line.

Commercial-Industrial Areas - There are only scattered areas of commercial and industrial development in the area between the Venus substation and the Exxon project site. The proposed transmission line route ("North A") and the "North 8" route would pass through an area used for commercial purposes. This area borders U.S. Highway 8 for about one-quarter mile. Present are eating, retail, lodging, auto repair, and enclosed storage establishments. The presence of a new transmission line would not affect the services these businesses provide.

The "Center" and "South" routes do not pass near any commercial or industrial developments. Also, the existing Venus substation is not near any such establishments. The proposed Exxon substation would be built at the mine/mill site. Its presence there is necessary for the operation of the proposed mine.

Archeological-Historical - The State Historical Society indicates all of the transmission line routes cross areas likely to contain archeological sites. The potential impact to these sites from construction of a transmission line, however, would be minimal. The major potential impact would be the disruption of part of an archeological site when holes are bored for the wood poles. The utility has indicated a willingness to halt work if any items of an archeological/historical nature are found to allow time for Historical Society review and recovery. The various alternate routes do not appear to differ significantly in their potential impact to archeological/historical sites.

Agriculture - Agriculture is not a major land use in the area between the Exxon project site and the Venus Substation. There are only small, scattered agricultural lands along any of the transmission line routes. Most farming consists of small, irregularly shaped parcels of hay, grain and pasture lands supporting dairy herds and livestock. No major impact is expected to any of these properties from a new transmission line along any of the alternate routes.

The three "South" routes cross slightly more agricultural land than the "Center" or "North" routes. Also, the "South" and "Center" routes would use H-frame structures. The H-frames, with two poles about 14 feet apart, are more difficult to locate to minimize field disruption compared to the single pole structures used on the "North" routes. Further work might be necessary to precisely locate the transmission line centerline to minimize the placement of structures in fields thus disrupting existing farming practices.

All routes would cross about one-half mile of farm fields on the east side of Highway 55 along the proposed Exxon access road. This land would be owned by Exxon and already disturbed by the new access road before the transmission line is built. Neither the existing Venus substation" nor the proposed Exxon substation are located on agricultural lands. Irrigation systems or aerial spraying are not used along any of the routes, thus there will be no impact to these agricultural practices.

Summary of Electric Transmission Line Alternate Routes - There are substantial differences between the two "North" routes (including the proposed route) and the other six routes (the "Center" and "South" routes). The disadvantages of the "North" routes are: (1) greater costs by about $500,000 to $800,000; and (2) affects to more residences and commercial properties.

The advantages of the "North" routes are: 1. Greater use of corridor sharing; 2. Less clearing of forest lands and change of wildlife habitat; 3. Less construction through wetlands; 4. Least impact at the Wolf River crossing; and 5. Less potential effect on trout streams.

Agricultural Impact Statement (AIS) Conclusions and Recommendations - The AIS prepared by the Department of Agriculture, Trade, and Consumer Protection indicates the agriculturally preferred route is the proposed route (north A). This route would require the second lowest amount of new right-of-way and a large segment would be located along existing corridors (Table 4-8). All of the alternative routes would remove land from timber production. The alternative routes would require up to twice the amount of land of the proposed route. Specific recommendations from the AIS include:

1. Advance notice of project related clearing and construction activities should be given to landowners so that they can adjust their operations accordingly;

2. Landowners and WPSC should discuss payment of penalties and/or increased tax rates resulting from the removal of land from the Woodland Forest Crop Tax Law Program; and

3. Once construction was completed, it might be possible to grow small commercial trees (e.g., Christmas trees, seedlings and/or ornamental trees) in the right-of-way. This may or may not be economically feasible, depending on markets, location, soils, available management time and skills.

Natural Gas Pipeline Corridor

One alternative route for the proposed natural gas line was evaluated (Fig. 4-4). The proposed route follows existing roads and the Exxon access road, while the alternate route generally follows the Exxon access road and the proposed electric transmission line route (Table 4-12).

The alternate route is about 1.7 miles longer than the proposed route. The alternate route also is more expensive due to increased costs for land rights and gas mains.

The primary environmental concern with both routes would be trout stream crossings. Both routes would cross Swamp Creek along the Exxon access road. The proposed route also would cross Drake and Rocky Siding Creeks, while the alternate route would cross Gliske Creek. Proper construction techniques, along with minor route alterations, should keep stream impacts to acceptably low levels.

Both routes would cross some small wetlands, require clearing of small wooded tracts, and temporarily disrupt some agricultural areas. The alternative route would temporarily affect fewer residents during construction. The two routes are nearly the same when considering these impacts, and only small environmental impacts would result from constructing the natural gas line along either the proposed or alternate route. The exception would be if the electric transmission line is not built as proposed, then the alternate natural gas route would require the clearing of about 30 additional acres of forest land.

Table 4-12
Alternate Corridor for the Natural Gas Pipeline

	Length, miles	
Corridor Type	Proposed Route	Alternate Route
Existing Roads	6.5	1.75
Exxon Access Road	2	3
Proposed Electric Line	0	5
Cross-Country	0	0.5
Total	8.5	10.25

Wastewater Discharge Pipeline Corridor Siting

Six alternative wastewater pipeline routes with discharge sites on Swamp Creek were considered (Fig. 4-3). Route B would discharge to Swamp Creek upstream of Rice Lake, while all route A alternatives would discharge to Swamp Creek below Rice Lake. Four alternative corridors for the last leg of route A were considered; these corridors were designated A1, A2, A3, A4. The A-series of alternatives have discharge locations within a one mile stretch of Swamp Creek. Exxon does not have the authority of eminent domain and is constrained to willing sellers of land along each route.

The environmental factors used in evaluating alternative pipeline corridors were potential impacts to Swamp Creek, Rice Lake, and wetlands. Economic factors included corridor length, construction, right-of-way, and pumping costs. Specific considerations such as stream flow and trout water designation of Swamp Creek above Rice Lake were also assessed. Social factors considered included commercially and culturally important wild rice beds in Rice Lake on the Mole Lake Sokaogon Chippewa Reservation, potential disruption to local residences, and the number of road crossings.

The route A alternatives would have the advantage of discharging to Swamp Creek downstream from Rice Lake where stream flow is greater and possible impacts to the wild rice in Rice Lake would be avoided. In addition, this segment of Swamp Creek is not designated as trout water. For these reasons, route A was selected as the preferred corridor.

Route B has some advantages because the length is only one mile and it provides the most direct and least expensive route available. In addition, route B would be located in the proposed access road right-of-way. This segment of Swamp Creek is a class II (some natural reproduction) trout stream, however, and the potential environmental as well as cultural impacts would be greater than at the preferred location.

Total wetland acreage disturbed during pipeline placement would be less for route B (0.5 acres) compared to route A (6.7 acres). While there would be disturbance to wetlands and wildlife during pipeline placement, regardless of the route selected, the impact would be temporary as the corridor would be revegetated following construction.

The nearest alternative receiving stream, similar in size to Swamp Creek, is the Peshtigo River. This river is 14 miles north of the mine site. Directing the discharge to the Peshtigo River watershed would reduce flow in the Wolf River watershed by the amount of mine inflow (between 1,200 and 2,000 gallons per minute). The corridor to the Peshtigo River would be at least 14 miles long versus 6.1 miles for the Swamp Creek route. In addition to the greater land disturbance and greater energy use for pumping, various portions of the Peshtigo River are classified as Class II and III (marginal quality) trout water. Depending on the flow in the Peshtigo River versus Swamp Creek, stricter water quality standards may have to be set for a Peshtigo River discharge to protect the trout fishery. An additional factor is the need to find landowners willing to sell right-of-way options along a Peshtigo River corridor.

FACILITY DESIGN ALTERNATIVES

TAILINGS DISPOSAL

Different tailings disposal options and facility designs offer various advantages and disadvantages with regard to ease of construction, operation and closure. The proposed design would contain tailings within surrounding earthen embankments. Design features include a low permeability, multi-layered final cover to minimize long-term leachate production with short-term leachate production controlled by bottom liners; leachate collection systems; reuse of slurry water; and treatment of leachate. Other options for surface disposal of tailings are summarized as follows:

Lake or submerged wetland fill - Although used in Canada and coastal areas, this type of tailings disposal method was rejected due to the potentially severe environmental impacts to surface waters and wetlands.

Conventional tailings dam - This technique would utilize a starter dam of native soils to initially confine the tailings. The dam would be periodically raised over the project life using coarse tailings plus on-site soils. Dams take advantage of topographic features, such as a valley mouth, thus making efficient use of tailings, and soil borrow, haulage, and placement requirements. Major disadvantages of this construction method are its reliance on a constant supply of coarse tailings or waste rock and the management needed to keep the dam above the level of water and fine-grained tailings. The proposed milling processes and mine backfilling requirements would provide little, if any, coarse tailings thus making this alternative design not feasible. In addition, the coarse tailings fraction from the Exxon project may be too fine to build a stable confining dam. The high sulfide content of the tailings also could result in acid seepage to surface waters or wetlands.

MWDF FINAL COVER

The final cover over the tailings must perform several important purposes. First, enable the site to return either to its original state or an acceptable alternative use while providing long-term environmental stability. Second, to reduce the amount of water seeping through the tailings thus minimizing groundwater contamination below the disposal site. Third, to isolate the site to prevent pyrite oxidation and subsequent groundwater contamination from acid leachate. Fourth, to prevent the exposure of the tailings mass with consequent surface water pollution. Finally, to reduce dusting and visual impacts of the tailings ponds. Potential cover alternatives include:

Soil Cover - A natural soil cover without liners would provide immediate control of dusting and might be suitable for limiting oxygen and water flow into the tailings. The amount of surface erosion would be dependent on the success of the vegetative cover. A soil cover might have drainage problems because the lower permeability of the tailings could lead to saturation and water logging in the soil cover. Direct contact of water and tailings might lead to migration of dissolved metals into the plant rooting zone of the soil cover resulting in poor plant health.

Vigorous plant growth and a thick soil cover could limit oxygen movement to the tailings surface but not eliminate it. Thus pyrite oxidation and leachate generation would proceed but probably at a very slow rate. Contaminants would continue to seep into the groundwater with this alternative.

Cover Soil Plus Low Permeability Liner - A low permeability barrier within the final cover should drastically reduce or eliminate the movement of oxygen and water into the tailings, thus limiting the outflow of leachate through the base. Low permeability or hydraulic barrier alternatives include:

Natural Clay - Clay is the customary capping material for landfills in Wisconsin. Suitable sources are not available in the project area, and transport from distant sources would be very costly. Approximately one million cubic yards of clay would be required to construct a five foot thick top liner. The advantages of clay are the use of conventional construction quality control techniques plus the familiarity with its use. The cost of mining, hauling, placing, and compacting the clay, plus the impacts to the borrow site, would make this a high cost/impact alternative.

Geomembranes - Various types of synthetic materials recently have been utilized as barrier materials. Geomembranes require care in fabrication and installation, and often require a cover soil. Leakage through a properly manufactured and protected geomembrane would be confined to punctures and improperly made seams. Polymers used in geomembranes are extremely stable and resistant to a wide variety of environmental conditions. The most common materials available for geomembranes are polyethylene (either high density or linear low density, polyvinyl chloride, and Hypalon).

The use of geomembranes in Wisconsin solid waste sites has been limited. A double-lined polyvinyl chloride papermill waste site was constructed in 1985. Polyethylene was approved and used as part of a landfill cap in a papermill sludge closure project in 1984. The longevity of these geomembranes is not known for certain because most of these materials have only been utilized for a few decades. In general, geomembranes protected from ultraviolet light by a soil cover have been effective.

Cover Soil Thickness - The physical integrity of the low permeability barrier (soil liner or geomembrane) would be protected by the overlying cover soil. A cover soil depth of three feet or greater, including topsoil, should protect the low permeability barrier from frost heave yet provide sufficient soil moisture for cover vegetation. Most root growth would be confined to the soil cover above the geomembrane or soil liner, and the liners should not be penetrated. Penetration by animal burrowing activities could occur, but would not be expected to be frequent because most animal burrowing occurs to a limited depth. The most noticeable exceptions are woodchucks and coyotes, which can dig to greater depths. In the long-term, a return to forest vegetation may reduce animal burrowing because it is not the preferred habitat of deep burrowing species. The proposed soil cover thickness of five feet would provide an extra margin of safety by limiting potential damage to the cap due to animal burrowing, wind throw, erosion, temperature changes or root penetration.

The depth of wind throw pits would depend on the depth of rooting, but is unlikely to be deeper than two or three feet. In addition, it would be 100 years + before trees of adequate size to create tipup mounds would be established on the reclaimed tailings ponds.

PLACEMENT OF SOIL STOCKPILES

Exxon's current plans call for placing a soil stockpile on top of tailings pond T2. This would delay the development of T2's final cover until the last tailings pond (T4) was closed. This would increase the total amount of MWDF reclamation and closure work at the end of project life. The Department may require soil stockpiling on nonwetland areas south of ponds T2-T4 or near the construction support area. This would entail additional land clearance, but would allow reclamation of pond T2 during the middle of project life.

MWDF LEACHATE COLLECTION

The MWDF would have a leachate collection (underdrain) system. The underdrain system would capture seepage from the tailings mass, thus minimizing the amount of leachate entering the groundwater. Alternative leachate collection designs for the underdrain system are discussed below.

Leachate Collection Pipe Spacing - Exxon has proposed to place leachate collection pipes at the lowest point in each of the four ponds. Due to the differences in ponds size, leachate from the tailings would have to travel approximately 600 feet in pond T2 and almost 1,250 feet in pond T4 before reaching the collection pipes. Generally, drain distances beyond 500 feet result in reduced collection efficiency. However, leachate collection efficiency also is dependent upon permeability of the drain layer surrounding the collection pipes. Because Exxon has proposed a very permeable drain layer, collection efficiency should be high. Adding collection pipes to reduce pipe spacing would increase efficiency even more. Table 4-13 shows the relationship between drain length, drain layer permeability, and collection efficiency.

Alternative pipe spacing designs would place additional pipe in the drain layer to achieve extremely high collection efficiencies. While there are a number of leachate collection pipe configurations, Figure 4-6 illustrates one such configuration. This design would allow more rapid interception by reducing leachate travel distance.

The MWDF leachate would be high in dissolved calcium and sulfates, but precipitation of calcite or gypsum in the drain layer or leachate collection pipes would not be expected. If it did occur, the collection efficiency would be reduced. Shorter drain distances with resultant greater leachate collection capacity, however, would reduce the potential for system failure due to sedimentation or clogged pipes. Figure 4-6 also illustrates alternative clean out points for the collection system. The decreased pipe spacing and additional clean out points more closely reflect current landfill design practices.

Drain Permeability - Leachate collection efficiency is strongly affected by drain layer permeability (Table 4-13). High drain permeabilities in the range of 28 feet/day (10^{-2} cm/sec) or greater provide high collection efficiency. Exxon's proposed drain layer permeability of 790 feet/day (2.8×10^{-1} cm/sec) would be extremely high, thus little additional leachate collection efficiency could be realized by increased drain layer permeabilities.

Table 4-13
Leachate Collection Efficiency Related to Drain Length and Drain Layer Permeability

Drain Length (Feet)	Collection Efficiency[1] Drain layer permeability = 10^{-1} cm/sec (280 ft/day)	Collection Efficiency[1] Drain layer permeability = 10^{-3} cm/sec (2.8 ft/day)
200	98%	34%
400	97%	17%
600	97%	11%
800	96%	8%
1000	95%	7%
1200	94%	5%

[1] Assumes annual infiltration of 124 inches, liner permeability of 10^{-7} cm/sec (.00028 ft/day), liner thickness of 8 inches, and base slope of 2%.

Liner and Drain Slope - Variations in slopes also affect leachate collection efficiency. Collection efficiency is especially sensitive to slope variations when base grades range between 0.25 percent and one percent. This sensitivity, however, decreases when slopes range between two and five percent. Slopes above five percent have relatively little effect on collection efficiencies. Between 60 and 80 percent of the interior of each tailings ponds would consist of side slopes with grades of 25 percent. Leachate collection efficiency on the side slopes would be high regardless of other factors. While increasing the slope of the bottom of the pond (proposed base grade is 2%) would increase collection efficiency, an increase also could result in construction problems. For instance, the two percent slope over the width of pond T4 would result in a 25 foot elevation difference from one side of the pond to the other. Greater slopes could increase liner construction costs, equipment operation difficulties, and erosion.

Liner Permeability - In general, the lower the liner permeability, the lower the seepage rate. A liner permeability of .0003 feet/day (10^{-7} cm/sec) or less is a standard for soil liner design. Exxon's proposed liner would have a design permeability of about .00014 feet/day (5×10^{-8} cm/sec). There would be no significant increase in leachate collection efficiency by decreasing liner permeability. Conversely, an increased liner permeability would increase the potential for greater groundwater contamination.

Liner Composition and Thickness - Landfills in Wisconsin commonly are required to use a liner of four to five feet of clay. The bentonite-amended soil liners were proposed because clay source studies indicated clay deposits in the vicinity of the orebody are inadequate and the costs for manufacturing a four to five foot thick bentonite-amended soil liner would be extremely high. Approximately 3.2 million cubic yards of clay would be required to construct a five foot thick bottom liner under a 400 acre tailings disposal site. Exxon indicated such clay purchase costs, at 1979 prices, would be 20 million dollars, assuming a clay source in St. Croix and Dunn Counties, Wisconsin. This is substantially more than the proposed bentonite-modified soil liner. Transporting large quantities of natural clay would cost considerably more than transporting smaller amounts of bentonite to the site. A DNR study confirmed the major conclusions of the Exxon clay source study. There is no indication of clay deposits of sufficient volume within Forest, northeast Langlade, or northwest Oconto counties. The long distances to potential clay sources indicate a natural clay liner is an impractical alternative.

The nearest clay deposits are approximately 40-65 miles from Crandon and would be accessible by rail transport. The DNR study, however, noted problems with the reliability of the clay source information, a lack of definite data on the quantity of clay available, variability in clay quality, and additional impacts at the clay source borrow area. Assuming a 20 foot thickness for the clay deposit, a 3.2 million cubic yard volume would disturb approximately 100 acres. This would be a minimum figure since additional clay would be needed for the final cover as well as the other lined facilities. Additional impacts associated with using clay include land clearing and borrow area reclamation.

The thickness of the clay liners compensates for the variable qualities of the clay and construction inconsistencies such as varying thickness, compaction and permeability. Exxon has proposed to compensate for material and construction uncertainty in manufacturing the soil liners by using stringent material and construction controls. In addition, the need for a thicker liner is decreased when drain permeabilities are high. Exxon's proposed drain permeability should allow very high efficiencies (at least within a few hundred feet of the drain) regardless of liner thickness. Due to the high drain layer permeability, a thicker soil liner or a geomembrane under the tailings ponds would not substantially improve leachate collection efficiency but could dramatically increase construction costs.

Secondary Liner - The first tailings pond could be underlain by a secondary liner and drain system. The second liner (e.g., a synthetic geomembrane) would intercept any leakage through the bentonite-modified soil liner and thus provide a rigorous performance test of the soil liner. It also would provide additional protection in case of greater than expected leakage through the soil liner. Overall leachate collection from the bottom of pond T1 would be greatly increased. Additional costs over those projected would result from installation of a second liner, drain system, and leachate collection equipment. If the amended soil liners performed as well as expected, the secondary liner might not be required for subsequent tailings ponds.

Leachate Collection Pipe Cleaning - Exxon has not proposed leachate collection system cleaning provisions. Pipe cleaning to reduce clogging and maintain leachate collection efficiency is an element of most landfill designs. Drain cleaning is similar to plumbing and sewer clean out work. Specialized access ports, fittings, bend sections, and access points in the collection system may be needed for proper pipe cleaning. These clean out access pipes also could function as leachate extraction pipes. Because of the long pipe distances and other limitations in clean out technology, the feasible pipe configurations may be limited at this time. Figure 4-6 shows locations of potential clean out lines for the MWDF.

Cleanout pipes could be accessed by stub risers located partially up the interior sideslopes. This would enable both cleanout and inspection with remote cameras for clogging and sedimentation problems.

MWDF Filling Schedule - There would be advantages in filling tailings pond T3 last instead of pond T4. Filling T4 last may impose more impacts due to additional need for off-site stockpiles. Reversing the filling sequence would allow for the placement of the soil stockpiles in the construction support area or the pond T3 location. This could result in increased construction efficiency and minimize transport of soil materials. Use of T3 last also would reduce total closure area and reclamation effort at the end of project life, which is an advantage to the state. Advantages may accrue to Exxon, in that construction costs of the MWDF final cover would be reduced.

Order of filling would have an impact on the amount of leachate collected during operations. Termination of leachate collection from the MWDF at the end of the project is unknown. The Department would require a review at the end of project life based on actual volumes collected from previously closed ponds.

RECLAIM PONDS

The proposed reclaim ponds would have an underdrain/vent layer between the two geomembranes. Exxon has proposed a variable thickness (8" to 18") for this layer, with the greatest thickness over the leachate collection/gas venting pipes. The minimum thickness of this layer could be increased to 12" or even 18" to minimize potential traffic damage to the bottom liner.

MRDF

Several design changes could be made to the existing proposal to reduce the volume of leachate.

1. The amount of precipitation and surface water collected within the leachate collection system could be reduced if the landfill were built continuously thus resulting in a single cell. This could significantly reduce leachate volumes but would require the release of some runoff from the waste surface. This should cause little or no off-site impact since the surrounding soils and wetlands would dilute or attenuate the minor amounts of dissolved substances the runoff might contain. The single cell design might reduce overall facility site size as well.

2. For the existing design, additional pipe could be installed at the toes of all internal slopes to intercept side slope runoff. Interception of the runoff could reduce seepage volumes substantially. This intercepted water could be safely discharged to the surrounding landscape because it would not have been in contact with the refuse.

3. Increasing base grade liner thickness (from eight inches to three feet) would reduce seepage. The base area of each cell would be small (100 feet by 100 feet) so construction costs would not be significantly affected.

4. A final cover with steeper slopes would increase runoff and overdrain effectiveness. Steeper slopes would reduce infiltration rates into the waste mass, regardless of the longevity or integrity of the geomembrane.

A second liner could be installed beneath the proposed bentonite-modified soil liner. A second liner would reduce leakage from the facility, would provide a backup in case leakage through the soil liner was higher than expected, and would intercept leakage through the soil liner and thus provide a performance analysis of the soil liner.

MONITORING ALTERNATIVES

The following monitoring alternatives were developed for consideration as supplemental to the monitoring plan proposed by Exxon.

Pipeline Monitoring - Inspections of wear-prone test sections of the tailings pipelines would serve as an indicator of the condition of the rest of the pipeline. With this approach, critical points could be monitored more frequently thus limiting the need for direct inspection of the entire pipeline length.

Groundwater Drawdown - Alternatives to the proposed drawdown-related monitoring program consist of reducing or expanding the scope of the monitoring program. Reducing the number of monitoring locations and/or the frequency of monitoring would be less costly but would not generate data sufficient for making reliable impact assessments. Expanding the scope of the monitoring program, especially by increasing the number of monitoring wells, would provide a more reliable data base for assessing project impacts. Indiscriminate additions, however, may not be justified in terms of the added cost versus the marginal increase in data reliability. Limited adjustments, such as adding or relocating monitoring wells in specific areas of interest, may be beneficial.

Groundwater Quality - As with the drawdown-related monitoring program, alternatives to the groundwater quality monitoring program center mainly on reducing or increasing the scope of the program. Reducing the program is not acceptable because the reliability of the data base would be compromised. Limited increases in the number of monitoring locations may be justifiable and beneficial. Additional well locations have not been identified.

In addition to altering the scope of the groundwater quality monitoring program, alternative methods of monitoring not proposed by Exxon can be considered. These include installation of a collection lysimeter beneath the preproduction ore storage pad in lieu of a monitoring well and conducting periodic physical and chemical tests on tailings in addition to the proposed leachate sampling.

Heavy Metal Concentrations - A program to sample soil, vegetation, and representative small mammals for heavy metal contamination from particulate deposition also could be conducted downwind of potential dust sources other than tailings ponds T1 and T2. These samples could be collected in a manner similar to that required for the tailings pond.

An alternative sampling program for the tailings ponds would collect samples along permanent (primarily downwind) transects located on Exxon's property. These samples could be collected late in the growing season each year for the first three years from permit issuance (background), the first five years of operation, and the last five years of the operation of T1 and T2. These soil, vegetation, and selected animal tissue and/or organ samples could be analyzed for zinc, copper, lead, manganese, total chromium, arsenic, and cadmium. This alternative would delete the proposed monitoring of mercury, selenium, and silver. The alternative program would sample for a longer period of time over a greater portion of the downwind landscape. Monitoring cost increases would be partially offset by the decreased number of parameters being analyzed.

Monitoring Alternatives for the Swamp Creek Discharge - The WPDES permit could require monitoring of bismuth, platinum, and tin for the discharge to Swamp Creek. Sampling for these elements at the wastewater discharge lagoon outlet could occur monthly on a 24 hour composite sample. Monthly testing may be reduced after one year dependent on results obtained and information available on the toxicity of these metals. Samples also could be collected semi-annually at the Swamp Creek outfall.

Sampling of the benthic organisms downstream from the discharge could be done three times annually (early spring, summer, and fall) rather than the twice annually proposed in order to more accurately evaluate impacts.

The bioassay study to evaluate the impacts of heavy metals from the discharge is proposed as annual. An analysis on a quarterly basis would provide a greater amount of data to analyze effects of heavy metals accumulation.

Fish sampling and whole fish analysis in the laboratory is proposed for heavy metal analysis. Analysis of fish fillets rather than the entire fish could be more representative for metals analysis.

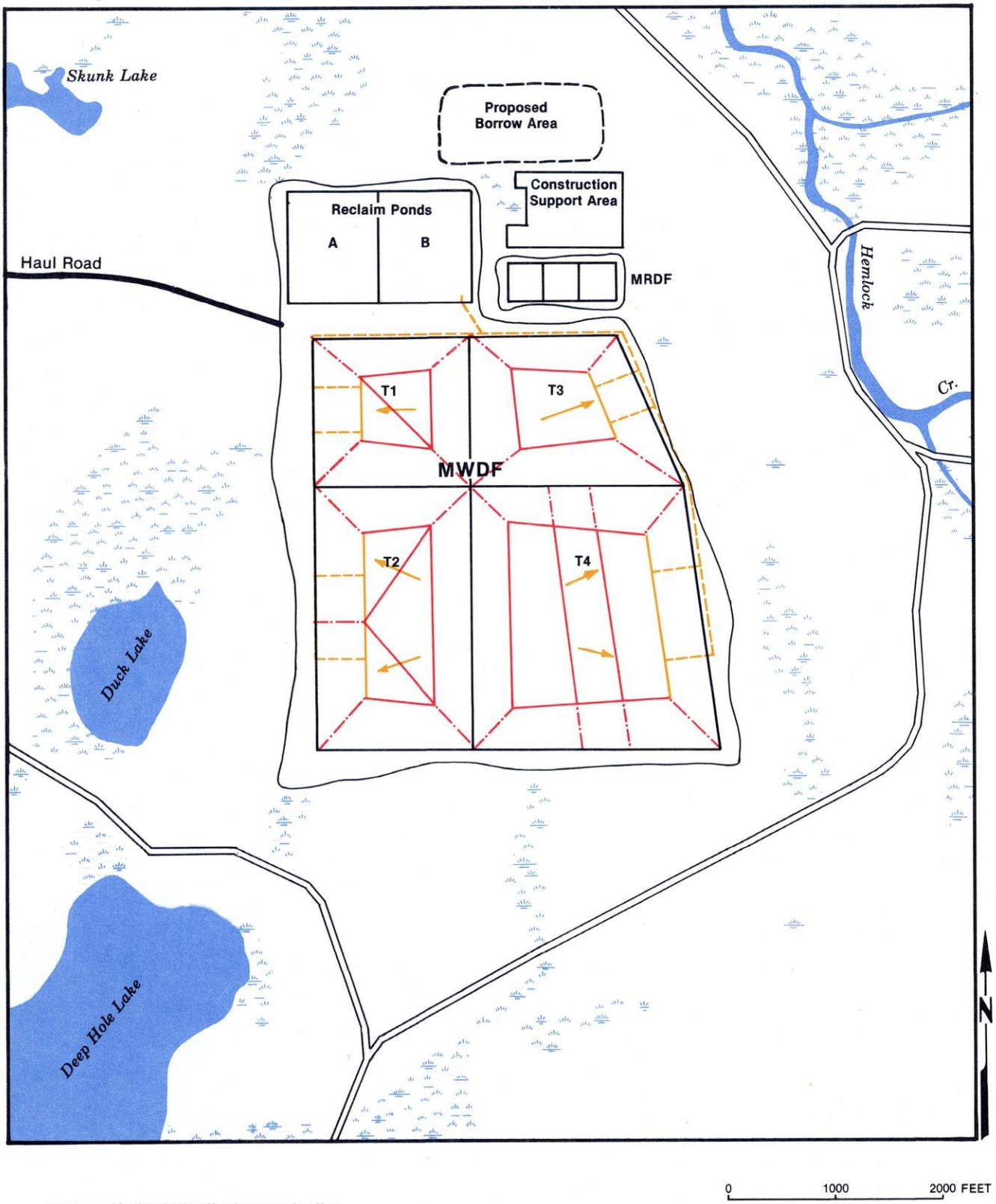


Figure 4-6. Alternative MWDF Leachate Collection Pipe Configuration

Sanitary Treatment Plant Monitoring Alternatives - Exxon has not proposed to monitor sanitary treatment plant influent or effluent. Since effluent from the sanitary treatment plant would be combined with treated mine inflow/intercepted groundwater at the mine/mill site, the only monitoring would be at the outfall point at Swamp Creek. Sanitary influent and effluent monitoring at the package plant would offer the following advantages:

1. Monitoring could prevent or detect occasional operating and/or maintenance problems resulting in poor quality effluent;

2. Monitoring could help determine the source of permit exceedances, if any occur, at the Swamp Creek outlet; and

3. Monitoring of fecal coliforms on a regular basis is necessary to protect public health.

Table 4-14 contains a monitoring program representative of what would be required in the WPDES permit.

Table 4-14
Influent and Effluent Monitoring Alternatives for the
Sanitary Wastewater Treatment Plant

Parameter	Sampling Frequency	Sample Type
	Influent Monitoring	
Flow	continuous	continuous
BOD_5	3 times weekly	3 hour composite
Suspended Solids	3 times weekly	3 hour composite
	Effluent Monitoring	
BOD_5	3 times weekly	3 hour composite
Suspended Solids	3 times weekly	3 hour composite
pH	daily	grab sample
Residual Chlorine	daily	grab sample
Fecal Coliform	2 times weekly	grab sample

Air Monitoring Alternatives - Asbestiform monitors at site B could be wind activated, operating only when the wind off tailings pond T1 blows toward the downwind monitor (Figure 1-25). The monitors could operate between 40-75 hours depending upon filter load. Wind activated monitors would reduce the potential for asbestiform from other sources (e.g. brake linings) contaminating samples.

Metal analysis of the suspended particulate samples could be upgraded from the one filter per sampling site per year to a chemical analysis of all the filters analyzed for particulate type. In addition, nickel could be added to the list of metals analyzed. The added analyses would increase monitoring costs but would increase data on seasonal variability in project-related particulate type and chemistry.

Surface Water Mitigation Monitoring - Due to potential water quality changes resulting from mitigation activities (groundwater augmentation of lake levels, and stream flows), additional monitoring should be considered. The additional monitoring would include:

1. Deep Hole and Little Sand Lakes - Both lakes are susceptible to water quality changes due to the addition of significant quantities of augmentation water. Alterations to the aquatic biota could also result due to changes in the water chemistry of these lakes. This could in turn affect the public rights and use of those waters. There should be additional quarterly monitoring for nitrates, total phosphorus, and iron (Table 1-14), and the pH sampling frequency should be monthly for these lakes. Chlorophyll-a analysis and Secchi disk readings should be taken on a monthly basis from May through September (5 months). This sampling effort should commence one year prior to construction and continue through the first three years of the operation phase. At that time, this requirement should be reviewed.

Additional fish monitoring (fyke netting during the spring (ice-out) and fall (mid-September), minnow seining (in mid-September), and boom shocking of the entire shoreline should be done. Fish sampling should be conducted during the first and third years of operation at which time this requirement should be reviewed.

2. Upper Pickerel Creek, Creek 12-9, Creek 11-4, Hoffman Creek, Hemlock Creek, and Upper Swamp Creek - Dissolved oxygen monitoring at the end of the pipe (prior to discharge to these streams) should be conducted. Field measurements for dissolved oxygen at the end of the pipe are necessary to ensure that the aerators are maintaining adequate levels of dissolved oxygen to meet the standards contained in section NR 102(3)(a), Wisconsin Administrative Code.

3. Flow Monitoring of Creek 11-4 and Upper Pickerel Creek would be more accurate with installation and recording from a flume rather than a proposed staff gage.

4. Groundwater Monitoring - Prior to adding any groundwater to lakes and streams, the quality of the water should be documented. As soon as the prospective water source is available for sampling (at least one year prior to augmentation), quarterly sampling should be conducted. Chemical analyses should be performed for the following parameters: arsenic, cadmium, chromium (+6 and +3), copper, lead, mercury, zinc, silver, selenium, iron, total phosphorous, nitrates, alkalinity, hardness, total dissolved solids, and sulfates. In addition, nickel and cyanide should be analyzed for on an annual basis. Field measurements should also be taken quarterly for dissolved oxygen, temeprature, pH, and conductivity.

   As a result of the groundwater drawdown, some localized changes are expected in groundwater quality. Consequently, chemical analysis of the groundwater should be conducted (at a minimum for the first three years of operation) to ensure the water quality criteria (refer to the limits in Table 3-8) are being met.

CONSTRUCTION AND OPERATION ALTERNATIVES

MINING METHODS

In selecting the appropriate mining method for a given orebody, the size, shape, dip, grade, rock strength and location of the deposit are important factors. The mining methods considered were open pit, underground or a combination of surface and underground.

Due to the thickness of the saturated glacial overburden and the near vertical orientation of the orebody, development of an open pit is not reasonable or environmentally desirable. Extensive site dewatering would be required and much greater surface disturbance also would result. The disturbance associated with pit construction and operation, and waste rock/overburden disposal would be substantially larger than for the proposed underground method. These considerations are applicable to the development of an open pit of any extent, therefore a combination mining method is also eliminated as a viable option. Open pit mining, however, would allow recovery of ore otherwise left in the crown pillar.

Other underground mining methods such as caving and cut-and-fill could conceivably be used to mine the entire Crandon deposit. In comparison to the proposed technique, however, these methods offer no apparent environmental benefits and are less cost-effective and efficient for an orebody of only average grade. Further, caving methods would increase the potential for surface subsidence in the area above the mine.

MINE BACKFILLING

Under section 144.83(2), Wisconsin Statutes, and Administrative Codes sections NR 182.11 and 132.07, minimum standards for metallic mineral mines include backfilling. Backfilling, placing coarse tailings and waste rock in mined-out stopes, is a desirable practice because it allows greater ore recovery and contributes to mine stability by reinforcing mined out stopes. This stability reduces potential rock failure and subsequent surface subsidence. In addition, the volume of waste requiring surface disposal is greatly reduced.

Backfill would primarily consist of the coarse fraction of the tailings. Other materials such as sand and gravel or crushed rock could be used but are not economically viable. If sand and gravel or another excavated material were used, additional environmental impacts associated with the operation of a pit/quarry and transportation of the material would result. Further, use of alternative backfill materials would require surface disposal of the coarse tailings, roughly doubling the required volume of the MWDF.

Another option is to use both fine and coarse tailings rather than just the coarse fraction. This would decrease the volume of supplemental backfill material (sand and cement) required and may increase fill strength. This is a relatively recent practice, however, and long-term performance information is not available. This option would not significantly reduce the volume of tailings requiring surface disposal and may present backfill dewatering and liquifaction problems unless stabilized with cement.

According to the proposed mining plan, all stopes would be backfilled. Only those openings outside the orebody, representing less than 10% of the total openings created during the project, would be left unfilled. These openings would be small and should not be vulnerable to rock failure. If collapse occurred, subsequent surface subsidence would be negligible. Totally filling all underground openings would not significantly increase rock stability or decrease surface disposal requirements. Placement of fill in the small scattered openings would be difficult and expensive.

Decreasing the area backfilled offers no apparent advantages but would decrease rock stability and ore recovery, and increase surface disposal of mine waste.

TAILINGS DISPOSAL

Thickened Tailings Disposal - The present proposal would produce a tailings slurry with a solids content of 55 percent. Tailings could be thickened at the mill to produce a high solids to water slurry (60 to 70 percent solids by weight). The high solids slurry would be transported and discharged into the tailings ponds similar to the existing proposal. The advantages of this alternative are the low volume of water pumped and reduced dike construction. Savings in pumping costs and earthwork requirements, however, are offset by the increased costs for thickening, dependence upon adequate thickening capacity at the mill and operational costs at the MWDF to create the final slope needed for reclamation. This relatively new technique was developed in semi-arid climates and is being tried in Canada, but further evaluation is needed. This method may not be applicable to the fine grained tailings Exxon would generate and the potential for increased dusting would be present.

Solid Tailings or "Dry" Disposal - For this alternative, tailings leaving the mill would be in a damp condition with a solid content of 75-80 percent by weight. The tailings would have to be dewatered with mechanical belt or filter presses similar to those used for the dewatering of the concentrates. In addition to the dewatering equipment, the conventional tailings thickener for the existing proposal would still be required.

A significant advantage of this method is the elimination of massive confining dikes and lower earth moving cost. Disposal and reclamation can be performed sequentially with reduced lead time and preparation effort, and side slopes can be built to any angle desired with thinner confining dikes and final covers.

This design is most applicable for operations with a low volume of tailings rather than high volume operations such as the proposed project. The solid tailings disposal option would radically alter site design, operation, and tailings transport. A prominent disadvantage of this method is the dependence upon good operation of the mechanical dewatering system because the tailings would be difficult to haul, place, and compact if the moisture content is excessive. In addition to the maintenance and overhead costs of the mechanical dewatering equipment, additional labor, conveyors, and trucks would be required to haul and spread the tailings at the disposal site. This method would preclude the use of pipeline transport unless tailings were dewatered at the disposal site. Consequently, the savings and initial preparation costs due to reduced earth moving requirements would be offset by the higher operating costs for hauling and placing the tailings. Transport and disposal of dry tailings would be susceptible to dust generation. Residual water in the tailings and moisture from

precipitation would necessitate a liner and underdrain system even for the dried disposal option. The cumulative mill, transport, and operation costs plus increased potential for dusting do not favor the dry disposal option over the existing proposal.

WASTE TRANSPORT

Exxon has proposed two methods of waste transport, (1) hauling waste rock by truck and (2) pumping tailings and water treatment sludges by pipelines. Alternatives which increase truck traffic, move the corridor alignment or result in a different transport mode, such as a conveyor system, are likely to result in greater impacts, particularly to wetlands and air quality. Specialized modes, such as dedicated rail transport, are applicable only where the topography is extreme or very large volumes of ore/overburden are moved. The proposed haul road/pipeline transport system and corridor alignment has the least overall impact.

The pipelines would consist of plastic (high density polyethylene) pipe buried six feet deep along the haul road corridor. Pipelines would have the advantages of low maintenance and operating costs, simplicity, and a proven record in conveying tailings and other abrasive materials. The greatest disadvantage is the high construction cost. If a weld should break either on the surface or underground, pressure sensors and slurry output should alert the pipeline operator. At the pressures used in modern pipelines, defects in the pipe can be made evident during the pressure tests during pipeline construction or in the periodic pressure measurements.

The haul road used by dump trucks carrying waste rock riprap would have an unpaved aggregate surface. Hauling waste rock by truck has the advantages of versatility, ease of adding or reducing the truck fleet as needed, elimination of additional waste rock crushing or processing, and mobility of placing waste rock at the MWDF. Co-disposal of waste rock with either slurried or dry tailings should not present major problems.

Exxon presently proposes to dispose of all non-marketable wastewater treatment sludges with the tailings. The present design of the MWDF eliminates the need for special handling of wastewater sludges. There are no significant advantages to the conveyor or truck hauling modes over the proposed pipeline transport of sludges. If the "dry" tailings disposal option were selected, the wastewater sludges and sediments from the reclaim ponds must either be dried or disposed of at a separate site. Sludges and sediments with excessive water could not be added to the tailings because instability problems may occur. Additional costs would be associated with the construction, operation and closure of a separate site and tanker truck/small pipeline transport of sludges. Project changes associated with an alternative transport mode could increase dust generation, wetland impacts, and system complexity at the mill and MWDF.

PIPELINE ALTERNATIVES

Buried Pipelines - Substantial advantages exist for the proposed buried pipeline system. Buried pipelines constructed with modern materials and methods have had long service lives, high reliability, and low maintenance costs. Defects in the pipes are detectable and repairable during pipeline construction. The integrity and leakage of buried pipelines can be checked by pressure tests, monitoring test sections, camera surveys or other devices. More problems with slurry transport systems originate from faulty valves, slurry feeds, pumps, and dewatering equipment than from the pipeline.

Buried pipelines are nearly immune to accidents. Soil-induced corrosion and microbial attack can be reduced or eliminated by using specialized coatings or corrosion-resistant materials. Buried pipelines are not visible and require minimal support structures other than the bedding of the trench. Temperature-induced expansion and freezing problems are decreased in buried installation. Surface impacts of buried pipelines can be minimized by revegetating the disturbed soil surface. Herbaceous or grassy vegetation would be acceptable along the corridor because pipeline inspections would not be hindered.

Surface Pipelines - Exposed pipelines, whether on the ground surface or elevated, require supporting structures or must be partially restrained to prevent movement due to the momentum of the slurry and temperature-related expansion and contraction of the pipe. Surface pipelines are exposed to the elements, can be more easily damaged by accidents and vandalism, are subject to freezing, and are aesthetically less pleasing. Exposed pipelines allow for easier inspections to examine for external faults, such as broken welds, and test for wear.

Pipeline Materials - Pipe manufacturers have conducted tests to compare the abrasion resistance and installation costs of various pipe materials. High density polyethylene (HDPE) plastic pipe, the pipeline material proposed by Exxon, shows more abrasion than carbon steel but is the best of the plastic materials. HDPE is a more abrasion resistant material than metals such as aluminum and mild steel. Tests conducted by the U.S. Army Corps of Engineers indicate HDPE pipe is three to five times more abrasion resistant than the conventional mild steel pipe commonly used with dredge spoils, fly ash, and tailings transport. Pipe sections of more durable material, however, could be added at suspected high abrasion points to minimize wear.

There are considerably different weight and joining methods between steel, concrete, and plastic pipes of equivalent diameter and pressure rating. HDPE pipe may weigh 90% less than the equivalent steel pipe for the same application. Concrete and steel pipes are heavy, stiff, and usually require transport and placement using lifting machinery on prepared roadbeds along the pipe alignment. In contrast, HDPE pipe is flexible and can be handled and placed by lightweight equipment. While installation of a plastic pipeline requires similar trenching and soil disturbance compared to a steel or concrete pipeline, there would be decreased time, equipment, pipeline bedding, and survey requirements. This is particularly pertinent because of the wetlands along the discharge pipeline corridor to Swamp Creek.

WASTE DISPOSAL

During the construction, operation, and closure of the proposed project, a number of wastes would be generated. The majority of the solid wastes (tailings, waste rock and refuse) and sludges would ultimately be disposed in the tailings ponds and landfill. Petroleum and sanitary sludge wastes would be handled off-site.

A portion of the closure wastes (e.g., inert demolition wastes such as broken concrete) may qualify for one-time-only disposal site under section NR 180.13, Wisconsin Administrative Code. If more than one of these sites is required, the maximum capacity would be restricted to a total of 10,000 cubic yards.

Any long-term storage, treatment, or disposal of hazardous wastes would require a plan review and license from the Department in accordance with Chapter 144 of the State Statutes. No such facility has been proposed for the project. All hazardous wastes would be transported to an off-site facility for storage, treatment and/or disposal.

Construction Wastes

Wood Wastes - Land clearing and grubbing wastes would be chipped for use as landscaping materials or burned in an air curtain destructor. Alternatives for handling these wastes include:

1. Open burning is possible, if done in conformance with the solid waste and air pollution control regulations. The large volume of material, high probability of incomplete combustion, the need for continuous management of the burning site, and the landfill space required to dispose of the residue, however, are disadvantages of this alternative.

2. Off-site landfilling in an approved site may be necessary for stumps which cannot be chipped or burned. Impacts include use of landfill capacity, increased truck traffic, and complications in the operations of the landfill due to the size and noncompactable nature of stumps.

3. Off-site use of the chipped wood by local industries for fuel is another option. Impacts include a potential increase in air emissions at the burning facility, and increased road travel and handling of the chips at the project site and at the burning site.

Inert Wastes - Exxon proposes to dump inert solid waste such as concrete, asphalt, and rail ballast, in approved unlicensed fills and landscaping projects, in conformance with the state solid waste regulations. An alternative is to dispose of the materials in a licensed landfill. Impacts would include the utilization of limited landfill capacity, additional land disturbance at borrow sites, increased dust emissions, and higher material handling costs.

Petroleum Wastes - Waste petroleum products (such as oil, hydraulic fluids, and lubricants) would be collected and either returned to the manufacturer or sent to an off-site reprocessing or recycling facility. Disposal is not an alternative because there are no landfills in the area approved for these types of wastes. Petroleum waste could be incinerated, but this would result in increased air emissions and may increase energy usage. An alternative method of hazardous waste handling would be on-site recycling. This may require a license under NR 181, Wisconsin Administrative Code. The economics of recycling wastes on-site would depend upon waste volumes, types and the relative costs of off-site treatment of the wastes. The impacts of on-site recycling may include an increase in air emissions and an increased potential for spills during waste handling, but it would reduce the quantity of petroleum products transported and utilized.

Sanitary Wastes - Sanitary waste from portable toilets would be produced throughout the life of the project but the greatest production would occur during the construction phase, especially during the first six months of the project and during summer construction peaks. These wastes could be disposed in the City of Crandon's wastewater treatment plant. This plant has sufficient excess capacity (volume daily flow, BOD and suspended solids), so disposal should not adversely affect plant operation. If the City of Crandon would not accept the wastes, an agreement would have to be reached with another municipal treatment plant. Laona and Wabeno, because of capacity or technical limitations, however, would probably refuse such wastes. These wastes also could be landspread.

After the package treatment plant begins operation, sludge would need disposal. Current estimates indicate 5,000-6,000 gallons of sludge would be produced every two months. Exxon proposes to hire a licensed disposer to handle the sanitary waste. Sludge disposal options available to a licensed sanitary hauler include:

1. Disposal at a treatment plant. This would reduce potential groundwater contamination and disease transmission compared with land disposal. Adverse impacts include the potential for operational problems at the treatment plant due to the waste volume or incompatible nature of the waste. A number of existing treatment plants in the area could not accept these wastes without experiencing operational problems.

2. Disposal at a sanitary landfill. This could adversely impact groundwater and surface water as well as cause operational problems with the covering of sludges. A beneficial impact is the reduction in the land spreading of these wastes.

3. Disposal by burial. This option would probably not be feasible during the winter, and complications involved in the immediate burial of liquid wastes could occur. Impacts include increased potential for groundwater contamination and disease transmission.

4. Incorporation into the soil. This is the preferred landspreading disposal method, however, none of the area's existing haulers utilize this method of disposal due to the costs. In addition, this is not a feasible option for winter disposal. This method of disposal increases the potential for groundwater contamination.

5. Landspreading, which is the most common sanitary waste disposal method now being practiced by haulers in the area. Sufficient land and spreading sites exist in the area. However, this disposal method increases the potential for surface and groundwater contamination and disease transmission. Another alternative would be to landspread the sludge on-site in acceptable areas.

Refuse - Initial construction wastes are proposed to be trucked to the nearest solid waste disposal facility at which disposal would be compatible with site capacity and management. However, there may be no waste disposal sites within economical trucking distance that would accept the waste. In that case, Exxon could choose to begin construction of its on-site disposal facility early so it would be ready to accept refuse at the beginning of construction. Another alternative would be for Exxon to store refuse on-site until the landfill was completed. Department approval would be needed for this alternative.

Operations Wastes

Refuse - Refuse produced during project operations includes garbage, paper, plastic, wood and metal scrap, tires, and worn equipment. Exxon has proposed to return tires and reusable packaging to the suppliers, and salvage and sell scrap metal. The remaining refuse would be disposed in the proposed on-site landfill. An alternative is landfilling in an approved off-site facility. Estimates of construction, operations, and closure waste indicate the total volume would be about 102,000 cubic yards (51,000 tons). These wastes could be trucked to regional, engineered landfills (Antigo, Oneida County, and Marathon County) but this would significantly reduce existing capacity at these landfills. Composting probably is not a feasible option due to the nature of much of the refuse.

Sanitary Sewage Treatment Alternatives - An alternative sanitary waste treatment system would consist of a septic tank/soil absorption system. This system would need to treat 23,000 gallons per day (gpd) or about 20 gallons per minute (gpm). A soil absorption field about 1.25 acres in size with an equal sized replacement area (totaling 2.5 acres) would be needed. Solids accumulating in the septic tank would require periodic disposal. Disposal at a municipal wastewater treatment facility or landspreading would be viable options.

Another treatment alternative is aeration of the sewage in a stabilization pond. A stabilization pond would hold the waste for a minimum of five months prior to discharge. During this time, the organic wastes either degrade or settle to the bottom producing an effluent suitable for discharge. This design requires a large area for placement of the pond and a liner to minimize seepage. Odors can be a periodic problem, particularly in spring when the winter ice melts. The advantages of this design are low initial and operational costs, good reliability, and simple operation.

Mechanical aeration designs also provide a number of options and differ primarily in holding time and organic matter removal. Of these systems, the aerated pond design has the longest holding time (but less than a stabilization pond). Air is pumped into the waste by either submerged diffusers or by floating mechanical aerators. Where severe winters cause ice buildup and low sewage temperatures, the subsurface aeration systems are more reliable. The aerated pond system requires less area than a stabilization pond but still needs to be lined to minimize seepage. Aerated pond advantages include simple operation, less odor, and reliability. Total system construction and operation costs, however, would be higher than for a stabilization pond.

One other design uses rotating media for wastewater/bio-solids contact. With this design, the wastewater flows through a tank where the discs of media are attached to a rotating shaft. Bio-solids, which grow on the rotating discs, are exposed to the air for half of a revolution and are submerged in sewage for the other half. Excess solids growing on the media are sheared off in the wastewater. These scoured bio-solids are removed in a final settling tank. Treatment efficiency for this system is comparable to the proposed system but construction costs would be slightly higher.

Effluent Disposal - Under Exxon's proposal, treated sanitary sewage effluent would be mixed with treated mine inflow/intercepted groundwater for discharge to Swamp Creek. An alternative would be to discharge to a wetland, lake or groundwater. The proposed treatment methods are capable of producing effluent of satisfactory quality for discharge to most flowing streams or wetlands. Additional treatment, called effluent polishing, would be necessary for a lake discharge, but substantially increase costs. A wetland discharge would mitigate some negative effects of the groundwater drawdown though impacts on wetland flora and fauna due to effluent quality and quantity must be considered.

Treated effluent could be pumped to a seepage pond or a storage pond where the accumulated wastewater could be used for spray irrigation during the growing season. The seepage pond system would require less area than the septic tank/soil absorption system but would require equivalent operational attention. The storage/spray irrigation system would affect more area than the septic tank/soil absorption system and would have greater operation and maintenance costs.

Additional groundwater monitoring would be required for any of the alternative effluent disposal systems.

Water Treatment Wastes - Four types of water treatment wastes would be produced: (1) water treatment plant sludges, (2) reverse osmosis membrane cleaning solutions, (3) sediments from the reclaim ponds, and (4) salt cake. Water treatment sludges would consist of metal hydroxides, carbonates, and calcium compounds. These sludges would have a low solids content (less than 10%) and would require thickening to allow placement of a soil cover if segregated disposal is desired. Even if thickened, these sludges would be difficult to handle and cover in a landfill. Landspreading is a possibility but the sludges have little nutrient or soil amendment value. Another method is co-disposal with municipal refuse in a conventional solid waste landfill. Landfilling with solid waste, however, is only possible at a landfill equipped with a liner/leachate collection system. A minimum 10:1 ratio, by volume, of refuse to sludge would be necessary. The nearest off-site landfill which could accommodate the proposed volume of sludge is the Marathon County landfill. This landfill already takes various industrial sludges and is unlikely to allow disposal from additional sources, especially from outside the county. Co-disposal of sludges would contribute additional dissolved solids, stable metal hydroxides, and carbonates to a landfill's leachate. In the MWDF, the sludges would marginally increase leachate loading but would add additional neutralizing capacity to the tailings pond.

The reverse osmosis membrane cleaning solutions (approximately 1,300 gallons/month) would consist of dilute solutions of detergents and particulates. This solution has no particular reuse potential, either as a cleaning solution or as a liquid suitable for land spreading or soil amendment purposes.

Sediments from the reclaim ponds would consist of fine tailings particles, lime, and precipitates of metal hydroxides and carbonates. This sediment has no expected economic value or soil amendment use. Placement of this material in the MWDF either periodically or at the end of the project life is the most feasible disposal technique. These sludges would add neutralizing capacity to the tailings.

Co-disposal of the cleaning solutions, reclaim ponds sediment, and water treatment sludges with the tailings is convenient and eliminates the need for additional processing equipment or additional disposal facilities. The lime content of these waste treatment sludges would increase the neutralizing capacity in the tailings ponds.

Salt cake is a by-product of the reverse osmosis/vapor compression treatment system and consists of hydrated sodium sulfate. The salt cake could be marketed if it was of commercial quality. Approximately half of the salt cake used in the U.S. comes from natural deposits while the remainder is a by-product from the manufacturing of materials such as rayon. Salt cake is used primarily in Kraft paper mills, laundry detergent as a filler, and glass manufacturing. There are three paper mills in Wisconsin capable of using Exxon's salt cake. Such use, however, would displace sodium sulfate sources currently supplying these mills.

Storage of salt cake (sodium sulfate) outside of the MWDF would be possible and preferable to land disposal. The projected annual production of salt cake is more than 2000 cubic yards, which would constitute a block 80 feet square and 10 feet high. If sufficient covered storage would be provided, salt cake could be stored until it could be sold, or if land disposal were required, until a tailings pond or MRDF cell would be ready to be closed. Salt cake could be placed in the cell, compacted, and covered quickly. However, such disposal might complicate facility closure by causing cap stability problems. On-site evaluation would be required to determine suitable disposal techniques, assuming salt cake could not be sold commercially.

Alternatively, a separate waste disposal cell at the MRDF could be dedicated to salt cake disposal. This could be phased and would result in only minor project expansion. Total projected salt cake production is slightly more than half of the total project solid waste generation. During disposal, salt cake would have to be covered to reduce the amount of water available for hydration and subsequent solution in available precipitation. The liner beneath the waste disposal cell would have to be compatible with a high sodium leachate.

TAILINGS PROCESSING

Secondary Metal Recovery - As mineral processing methods have improved in the mining industry, tailings have been reworked to extract additional ore. Tailings, as well as waste rock, have been reprocessed in flotation circuits or by heap leaching to recover valuable metals like gold and silver. Exxon's tailings, however, would not be suitable for heap leaching or additional ore flotation. The ore mineralogy is not conducive to good metal recovery and the tailings particles would be too fine or have too great a neutralization capacity for efficient leaching. In addition, the presence of pyrite would lead to considerable dissolved iron which would complicate metal recovery.

Pyrite Separation and Disposal - Segregated disposal of the sulfide minerals from the non-sulfide minerals would allow future access to a relatively rich pyrite source. Segregated disposal of pyrite, however, would require stringent site design requirements, such as additional leachate control and monitoring wells at the pyrite disposal/storage site. Several points about segregated versus unprocessed tailings disposal need to be considered.

1. Additional flotation circuits would be needed at the mill to extract pyrite from the tailings. The additional flotation circuits would require more power, lime, sulfuric acid and reagents. The amount of pyrite produced would depend on whether all the tailings, both fine and coarse, were processed. In addition, removal of the pyrite might create a backfill deficit which would require supplemental sand and gravel. Moreover, the greatest amount of pyrite would be produced during the massive ore phase thus making management of the pyrite separation facilities and marketing of the pyrite more difficult.

2. Flotation cannot achieve a 100% separation of pyrite from the non-sulfide minerals. Typical pyrite flotation can reduce pyrite concentration in the non-sulfide mineral tailings to one percent or less. Even at this level, however, the non-sulfide tailings could produce acidic leachate thus providing little relief from the existing tailings isolation requirement.

3. Pyrite tailings would require a separate, lined disposal site approximately half the volume of the proposed MWDF. Thus, there would be a simultaneous need for two operating containment sites at any one time. The doubled disposal requirements also would increase construction and operation costs as well as pumping, pipeline, leachate collection/treatment, and final cover considerations. Locating a pyrite disposal site would be subject to the same restrictions as the proposed MWDF. A pyrite disposal site would require all of the presently proposed controls and monitoring plus additional controls to provide adequate environmental protection.

4. The removal of non-sulfide minerals from the pyrite might be counterproductive for long-term groundwater protection. These minerals would provide some neutralizing capacity if the tailings began to oxidize. Pyrite oxidation should be limited to the upper few feet of the tailings mass due to the fine grain size of the tailings in a non-segregated disposal site. Any leachate formed would be neutralized by the non-sulfide minerals and wastewater sludges beneath the zone of oxidization.

Pyrite Processing and Marketing - Exxon evaluated several pyrite processing techniques, the historical and potential uses of pyrite, and the markets for pyrite products in North America. Several processing techniques proved to be technically feasible at plant-level facilities. These techniques could be used if pyrite concentrate markets can be found and by-product sulfur output can be matched with the needs of sulfur users. Given the present price and market structure, however, pyrite and by-product sulfur marketing is not feasible.

Pyrite is not an economically viable source of iron ore in North America given the present structure of the steel industry, the reliance on taconite ores, and current world markets. Pyrite also is an uneconomical source of sulfur or sulfuric acid for the foreseeable future. Potential acid users are too small (metal finishers), in economic trouble (steel mills), or too far away (phosphate fertilizer industry), and there is considerable competition in the Midwest acid markets from existing Canadian smelters. Moreover, environmental restrictions on power plant emissions and oil and gas producers may result in new, large sulfur producers in the near future leading to a glutted market. On balance, the available pyrite processing alternatives would be less desirable from both an environmental and economic standpoint.

Sale of pyrite concentrates and sulfur by-products is unlikely to reduce tailings disposal requirements or be profitable unless an additional processing plant is considered. Rather than ship sulfur or sulfuric acid to chemical process plants in other parts of the county, a zinc refinery/chemical process plant could be developed at or near Exxon's mine/mill. This plant would process the pyrite or sulfur by-products from the mine and produce a higher value product. A zinc refinery, if constructed, would generate a surplus of acid beyond the refinery needs due to air pollution controls.

The most profitable alternative would use the acid produced by a zinc refinery/chemical process plant to produce phosphoric acid and diammonium phosphate fertilizer. The return on investment for the phosphate fertilizer facility, however, would be several percentage points lower than is typical for the industry. The largest and most profitable alternative would provide a return on investment of only slightly over 5%. Normally, industrial investors would demand a substantial premium over what a safe investment would return. The potential for unexpected increases in project cost, variable market conditions, an uneven national economy, variable fuel and raw materials costs, the necessity to develop a local infrastructure, and the low return on investment do not favor this alternative.

The total cost for construction, operation, and reclamation of the mine/mill/MWDF and ancillary facilities is $534,000,000. The investment costs for a phosphate fertilizer plant would range from $133-400 million, with the highest investments the most likely to be profitable. The capacity of the larger scale plants also would be aided by acid from a zinc refinery. A potential zinc refinery of a size appropriate for the orebody and expected ore production might require a capital cost of an additional $250,000,000. These additional investments could more than double the required capital costs of the project.

Other project development factors also must be evaluated. A zinc refinery/pyrite refinery - phosphate fertilizer plant complex would cover several hundred additional acres of land, would employ several hundred people each, would involve around-the-clock operations similar to the mine/mill, and would multiply total project power and water requirements by several times. Mill costs would increase due to the additional costs associated with pyrite concentrate production and tailings disposal. Such a facility could employ over 100 people, most of whom would require training in chemical and industrial skills. Many of the jobs could not be filled by local residents. Cars, trucks, and rail traffic would increase due to the additional labor force (approximately two to three times) and raw material requirements (due to imported phosphate, rock and ammonia). Additional social, public service, and support requirements would be imposed on the local economy and governments. These costs could be several times those imposed by the proposed mine/mill.

The environmental impacts for a pyrite refinery - phosphate fertilizer plant would be particularly significant with regard to the solid waste disposal, water consumption, water treatment, and air emissions. About 2/3 of the total pyrite mass processed to produce sulfuric acid would become iron cinder. Since gypsum production is an inherent by-product of the phosphate fertilizer process, about 5 times as much gypsum waste would be produced as pyrite consumed in the process. A comparison of waste disposal requirements for processing only the fines compared with processing the coarse and fine tailings fractions is made in Table 4-15. Surface disposal requirements could increase substantially, up to 10 times in volume, depending on the amount of pyrite processed. Gypsum, a hydrated sulfate of calcium, is not nearly as dense as tailings, and thus would result in a greater disposal volume.

Table 4-15
Summary of Processing Waste Disposal Requirements
(units in millions of cubic yards)

	No Pyrite Processing	Process Pyrite Fines Only	Process Pyrite Pyrite Fine & Coarse
Tailings in MWDF	21.6[1]	11.1[2]	3.9[2]
Gypsum Waste	0	74.5[3]	343.8[3]
	21.6	85.6	236.7

[1] Based on MWDF proposed volume.
[2] From Coefield Associates Report, June 1986.
[3] From A. Trevino's Report, Dec. 1984.

Neither iron cinder nor gypsum are likely to be more easily disposed than either tailings or the pyrite concentrate. The iron cinder is likely to be much more permeable than the proposed tailings and could produce an acidic leachate. Gypsum is a large volume waste which also can have an acidic leachate. Due to the higher uranium and radium content of imported phosphate rock, the waste gypsum would produce detectable radon emissions. These emissions, however, would be well below the limits established for low-level radioactive waste. Currently, land disposal is the usual disposal method for by-product gypsum. The material is not suitable for reuse except for some limited soil amendment or sulfur enrichment uses. Areas which could utilize waste gypsum as a soil amendment are restricted to arid western areas with sodic or saline soils and to peanut-growing areas in the southeastern U.S.

Project management would be complicated by the construction and operation of a zinc refinery and/or a pyrite refinery - phosphate fertilizer complex. While the mine/mill and a potential zinc refinery would be affected by metal prices, phosphate fertilizers would be affected by agricultural markets and phosphate rock prices. Phosphate fertilizer is a successful export product but agricultural market swings may not correspond with mine/mill production rates.

Processing pyrite at a location other than the mine/mill is unlikely to improve waste recycling economics or reduce environmental impacts. Transport costs compared with the low value of the product would not favor such a shift. Waste disposal requirements at the mine/mill for the pyrite - free tailings and other waste, though reduced, would still exist. Air standards might limit construction of a refinery/fertilizer complex to areas where the potential sulfur dioxide emissions would not be a problem. Solid waste disposal facilities would have to be constructed at the location of the pyrite processing facility.

In summary, producing a pyrite concentrate is technically possible but is unlikely to significantly aid project waste disposal requirements and would require additional process lines and associated equipment and chemicals at the mill. Water treatment plant costs and sludge generation would increase as well as reagent consumption. If all pyrite from the mine were reused, additional mine backfill would have to be developed from local sand and gravel sources, thus, increasing land disturbance. There would be greater requirements for air and water emission controls, and monitoring because a wider array of contaminants could be released. Pyrite concentrates have little realistic use in North America as a chemical feedstock so separate storage is likely to be permanent disposal. Lastly, removal of non-pyritic minerals would remove desirable neutralizing capacity from the pyrite concentrate.

WASTEWATER TREATMENT AND DISPOSAL

Alternatives for the treatment and discharge of wastewater from the mine workings, process water from ore milling and tailings disposal operations, and storm water runoff are considered in this section. Alternatives for the treatment and disposal of sanitary wastewater (sewage) are described in a separate section.

Treatment Systems

There are three general categories of available treatment technologies: chemical, physical, or biological treatment. It is often necessary to use a number of treatment processes to efficiently remove wastewater pollutants. For example, chemical precipitation is usually followed by physical separation such as settling or filtering. The primary pollutants to be removed include: dissolved metals, organic chemicals, acidity or alkalinity, chemical anions, and suspended solid particles. The following criteria were used to evaluate alternative treatment processes:

1. Meet effluent limitations and/or standards;

2. Remove scale forming compounds (for mill process water);

3. Provide cost-effective treatment;

4. Use proven technology;

5. Be flexible with respect to influent water quality;

6. Remove thiosalts (for mill process water);

7. Remove metals;

8. Produce environmentally acceptable sludges; and

9. Produce a marketable sludge by-product, if possible.

Process Wastewater Treatment - EPA effluent guidelines require all ore milling process water be recycled, except for excess annual precipitation and mine inflow. The company predicts the proposed reclaim ponds, in conjunction with the water treatment plant, would produce water of sufficient purity for reuse in the mill processes. Alternatives to the proposed process wastewater system include:

1. Operation of the reclaim ponds could be modified during winter conditions (low water temperatures and ice cover) by subsurface aeration or addition of chemical oxidants to increase biological/chemical activity. This would reduce concentrations of reduced sulfur ions, organic chemical reagents, and cyanide in the effluent.

2. A chemical/physical treatment system could be substituted for the reclaim ponds. Such a system could use chemical oxidation and aeration to remove organic reagents and cyanide, and to oxidize reduced sulfur compounds to sulfate. Chemically aided clarification or filtration could follow for suspended solids removal. A cyanide oxidation system could be installed at the outlet of those flotation circuits utilizing cyanide to minimize cyanide dispersion throughout the mill process water system. In a similar manner, a chromium reduction unit could be installed so that the resulting trivalent chromium could be removed by the treatment system.

   Some water surge or storage capacity, however, is desirable in the mill water system. If the proposed reclaim ponds were eliminated, a storage pond would have to be built to provide sufficient capacity to store mine inflow during treatment plant down times. Thus, some surface disturbance would still occur.

Mine Water Treatment Alternatives - Optimization of the proposed system and three alternative treatment systems were examined for the contaminated mine water and intercepted groundwater. The proposed system has been optimized for cadmium removal. A variety of precipitation, settling, filtration systems were dropped from consideration due to the probable lack of compliance with effluent limitations.

Optimization of the proposed precipitation/filtration process could be achieved by additional precipitation with iron or starch xanthate or by pretreatment (use of hexavalent chromium reduction system for the lead thickener overflow). These measures could result in reduction of currently projected effluent values for these parameters (i.e., 50% or greater) based on theoretical considerations, literature review, and limited lab testing by Exxon.

Alternative 1 for treating mine water is identical to the proposed mill reuse water treatment system (precipitation/filtration/reverse osmosis, vapor compression/evaporation). Advantages of this alternative include a substantial redundancy with the mill water system (equipment interchangeability, operator familiarity, common reagent needs) and production of sodium sulfate, a potentially saleable by-product. Effluent from this alternative system would be lower in dissolved solids (sulfates, hardness), organic chemical residues (milling reagents, oil/grease), and possibly dissolved metals than the proposed system. Disadvantages of this system include high equipment, operational, and energy costs, and an increased amount of residual sludge or solids for disposal.

Alternative 2 consists of ion exchange columns for removal of cations (dissolved metals) and anions (sulfate), with pretreatment consisting of chemical oxidation for iron and reduced sulfur compounds, sedimentation/filtration for solids removal, and activated carbon adsorption for organic chemical removal. This system would produce a higher quality effluent with lower dissolved solids than the proposed system, and could produce a saleable by-product. Disadvantages would include higher operational costs and a larger quantity of wastes for disposal because the solids/sludges would not be a marketable by-product. If this system was used on only the intercepted groundwater, the activated carbon adsorption step probably could be eliminated. The chemical costs would be substantially reduced due to the lower concentrations of substances in intercepted groundwater compared to the contaminated mine water.

Alternative 3 is full flow evaporation with pretreatment consisting of precipitation and filtration. This system would be very reliable and would produce effluent of excellent quality. Operational costs would be very high for this system, and nonmarketable sludge/solids would be produced. Supportive pilot test data have not been developed at this time.

Advanced mine water treatment systems (Alternatives 1-3) could achieve significant reductions (50% or greater) in projected daily average effluent values for parameters of human health concern (e.g., arsenic and chromium). The projections for RO/VCE treatment (Alternative 1) are based on Exxon's water model results and current estimates of mine sump water quality and effectiveness of precipitation/filtration pretreatment. Quantitative projections for ion exchange treatment (Alternative 2) are not possible because pilot testing has not been conducted. However, significant removal may be possible if suitable exchange resins are selected and process operation is optimized. Although not confirmed by pilot study results, full flow evaporation (Alternative 3) may have even greater reductions for such parameters. Reductions could approach the limits of detection.

Treatment of contaminated mine water by full flow evaporation (Alternative 3) supplemented with effluent storage (see next section) as needed may provide the flexibility necessary to allow discharge when very restrictive effluent limits would apply, or for lake mitigation. Some lake discharge also may be possible with the use of treatment alternatives 1 or 2.

Disposal Alternatives

Alternative disposal include effluent storage, multiple discharge sites, land disposal or combinations of these options.

Effluent Storage - The most significant impacts of a wastewater discharge occur during periods of low stream flow. Effluent storage is a means of mitigating or eliminating these impacts by varying the discharge rate. Such facilities would require sufficient volume to retain all, or a portion, of the wastewater otherwise discharged during the low flow periods. Stored effluent could be discharged as stream flows increased. The effective use of effluent storage could result in less restrictive effluent limitations due to a reduction in discharge volume during periods of low stream flow. Effluent storage could allow for the use of treatment systems or operating alternatives which otherwise could not meet effluent limits.

Multiple Discharge Sites - Multiple discharge locations could minimize the impacts associated with a single, large discharge for a continuous wastewater source. Two or more discharge locations on a single stream could be chosen so that effluent from the upstream discharge location(s) was completely mixed with the streamflow prior to reaching the downstream discharge location(s). If the effluent parameters were close to background stream conditions and the discharge was divided between several sites, less restrictive water quality effluent limitations might be imposed. This alternative also could be used in conjunction with effluent storage facilities to further minimize

potential effects on the receiving stream. Multiple discharge locations would require additional land purchase and temporary construction disturbance, increased costs, and the need for additional monitoring.

One other means of reducing the total effluent discharge to Swamp Creek would be to discharge intercepted groundwater to wetlands in the Swamp Creek watershed. This might alleviate mine dewatering impacts on some wetlands near the mine site. Such a discharge could be continuous or seasonal depending upon the need to maintain water levels. Some of these wetlands might contribute flow to Swamp Creek, thus increasing surface runoff to Swamp Creek. This could mitigate mine dewatering and effluent discharge impacts on Swamp Creek during low flow conditions.

Land Disposal - Land disposal methods for intercepted groundwater or contaminated mine water discharge include: infiltration (seepage) basins, spray irrigation, ridge and furrow fields, and subsurface absorption beds. Effluent limitations would be set at levels below the primary and secondary drinking water standards to protect groundwater quality. Effluent and groundwater monitoring requirements would be part of any WPDES wastewater discharge permit issued for the proposed facility. Additional land disturbance would be associated with a land disposal system.

Land disposal of wastewater effluents is acceptable in Wisconsin primarily for effluents which contain biologically degradable pollutants, or pollutants which would be beneficial to the soil or plant life. Effluent from the proposed contaminated mine water treatment system would contain residual inorganic pollutants which could exceed applicable groundwater standards. Metal cations in this waste stream would tend to be adsorbed by soil particles but would not be otherwise degraded by or removed from the soil system. The chemical anions (primarily sulfate and bicarbonate) would tend to move through the soil column and would eventually reach groundwater. Use of the proposed reverse osmosis/vapor compression evaporation system, ion exchange or full flow evaporation for contaminated mine water treatment could probably produce an effluent suitable for land disposal.

The intercepted groundwater stream may be of adequate quality to allow discharge to a land disposal system. The quality, however, would vary over time and location of groundwater extraction, and treatment might be necessary to make this water acceptable for land disposal. Benefits of land disposal of the intercepted groundwater would include: reduction in effluent discharge volume to Swamp Creek and enhance recharge of the groundwater during drawdown conditions. A land disposal system would require a larger disposal area hence more surface disturbance than the proposed method.

A combination of these techniques might consist of a discharge to a land disposal system, if effluent quality was acceptable during periods of low stream flow. Such seasonal discharge could reduce groundwater impacts and concerns over the hydraulic capacity of a continuously operating seepage basin or drainfield.

Stormwater Runoff Alternatives

Alternatives to the discharge of collected stormwater runoff from drainage basin #1 (Figure 1-7) include runoff reduction measures, creation of seepage basins, or treatment of collected runoff. Runoff collected in drainage basins #2 and #3 would be treated in the water treatment facilities under the current proposal. Runoff reduction consists of the use of porous pavement for roads or parking areas, the use of vegetation and the minimization of steep slopes wherever possible in construction areas, and the creation of seepage impoundments to allow percolation of stormwater thus minimizing total runoff. Runoff collected in drainage basin #1 also could be pumped to the water treatment system. This would result in additional water being discharged through the pipeline to Swamp Creek, but would eliminate runoff impacts on surface waters and wetlands near the mining site.

Stormwater discharge to surface waters may have several beneficial impacts. Discharges to lakes, streams or wetlands could offset some of the impacts of lowered groundwater levels. Releasing runoff from drainage basins #2 and #3, however, would be unacceptable because environmental contamination with sulfates and metals may occur.

AIR POLLUTION CONTROL

Approximately 20,300 tons of brush, limbs, and stumps would require disposal during the construction phase. Most of this woody waste would be chipped and sold as fuel or used as mulch, but approximately 1,800 tons may be burned at the site. While use of the proposed air curtain destructor(s) may lessen the resultant emissions to the air, these emissions could be eliminated entirely if all wastes were chipped or disposed at a sanitary landfill. Chipping large stumps, however, is not feasible, and landfilling would consume valuable disposal space.

Reductions in gaseous pollutants (nitrogen oxides and carbon monoxide) from mining equipment are not feasible with add-on control devices. Reductions in pollutant emissions would be best achieved by decreasing fuel and explosives use.

Dust reductions could occur if the east and west exhaust raises were equipped with add-on dust collection equipment. The large air flow from the exhaust raises would make operation of this equipment prohibitively expensive. An exhaust raise equipped with a fabric filter baghouse would have a capital cost of approximately $3.4 million (1985 dollars). Assuming the baghouse achieved a 99% reduction in predicted dust emissions and the interest rate was 10%, the annual capital cost over the life of the mine would be about $16,000 per ton of dust collected. This is considered an excessive cost for air pollution control equipment considering the level of control that would result. Alternative add-on control devices would have similar costs.

Dust Control - Paving surfaces with asphalt or concrete rather than periodic watering would reduce dust. Alternative paving techniques include soil cement construction or roller compacted concrete. Soil cement strength and longevity is partially dependent on the characteristics of the on-site soil and the thickness of the paved surface. Roller compacted concrete is similar to soil cement but utilizes larger and more well graded aggregate. While usually requiring an aggregate borrow source, roller compacted concrete offers a higher strength road suitable for supporting heavily laden vehicles for long periods of time with minimal maintenance.

All of the paving techniques involve a substantially higher initial investment in capital costs for road construction versus the routine maintenance of an unpaved road. Given the cost of paved road construction compared to the cost of tanker trucks for wetting road surfaces, haul road paving would not be justified as a dust control technique.

Dust control agents other than water are available on the commercial market. The binding action of water can be enhanced by adding dust control agents which temporarily cement the soil particles. Depending on application rates and rainfall, individual agents may last from a few weeks to several months. All of the chemical dust control agents cost more than simply spraying water, but yield a trade-off in savings in labor, fuel, and vehicle usage.

Watering and/or chemical agents would provide short-term dust control at all construction sites. Long-term control is best accomplished by revegetating sites where applicable. In addition, plants help control water erosion as well as dust emissions. Mulches and erosion control mats which aid in revegetation efforts also aid dust control. Traditional mulching materials, such as chopped straw and wood chips, as well as several commercial products available, such as spray-on mulch-seed-fertilizer combinations, erosion control nets with interwoven wood shavings or paper, and tangled plastic fibers, are available. All of these materials provide protection from soil drying and erosion by rainstorms or spring runoff.

Membrane or fabric covers of natural or artificial materials could be used to confine and protect soil stockpiles. These covers, however, are commonly utilized to protect small soil stockpiles due to cost and effectiveness considerations.

Dust Control at the Tailings Ponds - The limited amount of silt and clay in the till and the compacting techniques used during embankment construction would limit the potential for dust production from the tailings ponds. During the operation of a tailings pond, the continuous discharge of the tailings

slurry probably would keep the entire surface of the tailings beach moist. If the tailings particles on the surface of the beach are kept damp, dusting potential would be minimal. The tailings surface, however, may dry during brief periods of mill process interruptions, hot weather, or may not be continuously wetted if the flow paths of the slurry water are channelized. A natural crust may develop on the tailing surface upon drying but this crusting would not eliminate dusting. Exxon proposes to control dusting by adding slurry discharge outlets as needed. Alternative methods for controlling tailings dust include:

1. A sprinkler system on the confining banks could supplement the tailings discharge points in keeping the tailing surface moist. This method requires a continuous input of energy and attention, and is less suitable over extended periods of time. An extreme example would be to flood the entire tailings beach. This method would control dust effectively but continuous input of water would be needed to maintain the pool. This technique would require additional waste rock riprap on the sideslopes to prevent wave erosion and potentially increase leachate generation.

2. Chemical dust control agents could be sprayed on the tailings surface. The maximum effectiveness of the best agents is approximately one year. Used effectively, chemical dust control agents would cause a crust to develop on the tailing surface which should be stronger and more resistant to destructive forces than a natural crust. Chemical dust control agents should have little or no effect on tailings compressibility, permeability, or leaching characteristics.

3. Mulches and erosion control mats could be used to minimize wind erosion on the tailings beach. Erosion control matting is likely to be extremely expensive, especially when compared with chemical dust control agents or spray-on mulches.

4. A layer of soil placed over the tailings and then revegetated should be regarded as a possibility only for a planned, long-term shutdown rather than an immediate response to a short-term dusting problem. When full, the tailings ponds would have unprotected surface areas ranging between 40 and 100 acres. If a long-term shutdown of the mine/mill is anticipated and a pond is more than 2/3 full, closing the pond in accordance with the closure and reclamation plan may be more advantageous than attempting to stabilize the tailings surface. Stabilization, however, would preserve some pond capacity during mine/mill startup but would require maintenance during shutdown.

CONCENTRATE TRANSPORT

The zinc, copper, and lead concentrates may be sent to three different locations. There are a number of smelters being considered in the Pacific Northwest, the south (Tennessee), and the northeast (Canada). The concentrates would be shipped out of Wisconsin via rail car on the Soo Line railroad. Concentrate transportation by truck rather than rail would not be advantageous given the proximity of the Soo Line track and the lower cost of rail shipments. Truck shipment might be feasible if the destinations were limited to nearby areas, such as the White Pine, Michigan smelter or local Great Lakes ports. All other United States and Canadian smelters considered as concentrate destinations are served directly by rail. The same situation is generally true for shipment to export harbors, especially if the railroad bridge at Sault Ste. Marie, Michigan were upgraded to carry heavier tonnage railcars.

High-pressure pipeline transport of metal concentrates was considered but was determined to be infeasible. Such systems are very expensive and are most advantageous in remote locations where roads or rail networks are inconvenient or non-existent. Another problem with pipeline transport of concentrates is that the ultimate destination of the concentrates could change over the project life.

Combinations of rail-water shipment exist for U.S. and Canadian smelters and export harbors. In most cases, however, handling and storage charges at transfer points would make such combinations more expensive than direct rail shipments. Such options would include use of the St. Lawrence Seaway to east coast destinations and use of the Mississippi River to New Orleans. The use of ports local to Crandon, such as Green Bay, are limited to a 8-9 months shipping season, making such a choice less desirable.

Smelting - The newest and most modern zinc smelter in the U.S. is in Tennessee. The White Pine, Michigan, smelter is closest but this facility is not equipped to handle zincSeveral facilities in Ontario, or even Japan, Europe or Ireland are possible endpoints for the zinc concentrate. The ultimate destination would depend on economic conditions, such as zinc prices, markets for the use of by-product sulfuric acid as well as transportation costs. Market changes may influence the destination of the concentrates several times during operation.

An alternative to shipping the zinc concentrates to existing smelters in Canada, Europe, Japan, or the U.S. would be to build a smelter in Wisconsin. The largest U.S. zinc deposits are in eastern and middle Tennessee, and smelter capacity for the Missouri-Tennessee zinc area is adequately filled by smelters planned or under construction. No zinc smelting facilities exist in the upper Midwest. A smelter, if developed, probably would produce high quality zinc for diecasting and galvanizing purposes. A smelter site would require 500 to 1,000 acres with the actual facility occupying approximately 200 acres. A 60 million ton orebody of medium grade ore would be required to support a smelter. The Exxon deposit with an annual production of 210,000 tons of zinc concentrate could support a smelter during the massive ore phase. A smelter with a capacity of 200,000 tons per year would have sufficient capacity to handle concentrates from smaller orebodies such as the Pelican River deposit during the stringer ore phase.

Factors influencing the development of a zinc smelter include environmental restrictions, existing zinc smelting capacity, the market for by-product sulfuric acid, and a long-term source of zinc concentrates. A decision by Exxon to build a smelter must take into account the location of other zinc reserves. Exxon has a zinc deposit in Tennessee, a lead-zinc deposit in Nova Scotia, and a zinc orebody at Pinos Altos, New Mexico.

Other factors influencing the location of a zinc refinery in Wisconsin include: 1) the lack of fertilizer production facilities which use the sulfuric acid by-product; 2) environmental restrictions; 3) the availability and cost of electric power at some sites; and 4) the seasonal nature of port facilities and Great Lakes shipping. Capital and operating costs for a refinery have been about half as large in Europe and about 1/3 as large in Japan, as they have been in the U.S. These differences are primarily due to currency fluctuations, less stringent anti-pollution laws, and lower labor costs. Release of zinc from U.S. government stockpiles also could affect the need for a zinc refinery.

Copper concentrates would likely be shipped to western U.S. smelters, the White Pine smelter, or Canadian locations. Given the unstable condition of the copper industry, the ultimate copper concentrate destination is likely to change during operation. Because of the poor international copper market, shipment overseas of copper concentrate is unlikely. An option originally considered was refining of the Crandon copper concentrates in Minnesota. Construction of refineries in Minnesota to process concentrates from that state's low grade copper-nickel deposits was once thought to be an option but this development is not expected in the near future.

Lead concentrates could go to any of several U.S. or Canadian locations. Since the quantity and value is small, this decision would not have a major impact. The lead smelter at Glover, Missouri, is the most likely choice.

ENERGY ALTERNATIVES

ALTERNATIVE VOLTAGE LEVELS

Wisconsin Public Service Corporation (WPS) voltage levels range between 12.5, 24.9, 46, 69, 115, 138, and 345 kV (kV=1,000 volts). Power lines of different voltages have differing physical dimensions, transmission capacities, costs, right-of-way requirements and impacts (in general, these all increase with increasing voltage level).

The utility proposes to provide service to the mine/mill site at 115 kV. The only reasonable alternative voltage level is 69 kV. A 24.9 kV line would not have enough capacity to serve the projected load. WPS is currently phasing out 46 kV facilities, so this level will not be considered further since no future facilities will be constructed. Service at 345 kV is far beyond the needs of the projected load and will not be considered.

69 kV Service - The electrical load could be served by a 69 kV transmission line from the Venus Substation (Figure 3-15). A 69 kV line would be able to serve the load levels projected yet tolerate the load fluctuations caused by the mine hoist motors. The 69 kV alternative would use single pole wood structures along the same route as the proposed 115 kV line. The two major differences between the 69 kV service and the 115 kV service are: (1) the 69 kV system would need a 115/69 kV transformer at the Venus Substation while the 115 kV system would not and (2) the conductor size would be nearly twice as large in the 69 kV system. The larger, heavier conductors associated with the 69 kV line would need stronger structures for adequate support.

The 69 kV systems would increase WPS costs by about $1,660,000 versus the proposed 115 kV system (1986 dollars). The 115 kV to 69 kV transformer and related equipment at the Venus Substation constitute $1,340,00 of this added cost. The larger conductor size and associated stronger support for the 69 kV system would add the remaining $320,000. Other major costs, such as land rights and right-of-way clearing, are the same for both the 69 kV alternative and the proposed 115 kV system.

The 69 kV system would have greater operating costs because of greater line losses. This greater line loss occurs because more electrical energy is lost as heat due to resistance in the heavier 69 kV transmission line. The cost of the 69 kV system line losses, over the life of the mine, would be roughly $1 million more than the losses in the 115 kV system.

The 69 kV line would produce less Radio Frequency (RF) noise than the 115 kV line. This may result in less interference of radio and television reception in buildings located near the new line.

The right-of-way width for a 69 kV line would be the same as for the proposed 115 kV line. The utility uses a right-of-way width of 80 feet for single pole lines at both these voltage levels. This width is chosen to give adequate clearance between the line conductor and vegetation at the edge of the right-of-way. The environmental impacts for clearing and maintaining the right-of-way would be the same for the 69 and 115 kV lines, as their right-of-way requirements are the same.

POWER SOURCE

The use of on-site electrical generation was evaluated as an alternative to the construction of a transmission line to meet electrical needs. On-site generation alone is not a reasonable alternative because of the high costs and the characteristics of the projected electrical load.

An on-site generation system would have to meet two major design characteristics (generating output level and load change response time) to adequately serve the Exxon load. A generating output level of about 40 MW would meet the projected peak demand (29.6 MW) and allow for some load growth. This capacity could be met by installing a number of small generating units, allowing for one or more units to be taken out of service for maintenance, while the others continued to meet the electric load requirements. The use of larger individual units, or one large unit, would result in inadequate capacity during maintenance periods or when problems require the shutdown of a unit.

The second major design characteristic is the capacity of the generating unit to rapidly change output levels to meet the extremely fast load changes resulting from use of the mine hoist motors. The load changes could be as rapid as 2.2 MVA in less than 20 seconds. Different types of electrical generation systems vary considerably in how fast they can change their electrical output, this being a function of their physical/mechanical characteristics. Imposing too rapid a load change on an inadequately sized generation system would result in the collapse of the generation system.

Steam - Other industries and small municipal utilities with similar load levels often meet some or all of their electric needs by the use of coal- or wood-fired steam generating stations. For large industrial applications, on-site generation is generally considered economically feasible only when the industry needs both electricity and steam (cogeneration). Steam requirements at the proposed project are too small for the efficient use of cogeneration. An industry or municipality with generating capacity, however, is usually still tied into the electrical transmission system. In most cases, the generating plants supplement or backup the electrical supply from the electric utility.

Steam generating plants (both electric only and cogeneration types) of the size needed to meet the proposed peak load would be slow in responding to the fast swings in load levels. Wisconsin Public Service Commission engineers do not think such a plant would be able to tolerate the rapid load level fluctuations resulting from use of the hoist motors. This inadequate response capacity rules out on-site generating as a viable means of meeting all of the electrical needs. Thus, an on-site steam power plant would still require a new transmission line and is not a feasible alternative.

Diesel or Combustion Turbines - Diesel generators and combustion turbine generating units should be capable of responding to the rapid load changes arising from use of the mine hoist motors because of their fast load response capabilities. The costs of producing electricity from these units, however, eliminate them as a viable alternative.

The capital cost of installing 40 MW of on-site diesel or combustion turbine generators would be greater than the cost of building the transmission line. The line between Venus and Exxon, with related substation improvements would cost about 4.2 million dollars. Installing on-site diesels would cost approximately $20 million, while combustion turbines would cost about $12 million. These costs are based on recent installations of other similar units. While these figures are only rough estimates, on-site generation would involve greater initial installation costs than would the construction of the transmission line.

Diesel and combustion turbine generating units generally are not used to provide the total energy needs of operations the size of the proposed mine/mill. While relatively inexpensive to install (compared to other types of generation), they are extremely expensive to operate. Utilities use these generators for short periods at times of peak demands or as emergency backup power sources. A rough estimate by PSC staff shows that using either diesel or combustion turbine units to meet all electrical needs over the life of the project would be prohibitively expensive. Generation at the mine/mill site to meet internal needs would still require backup electrical power from the electric utility to insure safe mine operation. The capital and operating costs for on-site generation are prohibitive and would still require a new transmission line to provide supplementary power.

MINE AIR HEATING

Four methods for heating mine air were evaluated:

1. Direct-fired air heaters in which the heat and gaseous by-products of combustion mix directly with the air passing through the heater. This is the proposed method.

2. Direct-fired heat exchangers in which the combustion is contained and the heat transferred to the air by contact with the combustion chamber surfaces.

3. Indirect heat exchangers in which the air is heated by passing over coils containing a circulating fluid warmed by a remote heat source.

4. Electric heaters in which the air flows over heated elements.

The direct-fired natural gas air heaters have the following advantages: 1) control of temperature and energy consumption over a wide range of intake air temperatures; 2) efficiency approaching 90%, resulting in lower energy costs; 3) simple construction and maintenance requirements; and 4) lower purchase and installation costs.

Several sources of waste heat which could warm intake air were identified. These include: 1) mine exhaust air, expected to exit at an average temperature of approximately 55°F; 2) mine drainage

water, expected to exit the mine at average temperatures of 50-60°F; and 3) waste heat from mine/mill air compressors. Four systems of waste heat recovery from mine exhaust air were considered: recirculating glycol methods, a refrigeration type cycle, a direct air to air plate-type exchanger, and an evaluation of heat recovery from groundwater pumped through coils in the intake air shafts. The design of the mine facilities and climatic conditions limit the practical and effective use of supplemental waste heat. For example, exhaust air streams might contain up to 30% of the heat required for air heating when incoming air temperature is at -25°F. The exhaust air raises, however, would be 1,000 to 3,500 feet from the air intake point. This distance limits the efficiency and practicality of waste heat transfer systems (e.g., recirculating glycol-coil exchange type). Exhaust air to intake air heat exchange is most effective when the intake and exhaust air openings are adjacent to one another on the surface.

Water pumped from the mine would contain recoverable heat. Supplemental heat recovery systems at other mines, however, have been most successful where mine water temperatures are considerably higher (90°F or greater) than those expected at Crandon (50°F to 60°F).

The waste heat from the air compressors has the greatest potential for supplemental waste heat recovery. This source is relatively close to the main shaft air intake and an indirect recirculating glycol system might supply 1% to 2% of the maximum mine air heating demand.

SURFACE PLANT ENERGY CONSERVATION

Based on an average minimum daily temperature of -14°F during the winter months, nearly all surface facilities would require heating. Peak demand has been estimated to be 15,000,000 BTU/hr. The air compressor plant would be self-heating during winter and would be a source of recoverable waste heat. Final engineering evaluation of this excess heat source would determine if the heat would be more suitable for supplementary heating of nearby surface facilities or for mine air heating use. Potential surface uses might include heating of the collar house or headframe. Use of waste heat from the air compressor as a source of air heating would only be useful during the winter months. Another alternative use for the waste heat would be to heat water.

An alternatives to heating the air in the main shaft to the 40°F minimum would be to insulate all pipes and surfaces that might be adversely impacted by colder temperatures.

The economics of the three supplemental heat sources cannot be fully evaluated at this time. Conditions of the contract reached between WPS and Exxon Minerals Company may be the determining factor of the cost-effectiveness of any of these supplemental heat sources. Contracts for large quantity natural gas users often are set with a minimum consumption clause. If the consumer does not use the mutually agreed upon minimum amount of gas, the consumer must pay for the gas anyway.

LAND USE ALTERNATIVES

WITHDRAWAL OF COUNTY FOREST LAND

A portion of the land required by Exxon to develop the mine/mill and MWDF is owned by Forest County and managed for forestry purposes under the County Forest Law. Exxon has exercised a purchase option for these lands. In order for Exxon to complete purchase the land from Forest County, the County Board will have to request the Department of Natural Resources to release the land from the County Forest law designation according to section 28.11, Wisconsin Statutes. There are several alternatives available in response to a request for withdrawal:

Deny the Application for Withdrawal - Withdrawal off Ch. 28 forest lands is based on a "higher and better use" test. If the application were denied by the DNR, an appeal resolution by two-thirds of the County Board would send this application to a five person committee to review the DNR decision. This committee could overrule the DNR decision and grant the withdrawal.

Withdraw only those lands to be physically developed by Exxon - This action would be contrary to the land purchase agreement presently existing between Forest County and Exxon.

Require Forest County to acquire replacement lands from private owners - Such a purchase may generate increased timber revenues from lands not currently being managed. It may be difficult, however, to acquire lands that block in with the existing county forest for efficient administration.

RECLAMATION AND FINAL USE ALTERNATIVES

MINE/MILL SURFACE FACILITIES

Before closing the mine, alternative uses of the surface facilities would be evaluated. If no desirable alternative uses of the surface facilities were found, the buildings would be removed and the land returned to its premining use and condition.

The surface facilities could be used for a variety of industrial applications. Office and shop facilities, warehouses, power facilities, fuel storage, water treatment facilities as well as the access road and railroad spur would all make the site attractive for other business uses. Use of the facilities as an industrial complex would provide jobs and economic stimulation, and would help offset the adverse impacts to the community from mine closure. If the surface facilities were demolished and removed, the mine/mill site would be suitable for any of the land uses acceptable prior to mining.

WASTE DISPOSAL FACILITIES

Reclamation and final use of the tailings pond and landfill must provide long-term isolation of the wastes from the environment. Thus, alternatives for reclamation and final uses of these facilities are limited.

The present use, timber production, may be acceptable if precautions are taken to minimize erosion and prevent damage to the caps. The tops of the facilities could be used for fields, pasture or forage, although the periodic plowing needed to rejuvenate sod crops would not be consistent with preventing erosion. Traditional farming practices associated with dairy farming would result in soil erosion, threatening the integrity of the caps. Similarly, active cultivation or grazing on the sideslopes of the facilities would be detrimental to the stability of the soil cover.

Multiple recreational uses are a possibility. Traditional camping, hiking, hunting, skiing and other activities would have no direct impact on the facilities unless overuse led to erosion. An indirect effect of these activities would be an increased potential for fires.

Building on top of the facilities would be restricted. Small structures could be built but deep foundations could not be used. Extreme care would be required for any construction to avoid damage to the caps and prevent soil erosion.

Alternatives for reclaiming the tailings ponds and landfill include changing the final topographic patterns and maintaining different plant communities on the site. Contouring and benching of the final cover would reduce erosion and blend the facilities into the surrounding topography. Alternate plant communities such as prairie and wetlands have been considered. An open prairie-like community for sharp-tailed grouse management could be maintained but would require regular burning and might accelerate erosion. A wetland community above the tailings ponds would reduce oxygen availability to the tailings but would probably increase the amount of water seeping through the facility.

RADIOACTIVE WASTE REPOSITORY

Final use of the underground mine as a radioactive waste repository would not be feasible. The mining plan requires backfilling with the coarse tailings. Without backfilling, all of the tailings would have to be surface disposed in tailings ponds, nearly doubling the size of these ponds. Surface disposal would require higher capital expenditures, higher operations and reclamation costs, and result in greater land use, increased leachate production and additional groundwater impacts.

No potential disposal sites in Forest County are being considered by the U.S. Department of Energy. The bedrock in the Crandon area is too highly fractured and therefore, is too permeable. A second exclusionary criterion for locating a radioactive waste repository in the Crandon area is the presence of mineralized zones. The two potential sites in Wisconsin are the Wolf River batholith, located in portions of Menominee, Portage, Oconto, Waupaca, Shawano, Marathon, and Langlade counties and the Puritan Batholith in Ashland, Bayfield, and Sawyer counties.

MITIGATION ALTERNATIVES

MITIGATION OF MINE WASTE DISPOSAL FACILITY IMPACTS TO GROUNDWATER

The following contingency procedures could be used to address unplanned or unexpected problems with the MWDF (i.e., events not predictable or unlikely given current understanding).

Changes in water quality/quantity or any other resource which could lead to significant environmental degradation would be detected by the monitoring program. Such changes would be verified to confirm their accuracy and an evaluation made as to their source and significance. If detrimental changes to a resource could occur, Exxon would be required to provide an evaluation of the situation. This evaluation would include proposed actions, if any would be needed, to insure the MWDF would not violate surface and groundwater standards or be in violation of the plan approval. The Department would review Exxon's evaluation and make a determination as to the actions necessary to insure compliance.

Potential actions include:

1. No action if no potential for violation is found.

2. Increased monitoring, such as additional sampling parameters, increased frequency of sampling or additional monitoring locations.

3. Operational modifications to provide additional acid neutralization, reduce the amount of leakage, or change the chemistry of the leachate would be evaluated for effectiveness and feasibility. An alternative to improve leachate quality might be to establish a washing circuit in the mill to replace process water with cleaner water in the slurry. Process water in the slurry would greatly affect leachate quality, and by improving the chemical characteristics of the slurry water, the ultimate quality of the tailings leachate would be changed.

4. Accelerated closure and capping of a pond if remediable action is ineffective. This would isolate the wastes and should reduce pyrite oxidation by eliminating the atmospheric oxygen supply.

5. Longer term pumping of the drainage layer could be required if tailings do not dewater as anticipated.

6. Installation of wells and sumps into the drainage layer might be needed if the proposed drainage collection system did not work properly.

7. Grouting of the drainage layer would help seal an area of leaking liner. This may not be beneficial, however, if the lack of drainage causes a buildup of hydraulic head thus producing even greater leakage rates. Grouting of the till soils or waste is also not likely to be entirely successful given the physical characteristics of these materials.

8. Design modifications could be made to successive tailings ponds. These could include decreased drainage collection pipe spacing and additional drainage layers in the tailings; increased liner layers and/or thicknesses; increased bentonite content of the liner mixture; or addition or substitution of alternate liner materials such as a polyethylene geomembrane.

9. Installation of wells into contaminated groundwater areas and pumping of contaminants. The pumped water would require discharge and would require treatment prior to discharge if contaminant concentrations were high enough. This alternative is least likely unless there is an accidental, massive contamination problem.

MINE INFLOW CONTROL ALTERNATIVES

The amount of mine inflow determines how much water must be pumped out of the mine, and thus determines the extent of the groundwater drawdown. Reducing the extent of the drawdown would result in reduced impacts to surface waters. The following alternatives are potential ways to reduce mine inflow:

1. Grouting is a common means of reducing groundwater inflow into mine workings. Grout materials are inert substances (bentonite or cement), and impacts to groundwater quality would not be anticipated. Additionally, water percolating through the grout would be flushed into the mine rather than to the aquifer. Exxon indicates it would be grouting as a standard mining practice.

2. The interface between the weathered portions of the orebody and the more permeable portions of the overlying glacial materials is the major pathway for mine inflow. This area could be grouted to reduce the permeability of the interface. The large and irregular nature of this interface make the feasibility of this action uncertain.

3. Inflow into the mine could be greatly reduced by blocking groundwater flow in the glacial deposits over the orebody with a bentonite slurry wall. This wall would encircle the orebody and would retard groundwater movement toward the mine. The length and depth of such a hydraulic barrier would probably make installation costs prohibitively expensive though technically feasible. The barrier, if not removed at the cessation of mining, would become a permanent barrier to natural groundwater flow.

SURFACE WATER MITIGATION PLAN ALTERNATIVES

A variety of modifications to the proposed mitigation plan exist which, individually or in concert, would help minimize impacts from the groundwater drawdown. As noted in Chapter 3, the proposed mitigation plan may not provide adequate quantities of water to fully mitigate all surface water impacts. If the proposed plan is inadequate, the following are alternate sources of mitigation water:

1. Treated wastewater could be used to mitigate impacts to lakes and streams. The quality of effluent would depend on the receiving water and on the proposed augmentation rate. Additional treatment and reductions in metal levels beyond that currently proposed may be necessary for stream and lake discharges. The specific configuration of treatment processes required would vary with the amounts of mitigation water needed and with the water body. Treatment alternatives for achieving various levels of effluent quality have been previously discussed under Wastewater Treatment and Disposal Alternatives.

2. Additional mitigation water could be obtained in the mine by maximizing the efficiency of the uncontaminated mine water collection system. Maximum achievable efficiency of the collection system is dictated by specific geologic conditions and cannot be accurately assessed in advance of mine operation. Also, segregating highly contaminated wastewater streams within the mine, such as backfill drainage, would improve the quality of the remaining water, making it more amenable for mitigation use.

3. Swamp Creek water could be pumped from an intake point just above the wastewater discharge point. This alternative would balance the amount of water being removed from the project area (via the wastewater discharge) and would alleviate shortfalls in mitigation water. A second pipeline would be required, but could occupy the same corridor as the wastewater discharge pipeline. Swamp Creek water would require some treatment for use as mitigation water, primarily phosphorus removal.

4. Groundwater from a high capacity well outside of the project area could be pumped to impacted surface waters. The well would need to be located sufficiently far from the mine site so that its pumping would not have any further effects on waters impacted by the mine. This would require a pipeline of at least several miles. Depending on the well location and rate of pumping, this alternative could cause a groundwater drawdown and quantity reductions in nearby streams.

Exxon recently outlined an addition to the proposed mitigation plan. This alternative proposes a discharge of treated wastewater to Little Sand, Duck, Deep Hole and/or Skunk Lakes if a shortfall of mitigation water develops. A specific system for treating wastewater was not identified. Any discharge of wastewater to the lakes would have to meet the specified effluent limits.

An alternate approach to mitigation which would provide adequate mitigation water would contain the following elements:

1. A system for collection of maximum amounts of uncontaminated groundwater at the mine would be utilized. This system would consist of a semi-circle of glacial aquifer wells and a mine water interceptor system.

2. A dedicated well (C-5) would be installed at Martin Springs for steady state mitigation.

3. Proposed wells C-1, C-2, C-3, C-4, and C-6 would be eliminated, thereby avoiding the adverse impacts from constructing the wells, pipelines and power lines. The waterbodies mitigated by these wells would be augmented by water from the mine site. Pumping of water supply wells WS-1 and WS-2 would be limited to very low rates during mine operation.

4. Provisions would be made to limit the total wastewater discharge to Swamp Creek to a flow rate which would insure sufficient water would remain in the project area to fully mitigate surface water impacts when the mitigation requirements could not be met by intercepted groundwater. This flow rate may be as low as 400 gpm. Reserve water treatment capacity would have to be provided to treat wastewater to mitigation quality.

5. Lake mitigation pumping would be continuous rather than waiting for minimum lake levels to occur. The mitigation rate would be equivalent to the mine-induced seepage.

6. Discharge locations for Creek 12-9 and Pickerel Creek would be relocated to insure mitigation of impacted stream segments (Figure 4-7).

In order to analyze the impacts of this mitigation alternative on the receiving waters, several assumptions were made. First, water quality impacts were analyzed with the assumption that, except for Skunk Lake, mitigation water is similar in quality to the area groundwater. Water withdrawn from the semi-circle of wells, the dedicated well, and the uncontaminated mine water interceptor system would be expected to meet this criteria. The second assumption was that by continuously pumping water into lakes at a rate equivalent to the mine-induced seepage rate, the natural lake levels would be replicated and impacts to lake levels avoided. In reality, it would be difficult to precisely match the mitigation and seepage rates, and minor deviations above and below the natural lake levels would be expected.

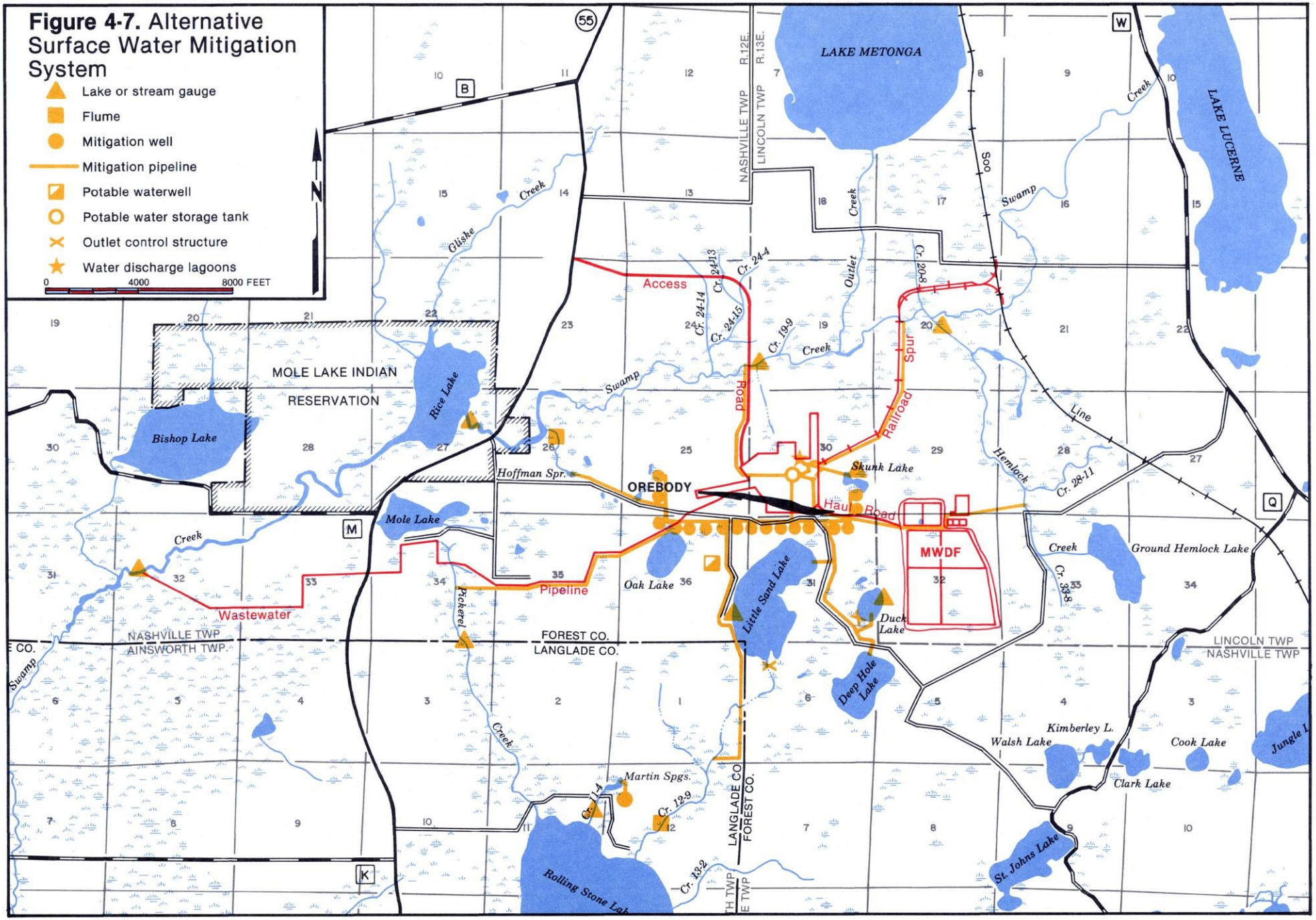
Lake Impacts with Migigation

Impacts to Lake Water Quality From Mitigation - Rates of mitigation pumping indicated in Table 4-16 were derived from the DNR/USGS lake model. Little Sand and Deep Hole Lakes are most susceptible to water quality changes from mitigation pumping. Both lakes would receive significant quantities of augmentation water resulting in water quality changes to which aquatic life would need to adapt.

Table 4-16
Mitigation Pumping Rates Required
to Maintain Lakes at Average Levels (gpm)

	Little Sand	Duck	Skunk[1]	Deep Hole
Expected	568	8	258	87
Maximum	709	12	438	102

[1] Actual mitigation requirements for Skunk Lake would likely be lower due to reduced seepage rates at the lake minimum level.


Figure 4-7. Alternative Surface Water Mitigation System
Lake or stream gauge
Flume
Mitigation well
Mitigation pipeline
Potable waterwell
Potable water storage tank
Outlet control structure
Water discharge lagoons
0
4000
8000 FEET
N
LAKE METONGA
LAKE LUCERNE
NASHVILLE TWP
LINCOLN TWP
R.12E.
R.13E.
Creek
Soo
Swamp
Outlet
Access
Road
Railroad
Spur
Line
Hemlock
Cr. 24-13
Cr. 24-4
Cr. 24-14
Cr. 24-15
Cr. 19-9
Cr. 20-8
Cr. 28-11
Cr. 33-8
Cr. 11-4
Cr. 12-9
Cr. 13-2
MOLE LAKE INDIAN RESERVATION
Rice Lake
Bishop Lake
Mole Lake
Oak Lake
Skunk Lake
Little Sand Lake
Duck Lake
Deep Hole Lake
Ground Hemlock Lake
Walsh Lake
Kimberley L.
Cook Lake
Clark Lake
St. Johns Lake
Rolling Stone Lake
Martin Spgs.
Hoffman Spr.
OREBODY
Haul Road
MWDF
Pipeline
Wastewater
Pickerel
Gliske
FOREST CO.
LANGLADE CO.
NASHVILLE TWP
AINSWORTH TWP.
LINCOLN TWP
NASHVILLE TWP
B
M
K
Q
W
55

Little Sand and Deep Hole Lakes receive water input primarily from precipitation and runoff from their immediate watersheds. They are isolated from most groundwater input. The low mineral content of the soils in the area results in low nutrient and dissolved solids in the runoff water which reaches these lakes. Precipitation is also low in dissolved solids and nutrients. Consequently, both Little Sand and Deep Hole Lakes are low in total dissolved solids and nutrients, low in pH, and poorly buffered (mean alkalinity less than 6 mg/l (as $CaCO_3$) in both lakes).

The addition of groundwater would raise the pH of these systems closer to the pH of the groundwater. Other indicators of the ionic content in natural waters, such as hardness, alkalinity, conductivity, and total dissolved solids (TDS) would be expected to increase substantially over background lake levels. The degree of increase is dependent on the rate of groundwater pumpage and the amount of mixing that would occur between the groundwater and the lake water.

The total phosphorus concentration in the groundwater is similar to existing levels in Little Sand and Deep Hole Lakes. Productivity increases (i.e., algal growth) are linked to changes in phosphorus loading rates and resultant in-lake phosphorus concentrations. Since the in-lake phosphorus concentrations would not be expected to change with the addition of groundwater, increased algal biomass would not likely result.

Alkalinity, conductivity and total dissolved solids (TDS) are other parameters linked to the productivity of an aquatic ecosystem. Increases in these parameters would be expected for Little Sand and Deep Hole Lakes. The projected increases in alkalinity, conductivity, TDS, and pH may result in changes in algal species diversity.

Table 4-17 provides a summary of the expected changes in water chemistry of Deep Hole, and Little Sand Lakes which would result at the specified groundwater pumpage rates. The conventional parameters considered were: iron, total phosphorus, nitrates, conductivity, alkalinity, hardness, total dissolved solids and pH. The resultant in-lake concentrations for these parameters were calculated by assuming total mixing of the lake water with the augmented groundwater.

The following mass balance equation was used to calculate changes in water quality as a result of groundwater pumpage to Little Sand and Deep Hole Lakes for the conventional parameters shown in Table 4-17:

$$C_M = \frac{C_L Q_L + C_{GW} Q_{GW}}{Q_M}$$

Where: C_M = The calculated in-lake concentration determined from the resultant mixing of the lake and augmented groundwater.

C_L = The average background lake concentration (from Volume VII of the EIR (1982)).

C_{GW} = The average groundwater quality from test wells in the stratified draft (refer to Footnote 1 - Table 4-17).

Q_L = The total lake water volume available for dilution as determined through natural gains in runoff and precipitation. Based on expected and worst case drawdown conditions, the total lake water volume available for dilution would be 942 and 1155 acre ft/year respectively for Little Sand Lake and 820 and 955 acre ft/year for Deep Hole Lake (based on projections from DNR lake models).

Q_{GW} = The volume of groundwater augmentation under expected and worst case conditions. For Little Sand Lakes, this would be 916 and 1144 acre ft/year, and for Deep Hole Lake, this would be 140 and 165 acre ft/year for expected and worst case conditions, respectively (based on projections from DNR lake models).

Q_M = $Q_L + Q_{GW}$; this equates to the total lake water volume accounting for the flushing rate. For Little Sand Lake, it is 1858 and 2299 acre ft/year and for Deep Hole Lake, it is 960 and 1120 acre ft/year for expected and worst case conditions, respectively.

The monthly average effluent limits shown on Table 4-18 were calculated using a mass balance equation as follows:

$$C_E = \frac{C_M Q_M - C_L Q_L}{Q_E}$$

C_E = The calculated monthly average effluent limit.

C_M = The water quality criteria necessary to protect fish and aquatic life or human health.

C_L = The average background lake concentration (from Volume VII of the EIR (1982)).

Q_L = The amount of water available for dilution, which would be 10% of the total lake volume (NR 102.03(4)(f), Wis. Adm. Code). Based on expected and worst case conditions for drawdown, this lake water volume available for mixing would be 95 and 115 acre ft/year for Little Sand Lake, respectively, and 82 and 96 acre ft/year for Deep Hole Lake, respectively (based on data from DNR lake models).

Q_E = The volume of groundwater augmentation under expected and worst case drawdown conditions. For Little Sand Lake, it is 916 and 1144 acre ft/year, respectively. For Deep Hole Lake, it is 140 and 165 acre ft/year for expected and worst case conditions, respectively (based on projections from DNR lake models).

Q_M = $Q_L + Q_E$, which equates to the total lake water volume taking into account the flushing rate. For Little Sand Lake, it is 1011 and 1259 acre ft/year and for Deep Hole Lake, it is 222 and 261 acre ft/year for expected and worst case conditions, respectively.

Very little impact to Duck Lake water quality is expected due to the low augmentation rates required (8 and 12 gpm).

Table 4-17
Projected Water Quality for Deep Hole and Little Sand Lakes with Groundwater Augmentation

		Deep Hole Lake		Little Sand Lake	
Parameter	Average Groundwater Quality (Range)[1]	Average Background Lake Water Concentrations (Range)[2]	Projected Lake Water Quality @ Groundwater Pumpage rates of 87/102 gpm	Average Background Lake Water Concentrations (Ranges)[2]	Projected Lake Water Quality @ Groundwater pumpage rates of 568/709 gpm
Iron	.35 (<.01-1.25)	.13 (.05-.42)	.16/.16	.04 (<.01-.16)	.19/.19
Total Phosphorus	.020 (<.01-.05)	.03 (<.01-.12)	.03/.03	.02 (<.01-.17)	.02/.02
Nitrates	.24 (<.05-.59)	.05 (<.01-.39)	.08/.08	.11 (<.01-.52)	.17/.17
Field Conductivity (umhos/cm)	191 (122-285)	28 (17-85)	52/52	2.7 (11-59)	96/97
Total Alkalinity (lab)	119 (102-187)	5 (<1-28)	22/22	2.6 (<1-6)	60/61
Total Hardness	123 (87-152)	15 (8-36)	31/31	11 (4-24)	66/67
Total Dissolved Solids	156 (105-219)	58 (8-196)	72/72	36 (2-173)	95/96
pH (S.U.)	7.6 (6.2-8.4)	6.1 (5.4-6.6)	6.3/6.3	5.5 (4.8-6.3)	6.5/6.5

NOTE: Values in mg/l unless noted differently.

[1] Based on average concentration values from test wells DMB-18, G40-R23, G40-L23, and TW-41. These test wells in the stratified drift are representative of groundwater water chemistry. The average concentrations were calculated based on the assumption that 75% of the groundwater augmentation would be from well WS-1 and 25% would be from well WS-2 (C. Schroeder, Exxon, March 1986). Actual augmentation water quality may vary due to localized differences in groundwater chemistry.

[2] The average background concentrations and ranges obtained from Volume VII of the EIR (1982).

The projected water quality changes for Little Sand and Deep Hole Lakes shown in Table 4-17 are well within the tolerance range for Wisconsin aquatic life species. Slight changes in species composition and diversity (to less acid tolerant organisms) would likely occur as the result of groundwater augmentation to these lakes.

After mining operations have ceased, it could take up to several years for Little Sand and Deep Hole Lakes to return to baseline water quality conditions similar to premining levels. Shifts in aquatic species back to the original diversity would likely occur as the water quality in these lakes returns to baseline conditions.

Table 4-18 contains water quality criteria (standards) for toxic pollutants as well as for dissolved oxygen (DO) which must be met to protect aquatic species. For comparative purposes, the average groundwater quality from representative test wells and the existing lake water quality are given for each of the parameters. The groundwater from nearby wells is representative of the quality of the water which would be used for augmentation. The monthly average limits listed for Deep Hole and Little Sand Lakes represent the end of pipe numbers which the augmentation water must meet to maintain the criteria values. Monthly average values were calculated based on expected and worst case augmentation pumping rates. Limits for Duck Lake are not presented because of the small discharge volumes.

The groundwater is of adequate quality to meet the monthly average limits for the toxic pollutants listed in Table 4-18. Monitoring of groundwater for heavy metals prior to augmentation would be required as part of the monitoring plan to assure the protection and propagation of fish and aquatic life for Little Sand, Duck, and Deep Hole Lakes.

As shown in Table 4-18, limits would also be set for dissolved oxygen for the discharge of groundwater to these lakes. The minimum value to be maintained for dissolved oxygen (DO) is 5 mg/l (NR 102.02, Wis. Adm. Code). It is reasonable to expect low DO levels in the groundwater. Consequently, aeration would be necessary prior to augmentation. The limits for DO are to be met at the point of discharge.

For pH, the maximum limits for Deep Hole and Little Sand Lakes would be 7.1 and 6.8 respectively if the standards in section NR 102.02(3)(c), Wis. Adm. Code were applied. Since the pH in the groundwater averages 7.5, some pH adjustments by the addition of acid would be necessary to meet the code requirements in NR 102. However, the pH requirements in the code would not be applied. Higher pH levels would likely result in greater algal species diversity, an increase in forage fish species, and a resultant increase in the productivity of the sport fishery in both Little Sand and Deep Hole Lakes. The end result would likely be increased fishing opportunities in these lakes.

Table 4-18
Lake Water Quality Criteria and Monthly Average Effluent Limits
for Mitigation Pumping

Parameter	Avg. Groundwater Quality[1]	Water Quality Criterion[2]	Deep Hole Lake Background Lake Concen.[3]	Deep Hole Lake Monthly Average Effluent Limits[4]	Little Sand Lake Background Lake Concen.[3]	Little Sand Lake Monthly Average Effluent Limits[4]
Arsenic	<.001	0.29[5]	<.001	.46	<.001	.32
Cadmium	<.001	.0022	.0016	.0026	<.0015	.0023
Chromium^{+6}	<.001	.0082	<.01	.013	<.01	.009
Chromium^{+3}	<.001	.085	<.001	.134	<.001	.093
Copper	.003	.0143	.0025	.0143	.005	.0143
Lead	<.01	.0016	<.01	Det. Lim.[5]	<.01	Det. Lim.[5]
Mercury	<.0001	.00015	<.0001	Det. Lim.[6]	<.0001	Det. Lim.[6]
Nickel	<.01	.002	<.01	Det. Lim.[7]	<.01	Det. Lim.[7]
Zinc	.01	.0712	.011	.11	.018	.077
Cyanide	<.001	.0104	<.001	.016	<.001	.011
Silver	<.001	.00085	--	.00085	--	.00085
Selenium	<.001	.077	--	.122	--	.085
D.O.		5.0[8]				

1 Based on average concentration values from test wells DMB-18, G40-R23, G40-L23, TW-41. These test wells in the stratified drift are representative of the groundwater water chemistry. The average concentrations were calculated based on the assumption that 75% of the groundwater augmentation would be from WS-1 and 25% would be from WS-2 (C. Schroeder, Exxon, March 1986). Actual augmentation water quality may vary due to localized differences in groundwater chemistry.

2 Based on data in the literature on chronic toxicity effects to resident Wisconsin aquatic species (the exceptions are copper and silver in which the acute toxicity values are listed because they are more stringent).

3 Average background lake data obtained from Volume VII of the EIR (1982).

4 The monthly average limits were calculated using mass balance equations. Limits are the same for both expected and worst case projections and are based on water augmentation rates of 87 gpm and 102 gpm for Deep Hole Lake, and 568 and 709 gpm for Little Sand Lake.

5 The monthly average criterion is below the level of detection. The detection limit (det. lim.) for the Lab of Hygiene for lead is 0.003 mg/l using the atomic absorption furnace technique.

6 The monthly average water quality criterion necessary to prevent exceedance of FDA action limits in fish and thus protect human health is 0.00015 mg/l. This criterion value is near the detection limit of most current analytical techniques.

7 The monthly average criterion is below the level of detection. The detection limit for the Lab of Hygiene for nickel is .020 mg/l using the furnace technique.

8 Represents a minimum value to be maintained at the end of the pipe.

Effluent limits for the Skunk Lake mitigation discharge (Table 4-19) were set to meet public health groundwater quality standards (NR 140, Wis. Adm. Code). Since this lake has a high leakage rate and would require continuous pumping, the in-lake water quality would have to protect public health and provide protection for animals drinking Skunk Lake water. Fish and aquatic life criteria were not deemed appropriate because no fishery is present and aquatic life is limited by frequent winter kills. Since the projected effluent quality from the wastewater treatment plant would not meet the limits for total chromium, selenium, sulfate, and total dissolved solids (TDS), Exxon proposes to blend wastewater with intercepted groundwater or potable water.

The monthly average limits shown in Table 4-19 were calculated using the following mass balance equation:

$$C_E = \frac{C_M Q_M - C_L Q_L}{Q_E}$$

Where: C_E = The calculated monthly average effluent limits.

C_M = Enforcement limits from the public health groundwater quality standards (NR 140, Wis. Adm. Code).

C_L = Mean background lake levels (from Volume VII of the EIR (1982)).

Q_L = The lake water volume available for dilution, as determined through natural gains in runoff and precipitation. Based on an expected and worst case scenario for drawdown, the total lake water volume from natural sources would be 99 and 130 acre ft/year for Skunk Lake, respectively (based on projections from DNR lake models).

Q_E = The volume of groundwater augmentation under expected and worst case drawdown conditions. For Skunk Lake, this is 417 and 706 acre ft/year, respectively (based on projections from DNR lake models).

$Q_M = Q_L + Q_E$, which equates to a total lake volume from natural and mitigative sources of 516 and 836 acre ft/year for expected and worst case conditions.

Table 4-19
Water Quality Based Effluent Limits for the Proposed Discharge to Skunk Lake[1]

Parameter	Background Lake Levels[2]	Criterion Value[3]	Monthly Average Limits at Flow Rates of 258/438 gpm	Projected Effluent Quality[4]
Arsenic	<.001	.05	.067/.059	.05
Cadmium	<.002	.01	.012/.011	.0006
Chromium (total)	<.017	.05	.058/.056	.072
Copper	<.011	1.0	.15[5]/.15[5]	.01
Lead	<.01	.05	.060/.057	.04
Mercury	<.0001	.002	.002[5]/.002[5]	.00017
Selenium	–	.01	.012/.012	.06
Zinc	.009	5.0	.75[5]/.75[5]	.06
Cyanide	<.002	.46	.57/.54	.006
Silver	–	.05	.062/.059	.003
Sulfate	<2.00	250.0	310/295	410.0
Iron	.45	0.3	.45/.45	0.4
Barium	–	1.0	1.24/1.18	.03
Fluoride	–	2.2	2.7/2.6	2.0
TDS	56.0	500.0	607/580	700.0

1 All values in ppm (mg/l).
2 Mean values taken from Volume VII of the EIR.
3 Enforcement limits from the public health groundwater quality standards (NR 140, Wis. Adm. Code).
4 Average values taken from Table 1 of the WPDES permit application.
5 Categorical limits apply which are based on New Source Performance Standards.

Thermal Impact from Lake Mitigation - The addition of groundwater at approximately 49°F - 51°F to Little Sand and Deep Hole Lakes would raise ambient water temperature under winter time conditions (November-April). The natural temperature range in these lakes during the winter months is from 33°F to 40°F. A thermal analysis was performed to determine what temperature increases would occur in these lakes and the sizes of the area that would be affected by mitigation pumping.

For Little Sand and Deep Hole Lakes, the area and temperature gradients of the mixing zones were calculated. Table 4-20 shows the lake area affected for selected increases in water temperature (up to 12°F above background temperatures). The calculations were based on a 51°F discharge temperature and expected and worst case augmentation rates of 568 and 709 gpm for Little Sand Lake and 87 and 102 gpm for Deep Hole Lake, respectively.

Table 4-20
Calculated Thermal Impacts to Lakes from Mitigation Pumping

Lake Water Temperature (°F)[1]	Lake Isotherm (°F)[2]	Area Affected in Acres Expected/Worst Case[3]	
		Little Sand L.	Deep Hole L.
34	1	6.33/7.90	0.97/1.14
36	3	3.92/4.90	0.60/0.71
38	5	2.80/3.50	0.43/0.50
40	7	2.07/2.58	0.32/0.37
45	12	0.89/1.11	0.14/0.16

1 Temperature at edge of the mixing zone.
2 Temperature increases above the 33°F background lake temperature.
3 Area enclosed by selected isotherms.

In order to comply with the standards contained in section NR 102.02(3), Wisconsin Administrative Code, the 3°F isotherm must not enclose more than one-tenth of the lake surface area. For Little Sand Lake, this would be 23.5 acres and for Deep Hole Lake, this would be 9.7 acres. For the mitigation flows calculated, and as shown in Table 4-20, there would be areas of noticeable temperature increases in both lakes. However, the increases would not violate water quality standards for thermal discharges.

To determine whether the expected temperature increases would impact lake fisheries, upper lethal threshold temperatures for fish species present in these lakes were examined, based on winter acclimation temperatures. Literature data indicated the upper lethal threshold was significantly higher (70-88°F), than the groundwater temperature of 51°F.

Due to the small size of the lake areas affected by increased temperatures, adverse impacts to events like fish spawning would be unlikely. Localized impacts to macroinvertebrates (i.e., insect development) could occur in the mixing zones of these lakes.

The discharge of groundwater that is colder than ambient lake temperatures (i.e., summer conditions) is not expected to cause adverse impacts to the aquatic biota in either Deep Hole or Little Sand Lakes.

Impacts to Aquatic Resources in Seepage Lakes from Mitigation - Mitigation of lake impacts would result in lake level maintenance near the premining levels. No reductions in shoreline aquatic habitat and associated macroinvertebrate populations would be expected. Wetlands associated with the lakes would not be significantly affected, and no impacts to wildlife would occur. Water quality changes from augmentation pumping would cause subtle changes in some wetland and lake plant species. An increase in sulfate levels in Skunk Lake may cause a shift in the relative abundance of wetland vegetation species.

Augmentation of Little Sand and Deep Hole Lakes would increase productivity and pH values. Invertebrates inhabiting the lakes, such as midges, caddisflies and worms, are tolerant of a wide range of water chemistries, and their populations are not expected to suffer adverse effects. Although there may be a shift in the relative abundance of existing species, the overall population may increase due to the change in water chemistry. There also may be an increase in snail and clam populations. The water chemistry changes would tend to slightly increase the biological productivity of these systems. No other impacts to public rights in lakes are anticipated from the mitigation pumping.

Impacts to Drainage Lakes from Mitigation - The groundwater drawdown would not directly result in any significant impacts to Ground Hemlock, Crane, Pickerel, Rolling Stone or Rice Lakes (Chapter 3). Rolling Stone Lake, however, could experience lowered dissolved oxygen levels if reduced flows in tributary streams were not mitigated. Adequate aeration of the groundwater used for mitigation discharges to Pickerel Creek, Creek 12-9, and Martin Springs would maintain dissolved oxygen levels in these tributaries and avoid mine-related depressed oxygen levels in Rolling Stone Lake.

Maintenance of flows in Upper Swamp Creek by mitigation pumping would not adversely affect water quality in Rice Lake.

Stream and Spring Impacts with Mitigation

Physical Impacts to Streams - Surface water mitigation would reduce impacts to stream flow, depth, width, velocity, and surface water elevation, as well as frequency of lower flows caused by the drawdown. Physical impacts to streams with surface water mitigation would be minimal even though streams would experience a net reduction in flow. This impact would be more pronounced for Upper Swamp Creek, Hemlock Creek and Creek 12-9. The mitigation proposal would maintain a recommended minimum flow in all impacted streams in order to prevent significant adverse impacts. All flows above the recommended minimum, however, would be reduced because the groundwater drawdown would cause a continuous reduction in groundwater discharge. Therefore, a reduction in total available flow throughout the year would occur until premining conditions were re-established.

The discharge of groundwater with colder than ambient stream temperatures for mitigating stream flows is not expected to adversely impact the aquatic populations to any of the streams requiring augmentation. Therefore, the evaluation of thermal impacts to streams from groundwater mitigation focused on the winter months (November-April) when ambient stream temperatures would be increased by mitigation pumping.

Thermal evaluations, as a result of groundwater mitigation, were conducted for the following streams: Swamp Creek (at SG-3, the outfall location, and Highway 55), Hemlock Creek (at the confluence with Swamp Creek), Hoffman Creek (at SG-E), Creek 12-9 (at SG-23), Upper Pickerel Creek (at SG-19), and Creek 11-4 (at the town road crossing).

To evaluate the thermal impacts of using groundwater for mitigation purposes, a mass balance equation was used. The equation assumes an allowable temperature rise of 5°F (NR 102.02(3)) at the edge of the mixing zone using 25 percent of the cross-sectional area of the stream (NR 102.03(4)) for $Q_{7,10}$ stream flow conditions (NR 102.03(3)). A worst case temperature of 33°F as well as an average temperature (40°F) was assumed for each stream under wintertime conditions. Table 4-21 lists the minimum mitigation water temperatures that must be maintained in order to comply with the thermal standards in NR 102, Wisconsin Administrative Code.

Table 4-21
Thermal Impacts from Mitigation of Stream Flows

Site	$Q_{7,10}$ Stream Flow (cfs)	Reduced Flows (cfs) Expected Conditions	Calculated Maximum Allowable Temperature (F°) of Mitigation Flow	
			Stream Temp. = 33°F	Stream Temp. = 40°F
Swamp Creek (SG-3)	4.7	.61	48	55
Swamp Creek (STH 55)	8.0	1.17	47	54
Swamp Creek (outfall site)	15.0	2.7[1]	45	52
Hemlock Creek (Conf with Swamp)	1.4	.55	41	48
Hoffman Creek (SG E)	.55	.14	43	50
Upper Pickerel (SG 19)	1.0	.11	49	56
Creek 11-4 (tn. rd. crossing)	0.4	.07	45	52
Creek 12-9 (SG-23)	1.1	.38	42	49

[1] Average effluent flow rate

The groundwater temperature used for augmentation would be in the range of 49-51°F. Consequently, the thermal standards would not be met for all sites, particularly at the lower stream temperatures of 33°F. A variance from the thermal standards would be necessary to allow a discharge of groundwater to these streams. A variance from the standards would be granted only if it were demonstrated that there would be no adverse impacts to fish and aquatic life. Data in the literature indicate thermal shock or stress would not occur as a result of discharging slightly warmer water in the winter months.

Impacts to Fisheries, Aquatic Organisms, and Wetlands - The primary species impacted by surface water mitigation would be trout. Though stream characteristics would be maintained by mitigation, successful brook trout spawning requires groundwater seepage areas. These areas would be reduced by the groundwater drawdown, particularly in Hoffman Creek and Springs. As long as the groundwater would be drawn down, groundwater seepage and trout spawning areas would be reduced.

Impacts to streamside wetlands, wildlife, benthos, macrophytes, algae, and zooplankton as a result of stream mitigation are predicted to be negligible to small.

Water Quality Impacts due to Stream Mitigation - The stream mitigation plan would maintain recommended minimum flow conditions. To the extent possible, groundwater would be utilized for augmenting stream flows. The groundwater quality of the various sources is expected to be similar to the quality shown in Table 2-2 for wells in the glacial drift. The augmentation water would be aerated to maintain dissolved oxygen standards (5-6 ppm). If this water were adequately aerated, there would be no appreciable change in dissolved oxygen concentrations in any of the streams that receive augmentation.

Most flow augmentation to streams would be from local groundwater sources. Comparisons were made between the metallic and nonmetallic parameters in the groundwater and those in the stream waters to determine whether flow augmentation would change stream water quality. The nonmetallic parameters compared included hardness, pH, specific conductance, alkalinity, nitrates, total phosphorus, and sulfate. In general, the groundwater contained less sulfate and total phosphorus than the stream waters, and augmentation would result in slightly lower levels of sulfate and phosphorus in stream waters. Conversely, groundwater augmentation would raise the surface water hardness, specific conductance and alkalinity, slightly. Overall, flow augmentation with groundwater would not measurably change stream water quality for either the expected or maximum impact case scenarios.

OTHER MITIGATION MEASURES FOR SURFACE WATER IMPACTS

The groundwater drawdown could be mitigated to some degree by reinjecting water through wells into the aquifer. If a ring of injection wells surrounding the mine were used, the groundwater level would be raised resulting in a cone-of-depression which is much steeper, but less expansive. Impacts to surface waters would be reduced or eliminated, depending on how effective reinjection was in restoring groundwater levels. Mine inflows would increase substantially as would pumping costs. Reinjection of any contaminants into the groundwater is prohibited in Wisconsin.

Lake seepage might be reduced by application of materials such as bentonite to the lake bottom. Bentonite could be applied on the lake surface and allowed to infiltrate the bottom, decreasing the lake bed permeability. However, the lake beds are already fairly impermeable, and the decrease in seepage might be slight. Any changes to the lake bed permeability which are achieved would be permanent. Application of bentonite in this manner would have adverse affects on lake fish and other aquatic life.

Installation of dams on Little Sand, Duck, and/or Deep Hole Lake may enable storage of excess water during wet periods, thus reducing the frequency of mitigation pumping. The effectiveness of dams in minimizing the need for mitigation is limited, since the higher lake levels caused by storing excess water result in higher seepage rates.

With the proposed surface water augmentation, trout spawning areas would be reduced or eliminated. One alternative to maintain brook trout populations where spawning habitat is reduced would be to implement a stocking program. Stocking could be designed to simulate pre-mining fish populations, although hatchery trout are not as desirable to as wild trout.

MITIGATION OF IMPACTS TO WATER WELLS

Section 144.855(4), Wisconsin Statutes, provides a mechanism for mitigating mining impacts to water wells. Exxon is required by law to replace or deepen wells, or otherwise provide water for those wells predicted to be impacted by the proposed mine. Modifications to those wells would occur in advance of the project.

A person claiming damage to a private water supply would file a complaint with DNR, and, if there would be an immediate need for an alternate supply of water, with the appropriate township, village, or city. DNR would investigate and schedule a hearing, if necessary, to determine the party responsible for the water well impact. Until a conclusion would be reached by DNR, the township, village, or city would provide water. After a conclusion had been reached on damage responsibility, the mining operator would have to pay for all costs, if it were deemed responsible, and provide service with water of equal quality and quantity. If the mining operator were found not responsible, the person filing the complaint would have to pay the municipality for water service during the process.

MITIGATION OF WILDLIFE IMPACTS

Concerns have been expressed regarding the impacts of seismic disturbances on bald eagles nesting in the area. The U.S. Fish and Wildlife Service guidelines on the management of bald eagles provide for a buffer zone of no activity surrounding an active eagle nest. Buffer zones, if established around eagle nests during construction and operation activities would minimize impacts. In addition, the recommendations set forth under the Federal guidelines should be followed to reduce disturbance to these birds.

MITIGATION OF SEISMIC VIBRATIONS

Blasting is designed to keep peak particle velocity below the point of causing structural damage to the surface facilities. The most obvious alternative to off-site structural problems, such as wall cracking in residences, is a reduction in the peak particle velocity resulting from a given blast. This can be accomplished by one of two possible methods:

1. Reduce the total charge in each blast. This would require more frequent use of charges, but would create less peak particle velocity at distant points.

2. Use more delays than current plans indicate and divide up the total charge per blast accordingly. Generally, the amount of charge per delay controls the peak particle velocity experienced at sites away from the blast. Use of more delays may provide better, more efficient use of explosives. In that case, the overall charge weight also may be reduced.

MITIGATION OF TRANSPORTATION IMPACTS

Increased traffic in the vicinity of the mine/mill site, particularly at shift charges, could cause increased congestion, areas of slow moving traffic, and temporary lines of traffic waiting at intersections. Partial mitigation of these impacts could occur in the following ways:

1. Additional turn lanes at the intersection of State Highway 55 and the mine access road would reduce congestion at shift changes.

2. Installation of a traffic signal at the intersection of State Highway 55 and the mine access road would reduce congestion by facilitating movement at peak periods. A signal could flash amber between shift changes and be set for full operation during shift changes. However, anticipated traffic volumes at signal installation are too low to justify installation of a traffic signal. Traffic direction by manual methods could provide faster traffic movement compared to no signalization, and with turning lanes, may adequately handle traffic increases.

3. Increased signalization along with placement of crosswalks in Mole Lake, or lower speed limits, could reduce the potential for vehicle-pedestrian accidents in Mole Lake.

4. Reconstruction of segments of Highway 55 and CTH S, along their existing alignments, would facilitate faster and safer vehicle travel. High priority roadway maintenance during winter such as plowing, sanding, and salting would reduce the likelihood of accidents and increase vehicle movement.

MITIGATION OF SOCIOECONOMIC IMPACTS

Negative socioeconomic impacts of mining could be mitigated in several ways . The Mining Investment and Local Impact Fund was created to ". . . assure that moneys will be available . . . for long- and short-term costs associated with social, educational, environmental and economic impacts of metalliferous mineral mining" (s. 70.37, Wisconsin Statutes). Payments from the fund are made to certain municipalities in the mining area during the various phases of mine development, operation and closure. In addition, discretionary funds are distributed each year to qualifying municipalities from the mining impact fund. There also is a mining-related damage fund, authorized by s. 107.30-35, Wisconsin Statutes, which provides compensation for mining-related damages to persons or property. Mining-related injury means death or injury to person or property caused by environmental pollution from emissions, seepages, leakages, and discharges. Awards are made from the mining damage appropriation administered by the Department of Industry, Labor and Human Relations (DILHR). Any person may make a claim to DILHR against the mine damage appropriation to recover damages from mining-related injuries up to the maximum award amount of $150,000.

It is not possible to anticipate all the beneficial or adverse consequences the project might have on the local study area or the range of mitigation strategies. The following sections identify potentially troublesome socioeconomic impacts that may occur during the construction period, during a temporary suspension or premature termination of the project, during the period of project operations, and during the closure phase. Sample policy and programmatic strategies and responsibilities are discussed that could mitigate the impacts identified.

Construction Phase

During the construction period the most significant adverse impacts of the project could be a variable demand for housing and public services and front-end financing problems confronting local governments. Exxon, the Mining Impact Board (MIB), and local government could individually or collectively mitigate these impact by a variety of measures. The MIB is expected to have insufficient discretionary funds during the construction phase so a more effective funding source to mitigate any adverse impacts may be needed. For example, public front-end financing can be accommodated by direct cash payments as well as by bond or loan guarantees.

The front-end financing of public capital and service needs by the cash prepayment of property tax obligations is a potential mitigation measure not specifically authorized by state law. This option would be costly to Exxon as it constitutes an interest-free loan to the taxing jurisdiction. Also, the company would be unable to deduct such payments from federal income tax liability until a local property tax obligation arises (i.e., after the project construction has occurred, the property is assessed, and the tax levied). The construction period payments made to municipalities by the MIB essentially are prepayment of net proceeds taxes.

Exxon could minimize the potential for a large inmigration in relation to the number of employment opportunities by carefully targeting employment announcements in terms of both geography and skill levels.

The Mining Impact Board could be a source of financial assistance for determining the origin and residential locations of all project-induced population. Workforce surveys or school enrollment surveys are two proven mechanisms whereby a systematic yet relatively convenient measure of population, demographic, and economic change in various study area jurisdictions can be obtained.

Temporary Suspension or Premature Closure

Suspension of the project for a year or more, or the unscheduled termination of the project during construction or operations would impact personal and business income and public finance in the study area. In addition to the obvious outcome of idled Exxon workforce members, there would also be unretired public debt. Out-migration and business failure and layoffs of secondary public and private employees also would worsen the effects of an unscheduled project shutdown.

The Mining Impact Board would be a logical source for financial assistance; however, the point at which termination occurred in the project's life would have an obvious bearing on the Fund's level of reserves. Mitigation by Exxon related to an unscheduled termination of the project could take a preventive form by maximizing local study area resident employment at the beginning of the project through aggressive recruitment, training, and employment practices. More ambitiously, Exxon could dedicate funds to purchase any outstanding bonds or notes incurred to finance public improvements, the demand for which was significantly tied to project-induced growth. Local government jurisdictions could mitigate the fiscal effects of a suspension of the project by structuring the amortization of any debt over the shortest possible timeframe. Care in avoiding ambitious capital expenditures during the construction phase before income from the mine is realized would reduce the likelihood of financial problems due to early shutdown or closure.

Operations Phase
Mitigation strategies on the part of the State of Wisconsin could include research and analysis designed to identify industrial sectors and specific companies that could realize the new business potential fostered by the project.

Closure Phase
The scheduled date of closure of the Crandon Project is sufficiently distant to enable the State of Wisconsin (Department of Development, Mining Impact Board) and the various jurisdictions to identify complementary economic development opportunities for residents, communities, and businesses in the study area who may lose jobs and millions of dollars in income. The likelihood of finding a substitute industry is unknown.

Intergovernmental Cooperation
Intergovernmental cooperation can encourage more efficient use of mitigation resources and can be encouraged by any organization able to make funds available on a discretionary basis, e.g., the Mining Impact Board. There appears to be increasing use of jointly supported facilities and activities for human services. Since state agencies and counties are facing serious reductions in federal funds, these joint ventures are likely to become even more important.

The Mine Impact Board is potentially the most important entity for fostering intergovernmental cooperation. This function may be adversely affected during the construction period if funding prior to revenue flow from the net proceeds tax is insufficient. The North Central Wisconsin Regional Planning Commission has served some of the larger jurisdictions with planning assistance, e.g., downtown redevelopment. It has also offered seminars on growth management. The smaller jurisdictions may find the Commission helpful as a supplier of consulting services or even as an advisor in determining the type of planning services that are needed for a particular community. In addition, the North Central Mining Impact Planning Committee, and the local mining impact committees will continue to be important sources of assistance.

A number of municipalities could be impacted by the proposed mining. Those municipalities not receiving mandated payments from the Mining Impact Board (MIB) would have a high priority for receiving discretionary funds from the MIB. In order to be reimbursed for mine-related impacts, those municipalities would have to justify those costs. Wisconsin statutes (70.395) are very inclusive as to what types of costs potentially would be reimbursable. One alternative would be for each municipality to independently calculate their mining-related costs. Another alternative would be for an independent party, with oversight from each affected municipality, to analyze and help determine the actual mining-related costs for each municipality. This method would be more cost-effective and possibly would result in more complete reimbursement to municipalities of mining-related costs.

Mitigation of Negative Impacts to Native American Tribes
The formation of mitigation alternatives for Native American tribes could be a dynamic process involving the applicant, local, state, and federal government, and the two Native American tribes. Together they would identify community needs, develop strategies for addressing these needs, and then assign responsibilities for data gathering and interpretation, funding sources, and initiation and implementation of mitigation procedures. The tribal mining impact committees could serve as the facilitator for such a forum. There are no state or local requirements to develop or implement mitigation alternatives for the tribes.

An essential element of any mitigation plan would be the development of a socioeconomic monitoring system. Monitoring of actual project impacts, such as residential location of the workforce or school enrollments, would allow comparison to projected impacts. In areas where impacts differ from those anticipated, mitigation measures can be adjusted accordingly. Monitoring also could involve evaluation of the effectiveness of mitigation measures which have been put in place.

There are several potential mitigation actions which Exxon could consider implementing to ensure employment and business opportunities for the tribes were maximized:

1. Work with each tribe's employment coordinator to establish employment guidelines dealing with the number of Native Americans that potentially could be hired, the types of jobs that could be filled, and alerting them to recruitment needs.

2. Waive conditionally certain educational requirements for experienced applicants without a high school or equivalent degree.

3. Develop a local, on-the-job training program and provide employee counseling to assure successful employment.

4. Implement an orientation program for new employees that is sensitive to the needs of Native Americans.

5. Establish a supervisory training program to inform supervisors of the special needs of Native American employees.

6. Support tribal enterprises through bidding preference, waiving of performance bonds, joint ventures, and assuring that invitations to bid are of a realistic size and nature.

7. Establish a system to provide pertinent project workforce information on Native Americans hired. The information would be used by the tribes in conjunction with the MIB to monitor tribal impacts.

8. Organize and implement, if needed, a daily transportation program for Native Americans to get to and from their jobs at the mine.

Potential actions of federal, state, and local governments to mitigate socioeconomic impacts include the following:

1. Federal and state government could provide technical assistance to the tribes in such areas as grantsmanship, planning, and community development.

2. Local and state governments could cooperate in a socioeconomic monitoring effort.

3. Specialists in Native American education at Nicolet College could assist the tribes in job training and placement.

4. Local governments could establish a limited development buffer zone around the Mole Lake Reservation. Additional development close to the reservation could have adverse impacts on the tribe.

The tribes could undertake several actions to increase the effectiveness of a mitigation plan. Some potential actions include:

1. An employment coordinator for each tribe could identify jobs and training opportunities with the applicant and serve as links to the potential workforce.

2. The tribes could make a formal commitment to cooperate with other units of local government to identify mutual concerns and needs in relation to the project.

3. Tribal public relations efforts could be established to inform the applicant of the tribe's special attitudes and needs and to develop an appreciation for Native American lifestyle and culture.

CHAPTER FIVE
COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT AND DEPARTMENT RESPONSES

PUBLIC COMMENTS ON THE DEIS

During the DEIS review period, meetings were held at the Nashville Town Hall on June 20 and 21 to receive public comments on the DEIS. An estimated 350 persons attended the meetings and a total of 79 individuals presented oral comments. Oral comments were received from: two state legislators; the Public Intervenor's Office (Department of Justice); county, town and city representatives; three Native American Tribes; several mining impact committees; representatives from nine environmental organizations; members from the Rolling Stone Lake Protection and Rehabilitation District and the Ground Hemlock Lake Association; and local property owners, residents, and business people.

During the public comment period on the Draft Environmental Impact Statement from May 12 through July 7, 1986, 139 comment letters were received. This excludes letters from state and federal agencies and Native American Tribes, which are reproduced in a subsequent section. Many of the comment letters received from the general public contained statements either for or against the proposed mining project or expressed an opinion on the desirability of certain impacts, but did not address the completeness or accuracy of the DEIS. However, numerous other letters did contain suggested revisions or additions to the DEIS.

At the public meetings and during the DEIS review period, the Department received petitions entitled "Public Response to Draft Environmental Impact Statement on Exxon's Proposed Mine at Crandon, Wisconsin". The petitions contained more than 1200 signatures. The petitions listed several environmental concerns for the Upper Wolf River watershed: Wolf River water quality, disposal of tailings, use of chemicals, tailings reprocessing, mine dewatering, surface water impacts, and long-term care responsibility. The petition did not directly address how these impacts were evaluated in the DEIS, but requested DNR not to act on the permit applications until threats to the area's natural resources were eliminated.

At the DEIS meeting and during the public comment period, concerns were voiced relative to many of the impacts described in the DEIS. These concerns are listed below:

Groundwater Impacts - impacts to waterwells within the area of groundwater drawdown and compensation process for wells affected by the project; groundwater contamination from the MWDF; groundwater contamination from the mine following closure; acid formation from tailings and resultant groundwater contamination.

Discharge Impacts to Surface Waters - impacts to Swamp Creek and Wolf River fish, aquatic plants, resident wildlife, mussels and other bottom-dwelling fauna from project related discharges; impact comparison at different discharge rates; process of developing effluent limits; warm water versus cold water effluent limits; impacts to wild rice along Swamp Creek; impacts to the entire Wolf River watershed system; accumulation of heavy metals by aquatic organisms and impacts of heavy metals in sediment; impacts to downstream water users, including the Menominee Reservation.

Socioeconomic Impacts - impacts of discontinuous mine operations; impacts following mine closure; metals prices in relation to projected amount of net proceeds tax; net proceeds tax in relation to corporate profits; impacts to property values; tourism impacts; Native American off-reservation treaty rights; Sokaogon Chippewa land claim; project impacts to local governments; Soo Rail Line abandonment.

Air Quality Impacts - heavy metals deposition from tailings dust; fugitive dust impacts; occurrence of asbestiform fibers in tailings dust; drying of tailings and resultant tailings dust.

Surface Water and Wetland Impacts - impacts to levels (Ground Hemlock and Rolling Stone Lakes plus the four project area lakes), stream flows and wetlands due to the predicted groundwater drawdown; assumptions used in lake level projections; potential loss of trout and trout habitat; wild rice impacts in Rice Lake.

Surface Water Mitigation Plan - secondary impacts to groundwater from mitigation pumping; worst case impacts from mitigation pumping; duration of mitigation pumping after mine closure.

Monitoring - monitoring on Ground Hemlock and Rolling Stone Lakes and tributaries to Rolling Stone Lake; explanation of monitoring and quality assurance methods; asbestos fiber monitoring; heavy metals monitoring in vegetation and invertebrates; construction and operations monitoring.

Others - risk assessment; long-term liability, long-term care and financial responsibility for MWDF; transportation impacts from hauling chemicals and concentrates; noise impacts.

RESPONSE TO PUBLIC COMMENTS

Based on the comments received from the general public, numerous revisions were made in preparing the FEIS. The comments listed above include the substantive areas in which changes were made. Changes included preparing new impact analyses, identifying more fully how impacts were analyzed, and making minor revisions to analyses based on new information for clarification. Each public comment letter was carefully reviewed for its DEIS comment contents. For valid comments, the appropriate changes were made. For comments which urged DNR to approve or deny permit applications or which were in favor or against mining, no changes to the DEIS could be made.

There were several areas of the impact analyses which were substantially revised for the FEIS. The analyses of surface water impacts if the proposed surface water mitigation plan were implemented, the lake drawdown analysis, and the impact analysis of MWDF seepage on groundwater were revised and updated to more accurately predict project impacts.

GOVERNMENT AGENCY COMMENTS ON THE DEIS

The following letters were received from federal agencies, Native American Tribes, state agencies and local governments in response to the Exxon DEIS. The letters are reproduced here in their entirety. Each comment necessitating a response is numbered in the margin. In a subsequent section, DNR's response to each substantive comment is indicated.

The Department responses in the section following the comment letters have been kept as concise as possible, partly because of the large number of comments received. In addition, the responses indicate whether new or revised analyses have been included in the FEIS. In general, in order to avoid duplication of the analyses, the responses indicate Department conclusions without providing in-depth supporting discussion.

AUG 06 1986

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

05 AUG 1986

REPLY TO THE ATTENTION OF: 5ME-14

Howard S. Druckenmiller, Director
Bureau of Environmental Analysis and Review
Department of Natural Resources
Post Office Box 7921
Madison, Wisconsin 53707

Dear Mr. Druckenmiller:

We have reviewed the State of Wisconsin's Draft Environmental Impact Statement (EIS) for the zinc and copper mine proposed by the Exxon Corporation for a site near Crandon, Wisconsin. Our review of this Draft EIS has resulted in concerns related to adverse surface water and groundwater impacts and loss of wetlands.

(1) The impacts of the proposed effluent is of particular concern. The concentrations of lead and mercury in the effluent from the mining operations are more than ten fold higher than USEPA Water Quality Criteria (Federal Register, Notices, Volume 50, Number 145, July 29, 1985). The concentration of cyanide is near its criterion.

(2) Furthermore, a problematic area is the synergistic effects of the metals in the effluent. According to the concentration addition model of Koneman (1979), metals act additively. The proposed effluent may be much more toxic than the individual chemical exposure limitations predict. Table 1-8, on page 17, provides both the projected effluent quality of the mine and the proposed Wisconsin effluent limitations derived from available acute toxicity information for resident Wisconsin species. When the concentration addition model is used for these compounds, the toxicity of the effluent is 1.5 times Wisconsin's daily maximum limitation. At this increased level of toxicity, the effluent will not adequately protect aquatic life.

(3) Additionally, the sulfite ore may contain metals such as tin, nickel, bismuth, and platinum, which are not listed in the effluent. If these metals are present, they will also contribute to the toxicity of the effluent.

(4) Oily contaminants from the shaft sinking operations will be produced during construction. Although oily contaminants will be extracted from the runoff, the Draft EIS failed to describe this runoff in sufficent detail for us to ensure that other contaminants will not be present. We should be provided more information regarding the components of this runoff.

With regard to approval of the proposed National Pollutant Discharge Elimination System (NPDES) permit limits for the mine discharge, our permits section has not yet received a draft permit submittal. We would like to enourage the submittal of a draft permit applications as early as possible. Specific permit issues cannot be discusssed outside the context of a draft permit submittal.

(5) Loss of wetlands is also a primary concern. Specifically, the amount of wetlands lost due to the development of roads, pipelines and rail corridors appears to be excessive. Loss of wetlands could be reduced by consolidating and integrating these access routes. Mitigation for wetland loss will not be considered until all feasible alternatives for avoiding or minimizing wetland impacts have been explored. The Final EIS must clearly demonstrate that wetlands have been avoided as much as possible. Mitigation plans for lost wetlands should be developed prior to our review of the Final EIS. Our review of the mitigation plan at this early stage will allow us to resolve any problems before the Final EIS. This will also expedite our review of the 404 permit application for this project.

(6) The significant lowering of project area lake levels is problematic given the present drought conditions. A violation of State Water Quality Standards may occur if penetration of light in the lakes limits the growth of of rooted aquatic plants. The proportionally increased volume of anoxic hypolimnetic waters could increase the frequency of fish kills. Exposure of non-vegetated shorelines to ice and wave action could increase lake turbidity and nutrient levels through erosion.

The Draft EIS contained an adequate analysis of the drawdown impacts on the area lakes and streams. Exxon proposes to mitigate the drawdown impacts by intercepting groundwater near the mine and pumping it into the impacted lakes and streams. The proposed mitigation plan appears hydraulically feasible. The utility of this mitigation plan is based on the reported minimal water quality impacts on the surface water bodies.

Although augmentation of lakes by pumping groundwater into these areas has been proposed to alleviate these conditions, problems of water appropriation and quality may ultimately disqualify this alternative from further consideration. Pumping groundwater for lake augmentation (7) will likely raise the naturally low pH of the native waters. State threatened Potamogeton species noted on one of the lakes will likely be adversely impacts by higher pH water.

The Wisconsin Department of Natural Resources and the Exxon consultants have conducted detailed studies of the potential impacts of the groundwater drawdown and any contaminant transport from the tailings pond and mine refuse landfills. The potential groundwater drawdown from the mining operation is predicted using a two-dimensional flow model which accounts for the variable hydrogeologic conditions in the area. A (8) conservative scenario to approximate a reasonable worst case drawdown should be added to the groundwater studies. By varying parameters such as groundwater inflow rates to the mine and recharge rates, a sensitivity analysis could be performed to assess the magnitude of the parameters needed to create impacts outside of the study area and more severe impacts within the study area. Once this analysis is performed, Exxon would need to justify the 200 gallons per minute of maximum inflow used in the Draft EIS modeling.

(9) Another area of concern is groundwater contamination. By accepting the fact that all landfills and impoundments eventually leak, long term monitoring of the disposal sites is needed. The estimated future groundwater contamination appears to be minimal assuming the 10% destruction of the cap is appropriate for a worst case analysis. The amount of cap destruction necessary to produce sulfate concentrations greater than 250 mg/l at the compliance boundary should be determined. This type of analysis would (10) provide a better estimate of the margin of protection the cap can provide under adverse conditions. These studies should address issues such as the percentage of the cap that can be removed and still maintain drinking water standards the compliance boundary.

The proposed mine is relatively isolated from drinking water wells and water bodies. The minimun distance is greater than 3 miles in the westerly groundwater flow direction. Based upon the findings of previous groundwater studies, which indicated that most groundwater contaminant plumes in sand and gravel aquifers attenuate to background levels within 3 miles of the contaminant source, significant groundwater contamination impacts on the border water bodies are not expected.

The water bodies which could be impacted by groundwater contamination are Hemlock Creek, Little Sand Lake, Deep Hole Lake, and Duck Lake. Provided the modeling assessment is a reasonable estimate of impacts and the monitoring network is effective, there should be ample warning time to conduct any remedial action.

Thank you for the opportunity to review the State of Wisconsin's Environmental Impact Statement for the proposed Crandon Mine. If you have any questions regarding these comments, or if you would like to arrange a meeting to discuss our concerns, please contact me at 312-886-7500.

Sincerely yours,

William D. Franz

William D. Franz, Chief
Environmental Review Branch
Planning and Management Division

AUG 0 1 1986

United States Department of the Interior

OFFICE OF ENVIRONMENTAL PROJECT REVIEW
175 WEST JACKSON BOULEVARD
CHICAGO, ILLINOIS 60604

July 31, 1986

ER-86/697

Mr. Howard S. Druckenmiller
Director
Bureau of Environmental Analysis and Review
Wisconsin Department of Natural Resources
Box 7921
Madison, Wisconsin 53707

Dear Mr. Druckenmiller:

The Department of the Interior has reviewed the draft environmental statement for the proposed Exxon Minerals Zinc-Copper Mine near Crandon, Forest County, Wisconsin. Overall, we found this to be a thorough and objective analysis of the complex environmental problems that such a project usually engenders. There are a number of issues that we feel do require further clarification, however. We do not believe there is sufficient consideration of potential long-term impacts associated with the proposed mine development, or of contingency plans to assure that adequate environmental protection will be provided. We also feel that special attention should be paid to the effect of long-term discharge to the Wolf River, and to the water resources of the Mole Lake Indian Reservation.

Our detailed 9-page comments with diagrams are enclosed. They are divided into general comments and specific comments referenced by page number. We appreciate the opportunity to participate in this draft document and look forward to working with you further.

Sincerely,

Sheila Minor Huff
Regional Environmental Officer

Attachments

Exxon Minerals Company Zinc-Copper Mine
Draft Environmental Impact Statement
Department of the Interior Comments

General Assessment

In general, we found the draft environmental impact statement provided adequate coverage of a complex group of interrelated problems that would be caused by a product such as this one. The discussion was usually clear and supported by a series of figures that illustrated project components well.

(11) We find some major shortcomings with the DEIS. There is a consistent pattern of failure to deal with the long-term potential impact of this project on the biota and natural resources of the area. In most instances, the planning
(12) horizon does not extend past getting the operation to a steady level of production. Also, there is a lack of clearly delineated goals for environmental protection, in particular contingency plans to assure that these
(13) goals are met. Some form of performance guarantee from the Exxon Corporation may be appropriate and should be considered. A clear commitment to long-term environmental protection should be an integral part of the mine development plan and should be well documented in the EIS. From the standpoint of the nearby Indian reservation (Mole Lake), the impacts to the water resources are a major consideration.

We also had some suggestions for minor additions to several topics, such as, the magnitude of the mine in terms of domestic supply and impacts from support facilities.

Long Term Impacts

It is indicated in the draft statement that adverse impacts are not expected to occur to the Wolf River. However, should data being assembled demonstrate that there might be measurable impacts to the segment of the Wolf River included in the National Wild and Scenic Rivers System, consultation in
(14) accordance with Section 7(a) of the Wild and Scenic Rivers Act must take place through the National Park Service with the Secretary of the Interior for any Federal licenses required for the proposed project. The segment of the Wolf River included in the National Wild and Scenic Rivers System is that portion of the river from the Langlade/Menominee County line downstream to Keshena Falls.

We are concerned that the DEIS does not address the effect of long-term discharge of heavy metals to Swamp Creek and consequently to the Wolf River. The Wolf River is considered a very valuable resource on a regional and
(15) national basis. A 25-mile segment is designated as part of the National Wild and Scenic Rivers System. It is a river of high water quality that supports a brown, brook, and rainbow trout fishery, popular with anglers. The Wolf River and Swamp Creek are also feeding areas for bald eagles and osprey nesting in the area, as well as other fish-eating avian and mammalian predators. Although the plan is to meet water quality criteria specified in the WPDES (Wisconsin Pollution Discharge Elimination System) permit application, the

(15) chronic release of various metals might still contaminate the biota of the aquatic systems downstream of the discharge if dissolved or suspended metals are sequestered by the biota and internally recycled in the local stream and river ecosystems. There should be an ongoing monitoring effort in Swamp Creek to detect contaminant uptake by the biota and a clear statement of the (16) contingency plan to deal with and rectify contaminant accumulation therein. Our concern goes beyond the projected concentrations of contaminants in the waste discharge and focuses on the total flux of contaminants through the downstream aquatic systems over time.

The composition of total suspended solids should be discussed in greater detail. It is not clear whether this parameter might include potentially (17) harmful metal particles that add to the total burden on the aquatic system. If this is the case, it should be considered in detail when discussing the proposed discharge permit.

Even though organic process chemicals are mentioned in several places in the DEIS, no consideration is given to them as potential contaminants in the proposed discharge to Swamp Creek. Experience has generally shown that (18) organic chemicals often constitute special problems in industrial discharges. Consequently, we believe that an inventory of chemicals entering the mine/mill site should be accompanied with detailed plans for removing organic contaminants from the waste stream on a chemical-by-chemical basis. The DEIS (19) is vague on the use of charcoal filtration for waste treatment. Such filtration could be effective in removal of organic contaminants. it is generally mentioned as a part of alternative 2 (page 227) for process wastewater treatment. We believe that alternative 2 should be explored in detail as a necessary component of operations. The organic-containing waste stream might be isolated before entering the reclaim pond and the total volume to be treated could be reduced. In addition, biological monitoring activities (20) in Swamp Creek and the Wolf River should specifically consider organic contaminants unless they are completely removed by a process such as charcoal filtration. In any case, specific organics should be included in the wastewater discharge monitoring and the reclaim pond monitoring plans.

In Table 1-13, mention is made of chlorination as related to cyanide discharge, but nowhere else in the DEIS is chlorination discussed. The introduction of chlorine and aromatic organic compounds into the same waste (21) stream opens up the possibility of unplanned chlorinated organics being formed. This possibility should be considered, evaluated, and appropriate contingency plans developed to preclude release of these contaminants to the environment. Specific monitoring plans should also be developed to detect these materials at appropriate places in the mill waste stream and in the biota in Swamp Creek and downstream, including the Wolf River.

We believe that all biological monitoring of contaminant levels should be done on at least a yearly basis for a minimum of the first 10 years of operation (22) because it will take at least 8 years for the groundwater to stabilize and the system to reach essentially a steady state. After the initial 10 years, less

frequent biological monitoring might be used (possibly every 3 years) to detect trends in the potentially accumulative heavy metals and organics. These comments apply to Swamp Creek, the Wolf River, and to airborne contaminant monitoring studies.

Monitoring of airborne contaminants, particularly in the biota, should be extended downwind beyond the project boundaries. Appropriate species in both (23) lakes and uplands should be sampled periodically for heavy metal accumulation, especially during the first half of the project life as contaminants potentially accumulate downwind. A clear action plan should be developed before operations begin to eliminate airborne contamination if it is detected.

Although the reclamation phase of this project is described, a clear set of goals for ultimate use of the site is lacking. We encourage the creation of as much wetland as possible on project lands other than the various waste (24) disposal areas during final site closure to replace some of the wetland values lost during the construction and operational phases of the mine. Wherever possible, the natural topography should be utilized to impede the flow of surface water and thus to encourage growth of wetland species.

The feasibility of returning as much of the material removed from underground (25) as possible should be explored in detail. Although coarse material will be used as backfill, fine tailings disposal as a cement slurry should be evaluated further. In the same context of returning material removed from (26) underground, polishing wastewater sufficiently for reinjection for groundwater maintenance should be considered more seriously.

Contingency Plans

Potential off-site contamination during ore shipping should be addressed in the DEIS. Rail lines run parallel nearby and cross the Wolf River in several (27) areas, providing potential for spills of contaminant material. A contingency plan should be in place to deal with contamination caused by acute (major accidental) spills and chronic releases (e.g., dust from rail cars).

Contingency plans to deal with various plant malfunctions are not adequately addressed, which raises several questions. No clear alternatives are presented for a long-term shutdown of the water treatment plant. If such a (28) shutdown extends past the holding capacity of the ponds (20 days), will the mine/mill be temporarily closed and the mine used to hold contaminated groundwater? If the treatment plant fails, will the mill shut down as implied on page 14? What plans exist to deal with a failure or leakage of the reclaim (29) and tailings ponds? Rather general statements about fixing problems are made on pages 193 and 237, but it is not at all clear how the entire mine/mill operation would respond to these problems. References to contingency plans for the MWDF are vague and no appropriate contingency plan is evident.

(30) Long-term plans for contaminant monitoring/containment are not specified in enough detail to evaluate their adequacy. Actions to be taken if monitoring (for how long?) detects leaks in the various liners containing contaminated

30 materials post-closure should be identified. The ultimate plan for closure of the reclaim pond should be described more fully. It should be clearly
31 identified whether enough material will be removed and placed in T4 to eliminate contamination at the reclaim pond. The material in cell A of the reclaim pond may be the most contaminated on the entire site. Special emphasis should be placed on its ultimate disposal, monitoring of its long-term fate, and, especially, on contingency plans if it begins to move from its entombment location.

Long-term groundwater contamination from the mine/mill complex is not
32 addressed in detail. No contingency plan is presented to deal with this problem and it is not at all clear what plans have been made to deal with the potentially 9,000-year interval before groundwater contamination equilibrates.

A plan to mitigate surface drawdown of area lakes and streams is described in the DEIS. Recognizing that the mitigation/contingency plan is still undergoing detailed development, we have identified several aspects of the plan that warrant further consideration and/or clarification.

The availability of an adequate source of mitigation water is not clearly evaluated in the DEIS. As alluded to in various sections of the DEIS,
33 mitigation pumping will further deplete groundwater and consequently increase the loss of lake levels and stream flows. This suggests a "red queen" situation of continually pumping faster just to stay even. The discussion of alternative groundwater pumping systems fails to adequately assess the role of the various alternatives for lake/stream level augmentation. In particular, can mine intercept water be used to a much greater extent than projected to augment groundwater levels by injection or surface application, thereby
34 minimizing the need to pump water from wells? It should be identified whether there is a higher proportion of intercept water potentially available for mitigation and, if so, whether this would alleviate problems or cause new ones due to inadequate water quality.

It should be clearly stated that the assurance of mitigation water supply is
35 more important than the the actual amount. In other words, a slightly lower flow pumped continuously may be preferable to a higher, but very erratic supply that causes large fluctuations in lake levels or stream flows. This concept should be incorporated into a goals statement for the mitigation plan.

The issue of mine intercept water availability during periods of mine inactivity and especially after mine closure should be addressed. The DEIS
36 does not specify how lake and stream levels would be maintained after the mine is abandoned and before groundwater is again at "normal" levels. It should be identified whether the maximum lake drawdowns (e.g., Table 3-5) would be realized during this time.

Fish and Aquatic Life

If mine drawdown creates lower stream flows, or if dry weather reduces stream
37 flows, it is not clear what this will do to the chemical and mineral percentages in Swamp Creek and Wolf River towards meeting EPA standards.

38 The accumulation effect of stable chemicals that will build up in the stream beds and fish tissues over time is not adequately addressed.

It is not clear how far toxic materials will move downstream before settling
39 out or whether it will be a continuing gradual process that could continue well after the life expectancy of the mine.

The discussion of the effects on the aquatic environment of final shutdown or
40 periodic shutdowns due to low market prices or other factors is not adequately discussed.

The biological testing and fish sampling is not expected to be adequate for the preservation and protection of aquatic resources of interest to the Menominee Reservation. Monitoring and testing stations should be continued
41 down the Wolf River at least as far as the Reservation for a more accurate indication of pollution problems downstream, and if, in fact, they present a potential threat to Indian trust resources.

If there is a fish kill, Exxon's proposal to restock is not acceptable. The
42 cause of the kill needs to be addressed and corrected or else restocking would appear to have little benefit.

Hydrologic Impacts

Swamp Creek, a major stream in the local drainage system, flows in a westerly direction one (1) mile north of the ore body to Rice Lake on the Mole Lake Reservation. Rice Lake, considered one of the best wild rice producing lakes in the State of Wisconsin, is a vital part of the economic, social, and religious life and traditions of the Mole Lake Indian people. Therefore, environmental changes, caused by the mining and milling operations, in the local hydrology, run-off, and drainage patterns, affecting the water quality and quantity of Swamp Creek and Rice Lake, will have a significant impact on the Mole Lake Reservation. Water pumpage, water contamination, and contaminant storage are the main factors of concern.

Water Pumpage - The DEIS states that "pumping water from the mine would cause a drawdown of the groundwater in the area. Lowered groundwater levels would, in turn, cause increased seepage from lakes and decreased
43 groundwater flow into streams." Groundwater drawdown at the mine site is predicted at 40 to 50 feet at year 28 of the life of the mine. Changes of water quality, due to the groundwater drawdown, in the streams and lakes can also be expected to occur. Exxon has proposed a plan to mitigate declines in stream flows and lake levels. However, the DEIS is quick to

say that parts of this plan are not yet fully developed and that the (43) ability of the plan to completely mitigate all possible lake and stream impacts is unknown. This makes the validity of the mitigating plan described in the DEIS questionable.

Water Contamination - The proposed project will have several potential sources of water contamination. Many of the reagents used in the milling and water treatment processes are toxic. Chemicals such as methyl isobtyl carbinol (MIBC), xanthates, sulfuric acid, to name a few, are very dangerous because of their toxicity. Sodium cyanide is considered extremely hazardous. One major concern is the potential for spills during transportation and storage of those reagents and fuel. It is not (44) unrealistic to assume that there is a high probability that, during the projected 29 years of operations, at least one (1) serious spill could occur. A discussion of this possibility and a "spill program" describing procedures to prevent and cleanup any spills, including spills from process piping and overflow systems, should be included in the EIS. Spills may enter into the groundwater system or come into contact with the surface waters. Reagents spills which cannot be recovered and used in the (45) process will become "waste" and should be considered as hazardous materials. They may fall under hazardous waste regulations. Waste designated as hazardous has to be taken to a permitted hazardous waste facility.

Failure of a tailings pond or reclaim pond embankment is considered in the DEIS a low probability occurrence. But, what if an embankment were to break during the life of the operations? The DEIS states that "in the case of a major embankment failure, the immediate response would be to (46) take whatever measures are necessary to ensure public safety." Has Exxon developed a plan dealing with embankment failures? Does this plan contain preventative measures and steps to be taken to curb contamination of the ground and surface waters affecting the water quality of Hemlock Creek, Swamp Creek, and, eventually, Rice Lake?

Contaminant Transport - Transportation of contaminants can take place through surface water and groundwater. Surface waters, carrying contaminants and pollutants, will follow the natural drainage into local streams and lakes. Changes of water chemistry and hydrologic properties (including water gains and losses) of Swamp Creek and Hemlock Creek will have an important effect on the environmental conditions of Rice Lake (See Figure 1-20).

To approximate the behavior of the groundwater resource, computer models were used to analyze the potential groundwater impacts. The modeling indicated that under existing conditions (Figure 3-2) groundwater under the project area generally flows away from the proposed mine/mill site in the direction of Swamp Creek (to the northH) and Hemlock Creek (to the east). The general flow of the groundwater under the proposed tailings ponds (MWDF) is in southwesterly direction and to the east to northeast

towards Hemlock Creek. At year 28 (See Figure 3-4) the groundwater under the tailings ponds site will flow in easterly (to Hemlock Creek and northerly to northwesterly direction (to Swamp Creek) around the cone of depression at the mine/mill site.

The USGS/DMR vertical model (Figure 3-9) shows a discharge of groundwater from the tailings ponds (MWDF) area into Hemlock Creek.

Contaminants transported in the groundwater will be entering the Hemlock Creek and Swamp Creek and eventually end up in Rice Lake.

Observations and Conclusions - From the preceding discussion, the following observations and conclusions can be made:

(47) a. Danger of surface water and groundwater contamination exist.

(48) b. Swamp Creek and Hemlock Creek are important contributors to the environmental conditions of Rice Lake.

(49) c. Changes in the hydrologic parameter values of the project area will affect the quality and quantity of Swamp Creek and Hemlock Creek and, therefore, will have an impact on the environmental conditions of Rice Lake.

(50) d. To protect Rice Lake close monitoring of the water quality and quantity in the project area and of Swamp Creek is needed to detect changes and to correct any adverse effect caused by the changes.

Recommendations for Hydrologic Monitoring

To provide timely detection of environmental changes that may effect the Mole Lake Reservation and to ascertain compliance with environmental standards and regulations, the following actions are recommended:

(51) 1. The hydrology, possible impacts of changes of the hydrologic parameter values, and the mitigation plan proposed or still under development should be reviewed by an expert (e.g., Water Resources Division, USGS) who has the well-being of the Tribe and their concerns in mind.

2. Water sampling and monitoring should be performed at the following points (also shown on Figure 1-20):

(52) a. At the discharge point of Hemlock Creek into Swamp Creek to monitor the water quality on the upstream and on the downstream side of the confluence of the two (2) streams.

(53) b. Just before the discharge point of Swamp Creek into Rice Lake.

c. In Rice Lake between the entrance and exit of Swamp Creek.

(54) d. In the northern part of Rice Lake (outside the influence of Swamp Creek).

(55) e. Collecting and analyzing water samples should be done by a neutral party.

(56) 3. Active tribal involvement in the monitoring programs (including corrective actions to be taken if needed) to protect the quality and quantity of the water entering and leaving the Mole Lake Reservation.

Other General Comments

The magnitude and importance of the proposed mine in terms of increased domestic mineral supply and lessened import reliance for zinc and silver, in particular, and for lead, gold, and copper. As noted in the DEIS (pp. 2-3), this single project would increase domestic zinc production by more than 40 percent while substantially lessening the nation's dependence on zinc imports (which rose to 70 percent during the last two years). Likewise, domestic silver production would rise about 8 percent--silver imports were about 60 percent of apparent consumption in recent years--and domestic gold, lead, and copper production would rise by lesser percentages. The mine would have a dramatic impact on domestic base and precious metals supply.

(57) In the case of support facilities, the type(s) of coolant(s) and cooling system for the transformers to be used at the site primary substation should be discussed and measures to contain spills and leaks of coolant liquids should be addressed. (58) Underground tanks are to be used to store gasoline and diesel fuel. Measures to prevent leakage from these tanks should be included in the impact analysis.

Specific Comments

(59) Page 36. Specific organic process chemicals should be included in Table 1-13 with associated sample type and sample frequency monitoring requirements.

(60) Page 37. Bioassay procedures and organisms should be identified before permit issuance and should be directed at detecting chronic effects. The long-term character of this project suggests that chronic effects are much more likely than acute episodes.

(61) Page 41. Monitoring plans associated with the reclaim pond should include monitoring of organic process chemicals.

(62) Page 41. The terrestrial and wetland monitoring program as discussed is desirable but should incorporate nearby reference areas for comparative purposes. In the absence of such a reference system, changes that do occur cannot be interpreted and consequently may be erroneously attributed to the mining activity or to natural events.

(63) Pages 50-52. The Affected Environment contains an adequate description of the geological structure of the project site and orebody. We suggest a brief addition to this section noting any other mineral resources in the area (e.g., sand and gravel) that might be affected by the project.

(64) Pages 110-111. Geological impacts refer only to the bedrock. We suggest that any impacts to other minerals, such as sand and gravel, in the study area should be mentioned. (65) We believe it would be appropriate to refer here the discussion of the importance of the mine (mentioned earlier) that shows the significant impact the project would have on our nation's mineral supply.

(66) Pages 119-134. Contingencies related to groundwater mitigation plans should be more fully discussed. The exact degree of drawdown is not predictable and, consequently, cases worse than anticipated should also be considered. In particular, the goals of mitigation are fuzzy and should be clearly stated in (67) order to permit evaluation of the probability of success or failure of mitigation plans if groundwater depression is more severe than projected.

(68) Page 217. We support the provisions specified for mitigation/contingency surface water monitoring but recommend that intensive sampling be continued for at least the first eight years of operation when maximum changes will be occurring. After that time period, periodic monitoring should continue for the duration of the project, perhaps on a 3-year schedule.

(69) Pages 228-229. The options for wastewater disposal discussed on pages 228-229 are very attractive and deserve a more detailed discussion. Increased use of mine intercept water for mitigation closes a cycle and should be considered even if the water requires additional treatment before the release. likewise, using advanced treatment systems to polish wastewater for eventual groundwater discharge through injection or land disposal closes the water use cycle and should be given serious consideration despite its current high cost. Advances in technology may make this economically attractive.

U.S. Department of the Interior

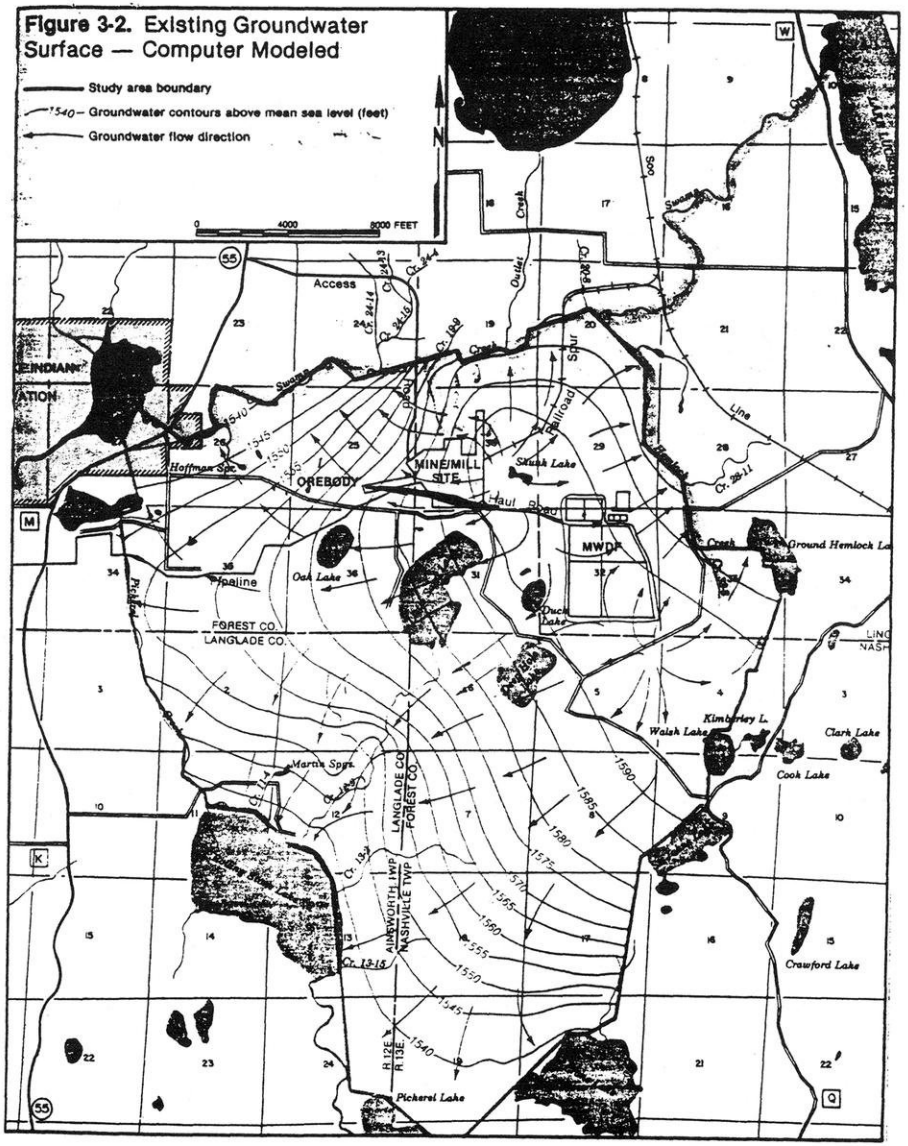
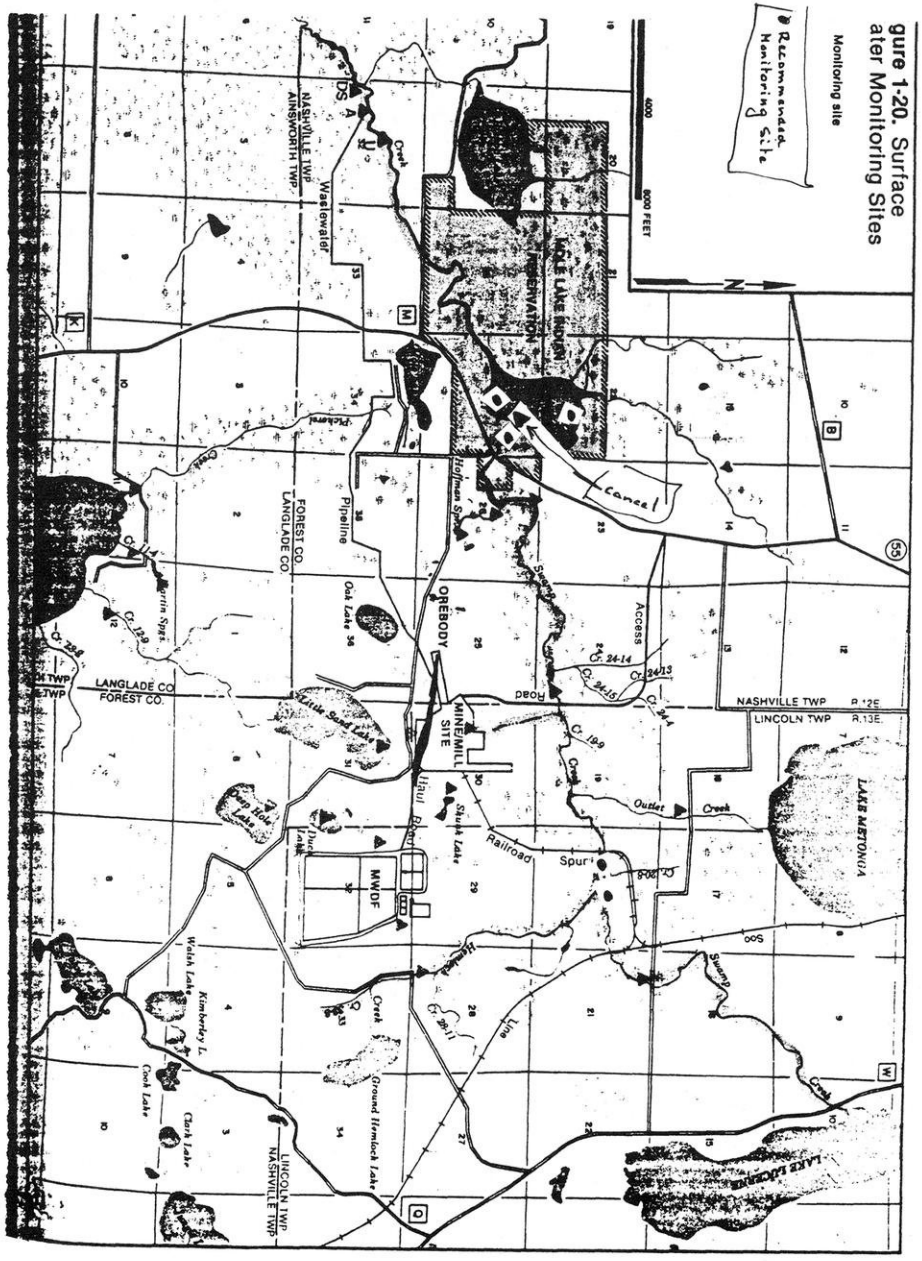
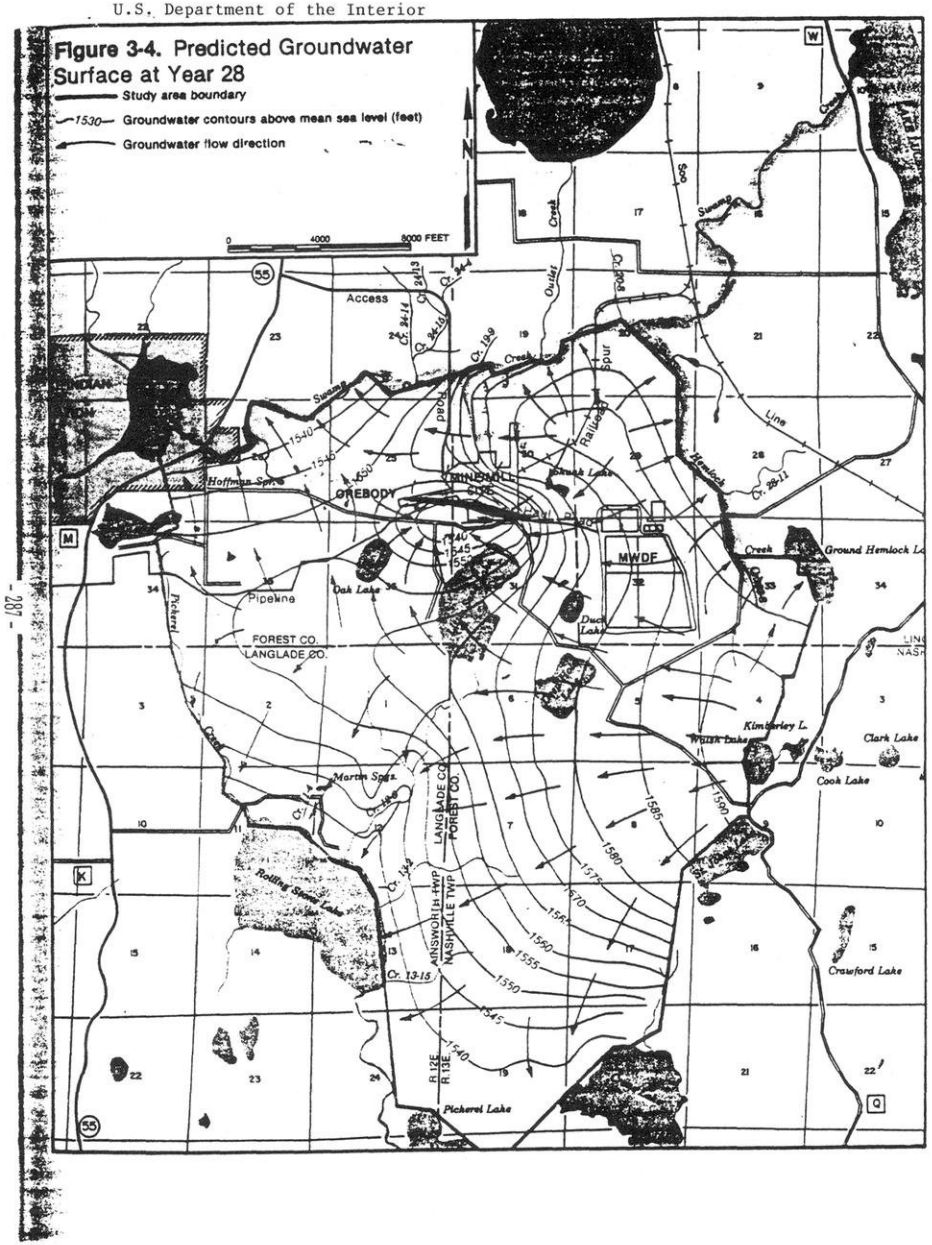


Figure 3-2. Existing Groundwater Surface — Computer Modeled



gure 1-20. Surface ater Monitoring Sites

U.S. Department of the Interior



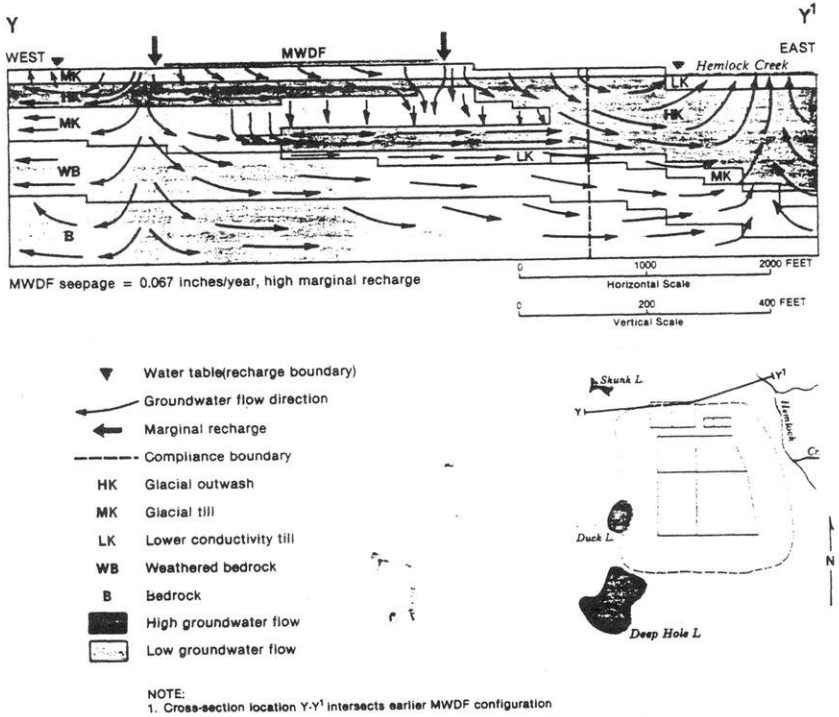


Figure 3-9. Groundwater Flow at MWDF as Predicted by USGS/DNR Vertical Model

COMMENTS & RESPONSES

United States Department of Agriculture

Soil Conservation Service

4601 Hammersley Road
Madison, WI 53711

MAY 14 1986

May 13, 1986

HSD

Howard S. Druckenmiller, Director
Bureau of Environmental Analysis & Review
Department of Natural Resources
Box 7921
Madison, Wi 53707

Dear Mr. Druckenmiller:

We have reviewed the Draft Environmental Impact Statement for the Exxon Minerals Company Zinc-Copper Mine, Crandon (Forest County), Wisconsin and have no comments to make.

Thank you for the opportunity to comment.

Sincerely,

Cliffton A. Maguire
State Conservationist

cc: T.A. Manning, SCS, Spooner, WI
P.D. Lindgren, SCS, Rhinelander, WI w/att.

The Soil Conservation Service is an agency of the Department of Agriculture

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U.S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101-1479

JUL 7 1986

REPLY TO ATTENTION OF

July 3, 1986

Construction-Operations
Regulatory Functions 86-026-0S

Mr. Howard S. Druckenmiller, Director
Bureau of Environmental Analysis and Review
Department of Natural Resources
P.O. Box 7921
Madison, Wisconsin 53707

Dear Mr. Druckenmiller:

We have completed our review of the Draft Environmental Impact Statement (DEIS) for the Exxon Minerals Company Zinc-Copper Mine at Crandon, Wisconsin. We appreciated reviewing a very understandable and readable document.

Our specific comments or questions are attached and primarily involve the proposed mitigation plan and social effects.

We note that the Corps Clean Water Act Section 404 jurisdiction is limited only to discharges of dredged material, or of fill material placed for the primary purpose of replacing an aquatic area with dry land or raising the bottom elevation of a waterbody. Neither wetland excavation or the disposal of mine wastes or tailings is regulated by the Corps under Section 404. Therefore, the scope of our jurisdiction in this case does not seem extensive. It appears that only some minor fills for road or rail crossings and segments of the mine waste disposal facility berms fall under the Corps individual-permit jurisdiction. Certain project fills, such as for minor road or rail crossings, and intake, outfall, and utility line structures may already be authorized under existing nationwide permits. The Corps regulatory scope is further limited here because construction method or location alternatives could allow features of the project to be built without Section 404 permits. We believe that the DEIS adequately addresses the effects of the proposal within the scope of our regulatory authority.

We look forward to reviewing the final document. If you have any questions please call Mr. Gary Elftmann at (612-725-7712) or Mr. David Ballman at (612-725-7772).

FOR THE COMMANDER

Enclosure

Wm. L. Goetz
Chief, Construction-Operations Division

St. Paul District, Corps of Engineers
Comments on DEIS, Exxon Minerals Company
Zinc-Copper Mine, Crandon, Wisconsin

(70) Page 39. Have the contingency plans as specified in N.R. 182.075(1)(c) for each of the five compliance boundary areas been developed? Will they be included in the FEIS?

(71) Page 43 and 133. It appears that the native brook trout population in Hoffman Spring Creek would be adversely affected by the proposal, even with mitigation. Does the DNR believe that a fish-stocking program and water augmentation constitute adequate mitigation? Has other mitigation/enhancement such as habitat improvement on Hemlock Creek or Swamp Creek, both of which contain native brook trout populations, been considered?

(72) Page 43. What criteria would be evaluated by the DNR in a request from Exxon not to activate the mitigation facilities? The EIS should explain the type of situation that could occur which would not require mitigation.

(73) Page 44. When will the ground intercept proposal be developed? Will it be presented in the FEIS?

(74) Page 68. The inclusion of Swamp Conifer, Shrub Swamp, Bog and Marsh, and Wetlands in the Terrestrial Ecology section is confusing. We suggest that a separate section such as Wetland Ecology be included in addition to Aquatic Biology and Terrestrial Ecology.

(75) Page 117. Since the design of the MWDF proposed by Exxon has changed why wasn't a USGS/DNR vertical model constructed for the new site?

(76) Page 119. Are worst-case impact scenarios for the mitigation plan being developed for presentation in the FEIS? This information seems vital before any decision regarding the proposal can be made.

(77) Page 135. If the proposed mitigation for Pickerel Creek and Hoffman Spring would not be effective, the modification discussed on page 238 should be evaluated and addressed in the FEIS.

(78) Page 137. Additional analysis for worst-case impact scenarios should be developed. It appears that there may be water available to mitigate only for the expected impacts. What would occur if the degree of impact is greater then expected?

(79) Page 145. Is any mitigation, either replacement or enhancement, being considered for the wetlands lost as a result of the project?

(80) Page 195. What time limitations would be placed on any DNR permits that may be issued? What type of review would be done before the permits could be reissued or extended?

(81) Page 216. Monitoring alternatives should be evaluated to allow for the best possible data base for monitoring project impacts.

(82) Page 237. Mitigation of Groundwater Drawdown Impacts - It appears that the alternatives could be expanded to determine if the impacts of the proposal could be further reduced.

Social Review of Exxon's DEIS for Crandon Mine-Mill

In general, the document is thorough in presentation of base conditions, project impacts, and assumptions. However, there is inadequate consideration of two related issues: induced industrial development and closure.

(83) Although impacts on the retail economy are shown to be insignificant (in comparison to the existing base), potential industrial development is discussed only in relation to the Mole Lake Reservation, rather than to the entire study area. The extent to which such secondary development will occur is critical to the distress which the local area will experience during the closure process.

(84) Closure itself is mentioned as generating impacts only in relation to the Native American communities, which certainly neglects the effects which the area as a whole will experience, with the loss of many hundreds of well-paying jobs after those jobs have been held for a generation or two.

(85) Also implied in discussion of the housing situation was the displacement of much of the tourist industry, as cottages are demanded for residential use by mine-workers; after closure, the demand for tourism may no longer exist.

(86) Physical capacity of public schools, which will have to be increased by many classrooms during the operation period, will be overextended after closure.

JUN 20 1986

United States Department of the Interior

BUREAU OF MINES

P. O. BOX 25086
BUILDING 20, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

Intermountain Field Operations Center

June 18, 1986

Howard S. Druckenmiller, Director
Bureau of Environmental Analyses and Review
Wisconsin State Department of Natural Resources
Box 7921
Madison, Wisconsin 53707

Dear Mr. Druckenmiller:

Thank you for the opportunity to review the Draft Environmental Impact Statement for Exxon Minerals Company Zinc-Copper Mine at Crandon, Wisconsin. Bureau of Mines comments will be included in the Department of the Interior's comments and will be forwarded to you by the Regional Environmental Officer in Chicago.

Sincerely yours,

William Cochran, Chief
Intermountain Field Operations Center

-290-

JUN 16 1986

Forest County Potawatomi Community, Inc.
Crandon, Wisconsin 54520

POTAWATOMI
(Keeper of the Fire)

COMMENTS

on the

DRAFT ENVIRONMENBTAL IMPACT STATEMENT: EXXON MINERALS COMPANY ZINC-COPPER MINE, CRANDON, WISCONSIN.

Prepared by
James P. Boggs, Ph.D. and Gene D. Linehan, Attorney.

For the
FOREST COUNTY POTAWATOMI MINING IMPACT COMMITTEE

June 12, 1986

I. Introduction.

The following comments are based on the understanding that the DEIS is part of larger regulatory process. It does not exist in a legal or policy vacuum.

Also, the DEIS does not stand alone in the sense that the data, analysis, and conclusions it presents rest, or should rest, on careful, state-of-the-art study and analysis. It would not be practical to include in the DEIS all of the methodological detail and substantive information on which its conclusions rest. Therefore this more detailed information is usually made available in "Technical Reports" for those people who are interested in it and request it. Since the DNR derived its conclusions presented in the DEIS from these Technical Reports, it is sometimes necessary to refer to them in commenting on the DEIS. I have not had available a copy of the Final Socioeconomic Impact Analysis, the Technical Report for the socioeconomic portions of the EIS studies, in preparing these comments, so I will use the draft, or Preliminary Socioeconomic Impact Analysis, which is dated July 1985.

II. The Utilization of the DEIS in DNR Decisionmaking.

What is the statutory and policy context in reference to which the DEIS should be evaluated and understood? The Wisconsin Environmental Policy Act (WEPA, Wis. Stat. 1.11) mandates state agencies to "Initiate and utilize ecological information in the planning and development of resource-oriented projects (1.11(2)(h) (emphasis added). "Ecological" in this context must be understood in its broadest sense to include socioeconomic information, since other sections of the statute require inclusion of socioeconomic studies. The purposes of WEPA

have been determined to include assuring "adequate consideration of environmental factors in the decision-making processes of state agencies before resources are irreversibly and irretrievably committed..." (Wisconsin's Environmental Decade, Inc., v. Wisconsin Dept. of Natural Resources (1983) 340 N.W.2d 168, 94 Wis.2d 263). The National Environmental Policy Act, on which WEPA is patterned, directs agencies to "utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences...in planning and decisionmaking which may have an impact on man's environment" (emphasis added).

The DEIS plays a critical role for an agency in discharging the statutory responsibilities mentioned above. Its purpose is to present in a readable, understandable way the information that the agency will use in its decisionmaking. So a major question in evaluating an EIS is how well it performs this function. Is the information it presents complete and useful? Is the information easy to understand, and its policy or decision-making implications not too obscure? Does the EIS leave the masses of tables and statistics in the technical reports, and present only the data most relevent to its analysis in readily comprehensible graphs or charts? In the socioeconomics section, does the DEIS describe possible impacts of the project on the people in the study area in human terms, and deal fairly but in a straightforward way with the difficult questions of equity that usually arise in connection with natural resource development projects.

Unfortunately, because of the way DNR interpreted its responsibilities under WEPA, it is difficult to evaluate the socioeconomic portions of this DEIS in relation to their intended functions. Despite the clear statutory language cited above, that WEPA intends the full range of information and analysis to be considered in decision making and planning, DNR still has insisted that it can or will use information gathered during the EIS study process only when it triggers some other "more substantive" (than WEPA) law. (Letters to DNR from Gene Linehan and James P. Boggs dated 1/21/86, 3/26/86, and 3/27/86; and replies dated 2/11/86 and 5/21/86. This administrative decision certainly seems to fly in the face of the language and intent of the law. It effectively excludes all of the social, cultural, and for many purposes the economic studies conducted for this project from playing an effective role in DNR's decisionmaking process.

The only other "substantive" law that could be triggered by socioeconomic data is Section 144.85(5)(a) Wis. Stats., which allows DNR to issue a permit only if "the proposed mine will not result in a net substantial adverse economic impact in the area reasonably expected to be most impacted by the activity."

However, all of the data and analysis on social and cultural impacts, much of the data on employment, social services and public facilities, data on values and traditions, and important historical pespectives developed by the research for the DEIS all are apparently excluded from the decision making process because there are no other laws that refer to these things.

The Potawatomi are naturally concerned about this, because socioeconomic impacts are probably the largest and most significant category of impacts we anticipate from this project if it goes ahead. DNR's approach to socioeconomic impacts means (87) that except for being studied, the tribe is effectively excluded from the review and planning process. Even though the tribe can offer comments like anyone else through the public comment process, and is a "party" to the Master Hearings procedure, any information we offer is apparently predestined to be ignored for planning purposes.

DNR has indicated the EIS itself is purely a "disclosure document," (presumably as opposed to one that will be used in decisionmaking). DNR's attorney has told the tribe (letter dated May 21, 1986) that the EIS will only "help the agency to make decisions called for by (other) statutes and codes...." Of course, any situation that calls for specific action under another statute will be responded to by the DNR under that statute. This is to point out the obvious, and does not constitute the effective integration into agency decisionmaking of either the broad range or possible interrelationships of effects that constitute the distinctive contribution of WEPA. WEPA presumably was not written nor passed by the legislature in order to facilitate agency compliance with existing statutes.

III. DNR's Treatment of the "Economic Impact" Clause.

The DEIS makes the claim that the mine will not cause a net adverse impact in the study area, and in fact that the net economic impact will be beneficial. This is one of those times, however, when we need to look beyond the DEIS's claims to the underlying technical analysis on which it rests.

The Denver Research Institute (DRI), DNR's socioeconomic consultants for this project, agreed in their earlier study plans to address this issue, after noting that Exxon's consultants had failed to do so. In DNR's revised study plan (May 24, 1984) DRI agreed to provide definitions for the various terms in the statutory test, and to outline some reasonable approaches to providing an answer for it (pp. 27-29).

In fact, however, DRI failed to address the issue. They state in the Preliminary Socioeconomic Impact Analysis (PSIA) that "In

our professional judgement, the test, specifying "...economic impact..." is confusing." This is hardly the professional judgement they were called upon to make! We do not want a "professional" critique of the statute.

88 Basically, then, DRI's and DNR's position at this writing is that the statutory test is impossible to address through study and analysis-- that the social sciences, and particularly economics, simply have nothing to offer in this context (except perhaps to provide reasons why it can't be done). We wanted a "second opinion" on this, and asked a respected resource economist, Dr. Thomas Power, to evaluate DRI's assessment. Power found DRI's conclusion that economics had nothing to offer "startling," and observed that "Economists have devoted a sigificant amount of effort over the last two decades developing the tools which would allow the economic evaluation of non-marketed goods and services" (Report to Mr. J.R. Holmes, Coordinator, Forest County Potawatomi Mining Impact Office, December 26, 1986, p. 2).

Basically, then, the conclusion presented in the DEIS that the project will have a net beneficial impact in the study area is not based on study and analysis. It simply represents an opinion by DRI and DNR. Their "common sense" tells them that of course a project of this type and magnitude will have a beneficial impact on the local area. This common sense opinion certainly is susceptible to challenge on equally common sense grounds: namely, that a great many mining communities across the country do not look exactly economically prosperous, especially those in which the operating mine has closed operations or pulled out.

Our main point, however, is that the statutory test has not been addressed in a systematic, interdisciplinary state-of-the-art way as required by law. We are not arguing at this point with the conclusion in the DEIS that the mine will have a beneficial impact in the local area. We are simply pointing out that this conclusion does not rest on adequate study and analysis. The necessary terms have not been defined operationally, and the necessary work simply has not been done for us to respond substantively.

DNR has "brushed off" Power's report with the observation that "His (Power's) professional judgment differs somewhat from that of DRI" (Letter from DNR to Linehan, May 21, 1986). We know that already; simply restating the obvious does not adequately address our concerns. The "judgement" in this case has not to do with the effect of the mine, but rather has to do with whether the social science professions have the methodological and conceptual tools to translate the statutory test into terms that the social sciences can work with (in other words, whether the legislative wording can be operationalized in some fashion), and whether a professionally defensible (not necessarily unassailable) way of

approaching the question can be devised. The social sciences meet these kinds of challenges daily. There simply is no question but that the social sciences have a great deal more to offer in this context than DNR has so far brought to bear on it.

IV. The Social Sciences and Native American Analyses.

DNR's administrative judgement that the social sciences would play no direct role in planning and decisionmaking (except in the case of the statutory test discussed above), has obviously played a critical role in the kind and quality of analyses obtained. DNR's decision early in the process not to integrate the social sciences into its planning and decisionmaking is revealed, among other ways, in the fact that not one of the "List of Preparers" of the DEIS (DEIS, p. 244) counts any of the social sciences as his or her area of expertise. If DNR had intended to use the information obtained, there should have been minimally a social scientist on staff to provide guidance to the consultants and to work with the information.

89 DNR and DRI actually cut out major portions of their researcher's analysis and information in preparing the Potawatomi portions of the Preliminary Socioeconomic Impact Assessment... (PSIA). The Potawatomi tribe has already submitted to DNR ten pages of detailed substantive analysis of the PSIA, that in part identifies the information that was deleted (submitted to DNR Nov. 28, 1985). Since the DEIS is considerably less substantive even than the PSIA, there seems little point in repeating this exercise for the DEIS analysis.

Nor is it the tribe's responsibility to do a proper study for DNR, nor even to map out a methodology or "table of contents" for such a study. To do so would seem especially futile when DNR has deleted from the PSIA a great deal of information that was already gathered and written up, that the Potawatomi Mining Impact Committee and Tribal Council reviewed, and which the tribe considers could be both pertinent and useful for planning purposes. We would like constructively to critique and supplement useful information that would be used. But we do not wish to spend scarce tribal resources to contribute further information or analysis in that way to what has become manifestly a pro forma process.

In sum, the gaps in data and analysis in both the PSIA and in the DEIS are not random; they do not result from lack of information or resources to do the work, and they do not by and large result from the absence of theoretical or methodological frameworks in the respective social sciences. They are the direct and predictable consequence of a seriously flawed procedure for implementing WEPA. Quite simply, DNR did not look for useful

information, because it recognized no statutory obligation to use it anyway. DNR did not know potentially useful information when they had it, because they put no one on their staff with the training or skills to recognize it, or to demand it, or to
(89) interpret it in usable fashion to non-social scientist administrators. The substantive weaknesses in the PSIA and in the DEIS must be seen in the context of the basic purposes and policy directives in WEPA. In that light, they can only be viewed as the outcome of fatal procedural flaws in DNR's implementation of the Act.

JUL 08 1986

STOCKBRIDGE - MUNSEE BAND OF MOHICAN INDIANS

STOCKBRIDGE - MUNSEE COMMUNITY

Route 1 Phone Bowler (715) 793-4111

BOWLER, WISCONSIN 54416

July 7, 1986

Mr. Howard S. Druckenmiller, Director
Bureau of Environmental Analysis and Review
Department of Natural Resources
P.O. Box 7921
Madison, WI 53707

Re: Stockbridge-Munsee Tribe's Comments on DEIS for Exxon Project

Dear Mr. Druckenmiller:

Enclosed please find the Stockbridge-Munsee Tribe's comments on the Draft Environmental Impact Statement Exxon Minerals Company Zinc Copper Mine Crandon, Wisconsin for the Department's consideration and response.

If you have any questions regarding this statement, please feel free to call. I look forward to the Final Report.

Sincerely,

David L. Besaw

David L. Besaw
Tribal Vice Chairman

DLB/ek

Enclos.

cc: Stockbridge-Munsee Tribal Council
Kim Vele, S/M Tribal Attorney
S/M Environmental Committee

STOCKBRIDGE-MUNSEE TRIBE'S COMMENTS ON THE
DRAFT ENVIRONMENTAL IMPACT STATEMENT
EXXON MINERALS COMPANY ZINC-COPPER MINE
CRANDON, WISCONSIN
(May 1986)

The following comments are based on a review of the DEIS only and not the supporting technical reports used as the basis for the Department of Natural Resources' conclusions in this report.

Comments

The Stockbridge-Munsee Community is a federally recognized Indian Tribe 47 Fed. Reg. 227 (Nov. 24, 1985) located in northern Wisconsin. The current reservation, which is located approximately 60 miles south, southwest of the proposed project site, was established by a Treaty with the United States Government in 1856. 11 Stat. 679. Approximately 16,000 acres inside the existing reservation boundaries is Tribal land whose title is held in trust status by the United States government. In general, the Tribe is most concerned about the potential impacts the mining activity will have on the Tribe's federally-protected treaty rights and land base. Unfortunately, the impact statement is void of any consideration to these issues as the specific comments which follow indicate.

1. The DEIS fails to recognize Tribal permitting authority. (pp. 3-4, DEIS). There are several reservations, including Mole Lake, Forest County Potawatomi, Menominee and the Stockbridge-Munsee which may have local (90) ordinances regulating the transportation of hazardous waste on the transportation corriders running through such reservations. Compliance with these lo cal ordinances would be required and should be included in the list of permits and approvals required for the project.

2. Subsequent to the publication of the DEIS, the Mole Lake Band of Chippewa Indians filed a land claims case. Does this involve land within the project (91) boundary as defined in Figure 1-3 of the DEIS and if so, how will this legal action affect such boundary lines?

3. The DEIS fails to identify contingent plans for the emergency repair of broken pipelines which will be used to pump waste to Swamp Creek. (p. 26, (92) DEIS). Given the potentially adverse impacts on the ground and surface water in the event such pipelines burst, Exxon should be required to develop such emergency plans.

4. Landscaping maintenance will include the use of fertilizers. (p. 27, DEIS) Specific chemicals used for this purpose are not identified in the report (93) and neither are the environmental impacts. This violates the provisions of the National Environmental Policy Act and should be considered in the final impact statement.

5. Airborn dust is recognized as an impact (p. 27, DEIS), but the impacted area being considered does not adequately address areas outside the arbitrary boundaries established in the DEIS. Mining impacts in the western United States have been reported as far as 50-60 miles from mining sites. The Department of Natural Resources was far too conservative to consider a (94) radius of approximately 5 miles as the impacted area. (p. 52, DEIS) Since the Stockbridge-Munsee Reservation is within 60 miles of the proposed project, the Tribe requests that the Department examine in more detail potential impacts in areas up to 60 miles from the mining site. That would be a far more realistic analysis of the impacts the mining activity will have on the surrounding environmental ecosystems.

6. Some of the wastes and/or chemicals used in the project will be transported on the Soo Line. The Soo Line runs through the Stockbridge-Munsee Reservation. Unfortunately, the DEIS fails to address the potentially adverse impacts resulting from increased use of this line, and potential spills from such transportation. Since an unforeseen accident could have (95) substantial impacts on the Stockbridge-Munsee Reservation and the exercise of treaty rights on the reservation, the Department's failure to consider these impacts is in violation of the policies behind the National Environmental Policy Act as well as other federal laws protecting such Tribal interests.

7. The tailings ponds, landfill, and reclaim pond pose the greatest potential for groundwater contamination. (p. 38, DEIS) The groundwater compliance boundaries are sufficient to detect immediate groundwater contamination, but (96) the Department has failed to consider and develop a monitoring plan which will detect cumulative impacts on ground and surface water well beyond the arbitrarily defined impact and project site areas.

8. The terrestrial ecology monitoring program only monitors impacts within three miles of the mine/mill site. (p. 41, DEIS) This appears insufficient in that cumulative impacts outside these boundaries could conceivably result (97) in a substantially adverse impact. This impact/monitoring area should be substantially increased to cover areas not immediately adjacent to the mining site.

9. The mitigation/contingency measures are only required if it is first determined that the activity causing "unreasonable detriment to the public or private water supplies" is "mine-related." (p. 43, DEIS) This will (98) precipitate extended legal debates over what is or is not "mine related." Moreover, Exxon is not clearly liable for any damage to the environment which may impact the exercise of Tribal treaty-rights. This potential issue should have been examined more closely in the DEIS and incorporated in any contingency plans.

10. One of the inlets to Rice Lake is Swamp Creek, a water body which will receive much of the effluents generated from the mine's wastewater treatment facilities. The DEIS (p. 59) states that Rice Lake "...supports extensive beds (99) of Wild Rice." The use and maintenance of Wild Rice beds is a treaty-protected right for the Chippewa Bands in Wisconsin, yet the DEIS

fails to consider the cumulative impacts the discharged effluents will have on such rice beds. If a result of these discharges is to destroy the (99) natural ricebeds, the decision to grant Exxon the permit may constitute a state abrogation of a treaty-protected right for the Chippewa Indians. Such a result constitutes a substantial and adverse impact and should be treated as such. Instead, the Department ignores this issue altogether.

11. A wide variety of birds and mammals will be traveling throughout the impact area. (pp. 70-72, DEIS) Thus, the ingestion of chemicals used in the mining project may be transported by such birds and mammals far beyond the (100) arbitrary boundaries used to define the impacted area. The DEIS should consider such potential impacts in this broader perspective before making any decisions on whether to license the project and its support facilities.

12. The impact of vibrations created from the mining activity are analyzed in in terms of human responses and impacts. (p. 74, DEIS) The Department (101) should require an analysis of the impacts this will have on wildlife habitat.

13. Some of the property needed to conduct the mining consists of county forests. Some Tribes have off-reservation treaty rights in the public areas within the ceded territory. The replacement of county forest lands with other public lands results in a net loss of land from public use which (102) results in a net reduction of land available for the Chippewas' exercise of of their treaty rights. (p. 148, DEIS) The Department has failed to provide any legal analysis of the impact this process has on treaty-protected rights to hunt and fish these public lands.

General

In general, the three areas which could substantially and adversely impact the environmental integrity of the Stockbridge-Munsee Tribe's land base and treaty rights are groundwater contamination, air quality, and transportation of hazardous wastes through the reservation. The DEIS fails to adequately consider the direct impacts the project will have on treaty rights of Tribes in immediate proximity to the proposed project much less consider the treaty rights of Tribes such as the Menominee and Stockbridge-Munsee Tribes outside the arbitrarily defined impact area.

COMMENTS & RESPONSES

JUL 14 1986

Menominee Indian Tribe of Wisconsin

P.O. Box 397
Keshena, Wisconsin 54135

Telephone
1-715-799-3341

July 7, 1986

Mr. Howard S. Druckenmiller, Director
Bureau of Enrivonmental Analysis and Review
Department of Natural Resources
P. O. Box 7921
Madison, WI, 53707

Dear Mr. Druckenmiller:

Enclosed herewith are the comments of the Menominee Indian Tribe on the DEIS for the proposed Exxon Mine.

Sincerely yours,

MENOMINEE INDIAN TRIBE

By: _____
Rita Keshena,
Attorney for the
Menominee Indian Tribe

enc

RK/sy

MENOMINEE INDIAN TRIBE
PRELIMINARY COMMENT
ON THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
DRAFT ENVIRONMENTAL IMPACT STATEMENT
EXXON MINERALS COMPANY ZINC-COPPER MINE
CRANDON, WISCONSIN

Rita Keshena
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Box 397
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715-799-3860

1. The DEIS has failed to give any consideration to the (103) Menominee Tribe's substantial interests which may be adversely affected by Exxon Mining Project.

The DEIS fails to mention the possibility of Exxon's proposed mining project adversely affecting the Menominee Tribe and its resources. The Tribe asserts that this is a serious omission and submits the following supportive comment:

The Menominee Reservation is located in northeastern Wisconsin and has boundaries coterminous with those of Menominee County. The area which is occupied by the Menominee Tribe has been the home of the Menominee since time immemorial. The Treaty of Keshena Falls (May 12, 1954; February 1856) established the present reservation boundaries with 225,734.95 acres currently held in trust and 8,166.64 acres of non-trust land administered by the County.

The population, while scattered throughout the reservation is primarily concentrated in five communities: Keshena, Neopit, Zoar, South Branch and Legend Lake. According to the East Central Wisconsin Regional Planning Commission the 1985 reservation population is estimated to be 4,001.

Physiographic characteristics include relatively flat plains mixed with low-rising hills and generally north-south ridges. Granite outcroppings are evident throughout the reservation specifically along the Wolf River. Glacially deposited material rich in sands and gravels characterize the overburden as it does in much of Wisconsin. Wet lands and peat bogs are extensive and surround many of the reservation's 130 lakes, numerous rivers and streams.

(103) Water is perhaps the most critical component of the reservations natural resource base. Fortunately, the area contains ample supplies of good quality water and there is little chance of depleting this valuable resource. All totaled, there are 187 streams ranging in size from small ephemeral streams which flow throughout the spring and summer to the Wolf River; one of the state's major waterways and a component of the Wild and Scenic River System.

In 1968 a segment of the Wolf River from the Langlade County line to about 1 mile above Keshena was designated as a Scenic River by the National Park Service. The miles of river that are designated as Scenic remain free of impoundments, are largely undeveloped and contain few access points for motor vehicles. Water quality is very high with above average hardness. Dissolved organic materials often cause the water to appear brown and the river is well known for excellent trout fishing. The river is also a popular site for white-water rafting and canoeing.

The Menominee continue to hold the natural resources located within the reservation in the highest esteem. Their concern has been evidenced by past and present involvement in all aspects of responsible natural resource management. The Tribe's commitment to the high quality of the Wolf River is just as important as other goals and values of the Tribe. In fact, the spiritual and cultural value to maintain the present water quality of the Wolf River may transcend state or federal standards.

2.

Additional comments are offered which refer to sibsidence, water quality impacts, and impacts to fish.

SUBSIDENCE

1. Potential effects of surface subsidence are briefly discussed on page 192 of the Draft EIS. The discussion indicates that the maximum (104) possible surface subsidence is less than six inches, and that the affected area should be limited to the surface area directly over and/or adjacent to the mine. The methods used to assess possible subsidence effects are not identified. The EIS should identify the source of subsidence projection, the methods used to project subsidence, and the extent of the affected area.

2. Although the amount of surface subsidence is projected to be small, subsidence fractures may increase the vertical hydraulic conductivity of affected strata and may increase the effects of mining upon overlying (105) ground water systems. The potential impact of subsidence upon hydrologic systems is not analyzed or discussed in the EIS. The EIS should discuss the possible effects of subsidence upon surface and ground water systems.

3. Subsidence prediction is not an exact science. Several years ago at the Henderson Mine in Colorado, subsidence fractures propagated through several thousand feet of bedrock to form a glory hole at the surface. This occurred during active mining operations at a mine predicted to have (106) no surface subsidence effects. This example illustrates the uncertainty of subsidence prediction, particularly in an area with no prior mining experience. Surface monitoring should be required to verify subsidence projections. Appropriate contingency measures could then be required should subsidence projections prove inaccurate.

3.

WATER QUALITY IMPACTS

1. The Draft EIS assesses surface water quantity and quality impacts as independent effects and fails to consider their combined impacts. The water quality projections shown on Table 3-21 are based upon existing low
(107) flow conditions. On Table 3-11, the EIS indicates that stream-flow would be reduced as a result of mining. This would reduce Swamp Creek's ability to dilute effluent discharges and would increase the projected chemical concentrations. Water quality changes should be projected using the reduced streamflows predicted earlier in the EIS.

2. Exxon's stream mitigation plan would provide for the maintenance of recommended minimum streamflows. Ground water from several wells would be utilized for augmenting streamflow. Augmentation would decrease the
(108) effect of streamflow reduction but could also alter background stream chemistry. Water quality changes resulting from the discharge from the waste water treatment plant should be projected with and without streamflow mitigation.

3. The water quality impacts provided in Table 3-21 are based upon average effluent flow (2.9 cfs). However, maximum effluent flow rates are approximately 50 percent greater (4.46 cfs). Discharges at the maximum effluent rate would
(109) have a greater impact upon water quality. Although maximum effluent rates would occur infrequently, the impact could be significant if concentrations acutely toxic to aquatic life are reached. Water quality projections should be provided using both the maximum as well as the average effluent rates.

4. Uncontaminated ground water intercepted by the mine would also be discharged to Swamp Creek. The EIS should discuss anticipated water quality effects from
(110) this discharge.

IMPACTS TO FISH

1. Several of the chemical parameters contained in the projected effluent discharge (Table 3-21) are toxic to aquatic life. Although the impacts to fish discussion (p. 141-142) considers trace metal bio-accumulation in macroinvertebrates and fish, the potential for fish
(111) toxicity is not discussed. This discussion may have been omitted because projected concentrations would be well below toxic levels. However, under reduced streamflows and maximum effluent rates concentrations could be higher than currently predicted. Table 3-11 should be
(112) expanded to identify chronic and acute concentrations for those parameters toxic to fish.

Respectfully submitted,

7/1/76

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MENOMINEE INDIAN TRIBE OF WISCONSIN

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June 19, 1986

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Madison, Wisconsin 53707

Re: Public Intervenor's Comments on the Draft Environmental Impact Statement

Dear Mr. Druckenmiller:

Enclosed are three copies of the Public Intervenor's written comments on the Wisconsin Department of Natural Resources Draft Environmental Impact Statement. Along with the comments prepared by the Public Intervenor, there are two consultant reports which are incorporated as part of my comments. One report is on the groundwater impact by Dr. Douglas Cherkauer. The other is a comment on the surface water effects by Dr. Arthur Brooks.

The office reserves the right to respond to comments made by other participants before the close of the comment period.

Sincerely,

Waltraud A. Arts

Waltraud A. Arts
Public Intervenor

WAA:pl

Enclosures

Comments on the
Wisconsin Department of
Natural Resources' Draft
Environmental Impact Statement

Waltraud A. Arts
Special Public Intervenor for Mining

June 19, 1986

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INTRODUCTION

A. The Law

The Draft Environmental Impact Statement (DEIS) is the Department of Natural Resources' (DNR) attempt to comply with sec. 1.11, Stats., which requires DNR to prepare a detailed statement of the effects of underground zinc-copper mining and milling on the quality of the human environment. The law sets some minimum standards for the DNR in that the statement must include:

> 1. The environmental impact of the proposed action;
>
> 2. Any adverse environmental effects which cannot be avoided should the proposal be implemented;
>
> 3. Alternatives to the proposed action;
>
> 4. The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and
>
> 5. Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented;
>
> 6. Such statement shall also contain details of the beneficial aspects of the proposed project, both short-term and long-term, and the economic advantages and disadvantages of the proposal.

Sec. 1.11(2)(c), Stats.

Section 1.11, Stats., known as "WEPA" is the legislature's mandate that environmental regulators, such as DNR, consider the environmental consequences of their actions.[1] Wisconsin courts have also interpreted WEPA as mandating public participation in agency decision-making:

1/ The statement of purpose is found in the session laws, at sec. 1, ch. 274, laws of 1971:

> SECTION 1. LEGISLATIVE PURPOSE. (1) The purposes of this act are to declare a policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; and to enrich the understanding of the important ecological systems and natural resources.
>
> (2) The legislature, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of this state, in cooperation with other governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations.
>
> (3) In order to carry out the policy set forth in this act, it is the continuing responsibility of this state to use all practicable means, consistent with other essential considerations of state policy, to improve and coordinate plans, functions, programs, and resources to the end that the state may:
>
> > (a) Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

(Footnote Continued)

COMMENTS & RESPONSES

The purposes of WEPA are basically twofold. First, the Act is designed to ensure adequate consideration of environmental factors in the decision-making processes of state agencies before resources are irreversibly and irretrievably committed. Hanson, Agency Decision-making Under the Wisconsin Environmental Policy Act, 1977 Wis. L. Rev. 111, 115-17. "The evident purpose of WEPA was to effect an across-the-board adjustment of priorities in the decision-making processes of agencies of state government." WED III, 79 Wis.2d 409, 416, 256 N.W.2d 149, 153. Second, the Act is designed to get information on proposed actions before the public and other state agencies. Hanson, supra at 117, 121. In this respect, WEPA's model Act, the National Environmental Protection Act (NEPA), 42 U.S.C. secs. 4321 et seq., has been called, "an environmental full disclosure law." Environmental Defense Fund v. Corp of Engineers, 325 F. Supp. 749, 759 (E.D. Ark. 1971), injunction vacated and case dismissed, 342 F. Supp. 1211, aff'd. 470 F.2d 289 (8th Cir. 1972), cert. den. 412 U.S. 931 (1973).

Wis. Environmental Decade, Inc. v. DNR, 94 Wis. 2d 263, 271, 288 N.W.2d 168 (Ct. App. 1979). This mandate follows the reasoning of the Wisconsin Supreme Court. Wisconsin's Environmental Decade v. Public Service Commission, 79 Wis. 2d 409, 414, 256 N.W.2d 161 (1977).

(b) Assure safe, healthful, productive, and aesthetically and culturally pleasing surroundings;

(c) Attain the widest range of beneficial uses of the environment while attempting to minimize degradation, risk to health or safety, or other undesirable and unintended consequences;

(d) Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

(4) The legislature recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment.

What WEPA requires, therefore, is that in the zone likely to be affected by agency action, citizens have an interest in knowing the consequences of agency regulatory action, the alternatives to the actions being proposed, and to participate in the decision-making process. These goals of WEPA depend, in the first instance, on an adequate disclosure of impacts, the environmental full disclosure, so that alternatives can be explored and the public can participate. Without that full disclosure the other goals of WEPA, that a good hard look be taken at the project and that alternatives be considered where there is a resource conflict, will fall by the wayside.

WEPA is nothing less than a "broad statement of governmental commitment to the protection and enhancement of the environment." Wisconsin's Environmental Decade, 79 Wis. 2d 409 at 414. The procedure required by WEPA must be utilized in the agency's decision making process in order to fulfill the requirements of the statute. This includes a disclosure of all potential environmental impacts which can be reasonably predicted and a discussion of the alternatives to those impacts.

The action enforcing portion of the statute is found at sec. 1.11(2)(c), Stats.:

. . . all agencies of the state shall:

(c) Include in every recommendation or report on proposals for legislation and other major actions significantly affecting the quality of the human environment, a detailed statement, substantially following the guidelines issued by the United States council on environmental quality under P.L. 91-900, 42 U.S.C. 4331. . . .

The EIS is a public disclosure document of all the potential environmental impacts which may reasonably be predicted will occur from a proposed action, and a discussion of the alternatives thereto. Calvert Cliffs Coordinating Committee v. Atomic Energy Commission, 449 F.2d 1109 (D.C. Cir. 1971); Atchison, Topeka, and Sante Fe v. Callaway, 431 F. Supp. 722, 727 (D.C. D.C. 1977); Realty Income Trust v. Eckerd, 564 F.2d 447 (D.C. Cir. 1977); Monroe Co. v. Volpe, 472 F.2d 693, 697 (2nd Cir. 1972); Natural Resources Defense Council v. Morton, 458 F.2d 827 (D.C. Cir. 1972); M.P.I.R.G. v. Butz, 541 F.2d 1292 (C.A. Minn. 1971); Trout Unlimited v. Morton, 509 F.2d 1276 (C.A. Idaho 1974); Jones v. District of Columbia Redevelopment and Land Agency, 499 F.2d 502 (D.C. Cir. 1974).

Social and economic consequences also, in addition to environmental costs, are to be considered in the EIS process. Sec. 1.11(2)(c)6., Wis. Stats. Revised Guidelines for the

Implementation of the Wisconsin Environmental Policy Act ("WEPA Guidelines") at p. 15; 40 C.R. 1500; Calvert Cliffs v. Atomic Energy Commission, supra, at 1113; McDowell v. Schlesinger, 404 F. Supp. 221 (D.C. Mo. 1975).

One of the purposes of the EIS is to inform the public, legislature and courts; the EIS is a full disclosure document. Monroe County v. Volpe, 472 F.2d 693 (2nd Cir. 1972); Realty Income Trust v. Eckerd, supra, at 727; Scientists Institute for Public Information v. Atomic Energy Commission, 481 F.2d 1079, 1091 (D.C. Cir. 1973); Environmental Defense Fund v. Froehlke, 473 F.2d 346 (8th Cir. 1972); Alabama v. Corps of Engineers, 12 E.R.C. 1888, 1891 (N.D.A. 1979); Environmental Defense Fund v. Corps of Engineers, 325 F. Supp. 749, 759 (E.D. Ark. 1971); McGarity, Thomas O., "The Courts, the Agencies and NEPA Threshold Issues," 55 Texas L.R. 805 (1970).

The consideration of secondary or indirect impacts are an essential part of the WEPA EIS process.[2] M.P.I.R.G. v. Butz, supra, at 1322; Hanley v. Mitchell, supra, at 647; S.I.P.I. v. A.E.C., 481 F.2d 1079, 1087 (D.C. Cir. 1973); Port of Astoria v. Hodel, 5 ELR 20657, 20659 (D. Ore. 1975); National Wildlife Federation v. Coleman, 529 F.2d 359, 365 (5th Cir. 1976); Lathan v. Volpe, 350 F. Supp. 262, 266, vacated and remanded on other grounds, 455 F.2d 1111, modif. on reh. 455 F.2d 1122 (W.D. Wash. 1972); McDowell v. Schlessinger, 404 F. Supp. 221 (W.D. Mo. 1975); See also Enk, Beyond NEPA (1973); Anderson, NEPA in the Courts (1973); Yarrington, "NEPA," 4 BNA Env. Report 29, Monog. 17 (1974); Lynch, "The 1973 Council on Environmental Quality Guidelines," 11 Cal. Western L. Rev. 297 (1974); and Nunn, et al., "The Adequacy of Environmental Impact Statements," 27 S.W.L.J. 630 (1973).

B. General Comments

The DEIS fails the "full disclosure" test mandated by the law. It fails mainly because it deals with impacts in a tunnelvision, fragmented fashion rather than drawing together system impacts which are at the heart of the WEPA requirements. The problem is not stylistic, but substantive in that the DEIS fails to consider how the separate actions impact a unitary environment.

---

2 Because of the extremely close parallel between NEPA and WEPA, federal court decisions under NEPA can be highly instructive for state court interpretation of WEPA. Wisconsin's Environmental Decade v. Public Service Commission, 69 Wis. 2d 1, 16, 230 N.W.2d 243 ("WED I"); Wisconsin's Environmental Decade v. Public Service Commission, 79 Wis. 2d 161, 174, 255 N.W.2d 917 ("WED II").

The area where this becomes most obvious is in the water problems. There are ground and surface water components of the impacts. DNR's analysis uses a facility by facility organization, i.e., what is the effect of mine waste storage, effluent discharge, pumping the underground mine, etc. After describing the effect of the facility, DNR fails to take the next logical and necessary step, drawing the impacts together and describing the system impacts of the project. The public cannot combine the impacts and make professional judgments on the long and short term effects on the environment. The DEIS fails to make system-wide judgments and without these judgments the statutory test is not met.

(113)

Another way the DEIS fails is that there is inadequate analysis to support many of the conclusions reached. For example, the DNR concludes mitigation of surface water impacts from mine pumping will adequately protect public rights, while in the same breath admitting the DNR has not concluded its own analysis of lake and stream drawdown, has not analyzed the impacts of the additional pumping for mitigation, and has not received a completed mitigation plan from the applicant. How can DNR conclude mitigation would be adequate under these circumstances?

(114)

This brings up another general comment on the judgments drawn in the DEIS; they are overly optimistic. The DNR appears to be downplaying the effects, especially combined effects of the project to the advantage of the applicant. Reading the document leaves the impression that there will be no adverse environmental consequences which is nonsense. The groundwater effects of storing mine wastes is such an instance. The DNR makes a prediction of no exceedance of standards at a compliance boundary based on modeling which is not calibrated and cannot be verified. This prediction is made despite the fact that DNR is currently doing a major revision in its own modeling analysis of groundwater contamination. How do they arrive at such an optimistic judgment if the modeling is not reliable?

(115)

A fourth general comment is that the DNR does not make clear when it is relying on data it has gathered and analyzed, versus Exxon's data and analysis. The reader is not aware of the verification, or lack of verification, done by DNR on particular issues. For example, DNR has done significant independent work on modeling groundwater pumping effects on surface waters, but has done much less on wetland impact analysis. Reading the DEIS does not tell you when verification of Exxon's data has been done nor does it tell you how the verification was done.

(116)

The verification issue points out another problem in analyzing the Crandon Project: there are different levels of uncertainty attached to various project impacts. There are some impacts, such as a description of the groundwater inflow into the mine which has a greater degree of certainty in prediction than

(117)

does an issue like movement of contaminated water out of the tailings disposal area to the groundwater. The DEIS does not
(117) differentiate between predicted impacts which have a high level of certainty and those with great uncertainty. This makes it impossible for the public to assess the risks associated with various project activities.

The subject of risk assessment brings up a final general criticism of the DNR's approach: there is no prioritization or departmental judgment made on which activities are likely to be the most environmentally significant, either in the short-term or
(118) long-term. The DEIS carefully omits departmental judgments on this question, yet this is the sort of evaluation the public needs in order to assess the project. Too much is left for the reader to piece together, while the DNR's views are buried behind disjointed technical treatments of separate facility impacts.

The remainder of my comments will be addressed to specific sections of the DEIS. Dr. Douglas Cherkauer, a hydrogeologist, has prepared comments of the groundwater impacts of the project which he incorporated as part of the Public Intervenor's review of the document. Dr. Arthur Brooks' comments on the surface water sections are also incorporated by reference.

These comments are submitted for two purposes: first, to begin the disclosure of impacts so the Final Environmental Impact Statement will give the public the information to evaluate what the Crandon Project means environmentally to Wisconsin, both positively and negatively, and second, to alert the DNR that the permitting proceeding to be held early in 1987 will require the DNR to minimize all risks of the project and to place the risks of uncertainty on Exxon Corporation, rather than on the public.

Rather than following the disjointed organization of the DEIS, these comments will attempt to pull together impacts in a more comprehensive approach. The reader of the DEIS must often go to numerous places in the document to understand a particular project effect. This is particularly difficult for citizens who are unfamiliar with the Project details, and the DNR should write its final statement in a more coherent fashion.

PROJECT PERSPECTIVE

This section deals with the estimated value of the minerals in the Crandon Deposit. In order to make the value clear, at least in current dollars, a calculation should be made of the absolute value of the metals. Professor Eugene N. Cameron, an
(119) emeritus professor at the University of Wisconsin-Madison, made such a calculation in his March 17, 1986, letter to the Public Intervenor which has been forwarded to DNR. His calculation is over four billion ($4,000,000,000.00) for the absolute value of the metals. Table 1-1 on page 2 of the DEIS should be modified to provide this information.

Professor Cameron also makes additional comments regarding the instability of the metals market. This analysis should be
(120) added to the listing of uses on pages 2-3 so that the public will understand that metals mining is a highly unstable undertaking historically and in the present.

There is a description of Exxon's plan to mine the zinc massive ore first (years 1-16) and the copper stringer ore second (years 17-29). This is significant when coupled with the uncertainties of metal mining and the fact Exxon is not required to mine the copper stringer ore. What is the effect
(121) environmentally if the stringer ore is not mined? Will the resource be recoverable later if Exxon takes the massive ore and quits its operation? The 10% figure used on page 7 for the amount of ore left in place is far too low if the stringer ore is left.

WATER SYSTEM EFFECTS
A. Effluent Discharge

The most direct surface water impact is the effluent discharge into Swamp Creek. This subject is dealt with in greater depth in a report submitted by Dr. Arthur Brooks, but it is generally predicted by DNR that Exxon can meet the water quality criteria set for Swamp Creek. What the DEIS does not do,
(122) however, is analyze the impact of a proposed thirty year discharge of this sort on the Wolf River watershed. The position that because an activity can meet a permitting standard, there is no impact, is untenable and illogical. The pollutants will go somewhere and impact analysis must be done on this question.

Swamp Creek, at the point where the effluent will be put in, supports a warmwater fishery with thirty-one species of fish identified (p. 61). There are very low levels of metals in the fish tissue at present (p. 61).

(123) DNR's impact analysis (p. 140-142), does not state how much effluent was used as the basis of the analysis. Assuming an appropriate discharge figure was used, the impact analysis is inadequate because it assumes the metals will remain in dissolved
(124) form and "under equilibrium conditions", while admitting bioconcentration is a possibility (p. 141, 142).

It is hard to support a conclusion of "no impact" to Swamp Creek when under low flows the heavy metals would be three times the concentrations before the discharge (p. 142). DNR's
(125) reasoning rests on a faulty premise which they use to bootstrap themselves into a "no impact" conclusion. Meeting a permitting standard is not equivalent to no impact, but DNR consistently takes this approach.

(126) The fishery impacts are inadequately analyzed for Swamp Creek and the Wolf River. There will be bioconcentration of

metals in the benthos and in the bottom sediments. No consideration of these effects is provided nor any analysis of (126) where the metals will go. Without consideration of these factors, the impacts cannot be known.

The discharge is estimated to be 1200 gpm but it is unclear whether this is the maximum discharge which will be permitted (p. (127) 17). While emphasizing that the effluent is not process water, DNR does not estimate how much process water will be released and how often this might occur (p. 16).

During construction, polluted water will be generated and the water treatment plant will not yet be available to treat the water (p. 24). How will the DNR guarantee that this water, 6.5 million gallons, can be held until the water treatment plant is (128) ready (p. 115)? Since the construction activities go in simultaneously, it is possible delays could result in a discharge of contaminated water (Figure 1-15). Mine development should not be permitted until water treatment is available (p. 24, Figure 1-15).

Reclaim ponds are part of the water treatment system for the project (p. 18). The proposed design is of one pond with a dike creating two cells (p. 18, 25). These cells hold very contaminated water from the mill and serve, according to the (129) DEIS, as part of the water treatment system. The nature of the "biological, physical and chemical" changes which occur in these cells is not explained (p. 18). It needs to be explained so that the 140,000 cu. yds. of sludge from these cells can be evaluated before being dumped into the last tailings pond.

The proposed design of the reclaim pond should be modified to provide a safer and more flexible design. A two-pond design with each cell being separately constructed would present fewer (130) risks of failure and more operations and maintenance options. The two-pond design was proposed and then withdrawn without explanation by Exxon. The original design should be reinstated to assure less risk in the functioning of the water treatment system.

B. Mitigation Discharge

The second type of discharge which will have an environmental impact is the discharge of mitigation water into area lakes and streams. This discharge is necessary because without it, there will be unacceptable detrimental impacts to surface water bodies due to mine pumping (p. 120, 129). Basically, the surface waters in the area are intimately connected with the groundwater, with the exception of Oak Lake, which is perched.[3] The lakes will lose additional water when pumping begins and stream flows will be reduced since most of the streams are groundwater discharge areas. In their natural state, the area lakes have levels of metals below detectable limits as

do the streams (p. 58-64). In addition to these lake/stream effects, area wetlands will be impacted by the drawdown.

The DEIS fails totally in its analysis of this question (p. 119-137). First of all, DNR has not analyzed the worst case for lake drawdown (Cherkauer). The tables and information presented on lake impacts in the DEIS deal with the expected (or middle (131) range) case for impacts. There is no reason to believe the expected case is more probable than the worst case; it just is in the middle of DNR's range. The protection of public rights in water is an absolute limit on DNR's ability to permit this project, so this issue becomes crucial. Unless the public can be assured their rights will be protected even if the worst case happens, the impacts have not been fully disclosed.

Without mitigation water all of the lakes would drop below levels necessary to protect public rights, and Skunk Lake would become a wetland (p. 120). There would be dramatic adverse effects on lake fisheries as a result (p. 121), and wetlands would be completely dewatered (p. 121).

DNR proposes using groundwater to add to the lakes except (132) for Skunk Lake where treated mine water would be used (p. 122). The problem is will there be enough water of sufficient quality to adequately mitigate these losses? The DEIS, by not analyzing the worst case, not specifying the water source or quality, and not analyzing the effects of water chemistry changes for the worst case fails to tell the public whether their rights will be protected (p. 122-126). For Skunk Lake, the proposed treated mine water would not meet standards for even the expected case (133) (p. 126). Wetland impacts are not addressed even though 600 acres are affected (p. 126, 130).

The stream impacts are dismissed just as cavalierly (p. 127-129). The decrease in groundwater flow will lower levels, decrease velocity and width, and alter flow frequency (p. 127). While admitting public rights would be adversely affected, the (134) DEIS does not fully describe the impacts of the drawdown on the streams (p. 129). Fisheries, especially trout habitat, would suffer serious impact since stream flows and groundwater discharges are related to successful spawning (p. 131). The benthos, vital to the foodchain, are also affected. What is not disclosed is the magnitude of the impacts.

DNR proposes to focus instead on mitigation as a way of (135) avoiding full disclosure (p. 133). Even with mitigation, however, there will be serious impacts. Stream flows will still

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[3] Figure 2-6 is an elaborate representation of a perched lake. Since the area lakes are primarily seepage lakes, this figure is misleading and should be changed.

135 be "minimal" (p. 133). Trout spawning areas will be lost even with mitigation (p. 133). Wetlands associated with streams are deemed to have "small" impacts even if it was stated earlier 600 acres of wetlands are affected (p. 130, 133). What is the 136 authority for the position that most of the wetlands "are believed to be perched" (p. 130)?

Even more serious than the failure to outline the "with mitigation" changes is the lack of certainty about the mitigation methods proposed (p. 135). It is obvious that the needed analysis of secondary impacts (i.e. increased drawdown due to the mitigation pumping) has not been done. The pumping of dedicated wells, assumed to be the source of mitigation water in the impact analysis, is stated as not effective due to the extra drawdown it would cause (p. 135). A vaguely-described "semi-circle of wells" is proposed but it is clear DNR has not analyzed whether enough 137 water could be produced from this system (p. 135, Table 3-17). Only Exxon's model was used to evaluate the expected, not the worst, case (p. 136). The possible increase in stream impacts due to pumping is not analyzed at all, nor are the effects on Hoffman's Spring, a crucial trout habitat (p. 136). Exxon's 138 model is used to simulate conditions north of Swamp Creek where the hydrogeologic conditions are unknown and therefore the model lacks any validity (p. 136).

It is ludicrous for DNR to suggest adequate mitigation of lakes or streams could be accomplished with only this sort of slipshod analysis behind its conclusions. Until the amount and quality of mitigation water can be identified and assured, DNR 139 cannot conclude that additional discharges into area lakes and streams would protect public rights in the quality and quantity of these public waters. The DEIS is damned by its own conclusion at p. 44: "The previously described measures may not fully mitigate mine dewatering impacts."

C. Surface Water Runoff

This issue will present special problems during construction when large areas are cleared as well as during operations and after closure. The potential for surface water contamination is great if the runoff controls are inadequate. While admitting soil erosion will have great short-term impact, only one 140 paragraph is devoted to that problem (p. 110). While the DEIS lists methods of control, it does not specify how these controls will be required, what happens if the controls are inadequate, or any monitoring of erosion control structures and devices (p. 23, 26-27, 110, 143). Since sediments will not be moved downstream as quickly as the pollutants mixed in the waters, the local effects of inadequate erosion control will be the greatest. The choice of whether to use a method of erosion control and which 141 method to use should not be left to the worker in the field, nor should the DEIS dismiss an important impact unless there are

enforceable assurances that reasonable and adequate measures will be taken to control this problem.

Over the life of the project, 858 acres of land will be directly affected (p. 143). No estimate is made of the amount of 142 soils lost to erosion or the impact of this loss on water quality. Erosion is not the only impact; soils lost will move into area waters and these effects are omitted (Brooks). Unless a plan is developed for identifying the crucial areas and implementing controls there could be serious and unanticipated damage to waters and wetlands in the area.

143 The proposed controls do not explain why 25 year-24 hours storm event planning is sufficient in some areas while a 10 year-144 24 hour storm event will suffice in others (p. 26). No explanation is given of when and where "permanent" erosion controls will be placed (p. 26). The "natural species invasion" 145 plan proposed will not be adequate if this means large areas will be exposed for a period of weeks or months (p. 27). Where will 146 seeding be required and when (p. 27)?

D. Contaminated Groundwater

There are various sources of contaminants to the groundwater from the Crandon Project. While the chief long term threat is tailings disposal, the mine and mill site, preproduction ore storage pad, sedimentation basins, sanitary landfill, buried pipelines, etc. are all potential sources of groundwater contamination. One source not identified anywhere in the DEIS is 147 the treated mine water which will be put in Skunk Lake and which may go into the groundwater.

The modeling of the movement of contaminated water out of the tailings dams into the groundwater has been called "without scientific merit" by Dr. Douglas Cherkauer. (His complete report 148 is attached as part of these comments.) If it isn't possible to calibrate or verify a model of how these contaminants will move into the aquifer and potentially into the surface waters (Swamp and Hemlock Creeks), how can the DNR conclude there will be no impact on surface water quality in the near or long-term?

If the modeling cannot make a scientifically sound prediction, the DNR should acknowledge this fact. (DNR is presently revising its own model once again.) The uncertainty of impact requires meticulous monitoring to see if performance can 149 be proven. If not, the state could be dealing with a whole different picture than what has been presented. DNR's conclusions on this subject are premature and can only be tested after the operations begin. The public should know the uncertainties and the DNR should be prepared to continue its modeling efforts after data is available to calibrate and verify this work. Until then, modeling can only prove that if you use the same data and good equations, you will get the same

149 results. The model cannot predict contamination time or levels at this point and it is misleading to use it in this fashion.

The mine itself, after closure, is a significant source of groundwater contamination (p. 111). The backfill used in the mine is primarily waste from the milling process and waste rock. An estimated 30.3 million tons of waste rock and coarse fines will be used as backfill, and it is clear that this crushed rock is a source of contamination (p. 110). The mine will fill
150 with water and the amount of interchange between the closed mine and the overlying glacial aquifer is not known. Under natural conditions there is some interaction, and blasting and other mining processes may increase rock fractures to the point that the abandoned mine will contaminate the aquifer. In nature, the permeability of the bedrock is "highly variable" dependent on weathering (p. 51). This possibility is not addressed in the DEIS.

The mine and mill site will be a source of contamination during operation but that contamination cannot be monitored due
151 to the drawdown of the aquifer during operations (p. 111). What happens when the water comes back up? Will the contaminants which have been put in the dry soils then move into the aquifer and what effects might this have?

What is needed is an analysis of all possible groundwater contamination sources and a prediction of the impacts during construction, operations and after closure. For those areas of high uncertainty, conservative estimates with contingency plans must be proposed. DNR is wishing the groundwater problems away in the DEIS rather than evaluating them.

E. Mine Inflow Model

Dr. Cherkauer has carefully evaluated the work of Exxon and DNR which predicts the drop in groundwater levels due to pumping in the mine. He concludes that the predictions on drops in groundwater levels are reasonable and conservative, therefore, the impact description on the size of the cone of depression is reasonable.

DISPOSAL OF MINE WASTES (MWDF)

The disposal of mine waste (tailings (23.3 million tons), coarse fines, waste rock, industrial sludges, and water treatment sludges) near the project site is an extremely significant project impact. It will create the largest solid waste facility
152 in the state and represents a permanent danger to local groundwater resources unless everything goes right. That is the major problem with the DNR's impact analysis of this facility. It assumes optimistically that nothing will go wrong. The impact analysis is inadequate because it gives Exxon the benefit of every "if." That matters because if these optimistic judgments

are maintained, there will be no contingency planning for things which could go wrong. Such planning for accidents and mistakes is the only common sense conservative approach to protecting the groundwater.

What's the big problem? The waste from the ores in the mine have a high pyrite content (p. 30-31). That means if they are exposed to air and water (either in the short or long run), they
153 will produce an acid leachate. The ability of the tailings to produce acid is thoroughly documented in Exxon's reports to the DNR. The problem becomes, then, how to prevent oxidation of the waste in perpetuity, otherwise acid leachate will threaten the ground and surface water resources in the area. Also, the bentonite liner could be deteriorated under acid conditions (p. 113).

The ability of any engineered design to keep these wastes in conditions that will prevent oxidation in perpetuity has not been demonstrated historically. It is only reasonable, then, to start
154 the impact analysis with a degree of skepticism about "impermeable liners" and reclamation caps which last for longer than the materials used have been available on the market.

The DNR should candidly admit there will be groundwater degradation as a result of the storage of these wastes, and that there is no way to adequately predict, in advance, the timing or
155 levels of contamination. It can be agreed that unless there is a catastrophic failure, it will take some time for leachate to move through the unsaturated zone to the groundwater and eventually to the surface waters. (See Dr. Cherkauer's report on the lack of validity of the current contaminant transport modeling.)

156 The conclusion that contamination impacts cannot be predicted should require extreme conservatism in the design, construction, and reclamation monitoring of the site. Design
157 issues include the adequacy of the leachate piping system. The present design includes only perimeter piping. If the leachate comes through more quickly than anticipated due to higher permeabilities in the waste, the piping design would be inadequate. Since coarse fines, waste rock and sludges will be put in at Exxon's discretion, the laboratory fine tailings
158 permeability analysis which is the basis of the design may be misleading. Field permeabilities are always different than laboratory permeabilities even assuming only fine tailings would be stored. The piping design is not sufficiently redundant to take care of the leachate if higher permeabilities are experienced. There is a need for interior piping to remedy this as well as some sort of clean-out system to allow for maintenance or repair if there is clogging. Without these additional safeguards, there could be impacts during operations which are much higher than predicted.

Because the tailings ponds will also be used as excess storage capacity for waste water in the event of a water treatment system problem, DNR should anticipate that large (159) amounts of leachate could be generated. The analysis does not include such an eventuality or a consideration of whether the piping system would be adequate if the ponds were used to store large amounts of process waste water.

The DEIS fails to identify the design seepage of each of the tailings areas during operations. This is an impact which is (160) significant, and a range of seepages if there is a failure during operations should be also identified (p. 112).

The design does not insure oxidation of the pyrite will not take place during operations. The waste will be exposed to air and water during transport and when it is dumped into the pond. If the compaction is a bit slower than anticipated or if the water cover is insufficient, such as during periods of shutdown, (161) significant oxidation could take place. There is no monitoring proposed to detect this. Since this problem could be remedied by the addition of neutralizing agents or other methods, it seems a simple precaution to require some monitoring of the tailings mass itself, not just leachate, to determine if acid formation is occurring. The literature shows there can be a layering effect of acid conditions in tailings areas so that leachate monitoring may only show the problem long after it is advanced.

The DNR emphasizes the reclamation cap in its assessment of the waste disposal issue, but does not discuss possible operations problems or impacts. While the cap is crucial for the (162) long-term, it does not assure design integrity for the thirty plus years the facility will be in operation. More analysis is needed of the possible operations impacts.

Construction of the bentonite-amended soil liner is a major problem not well-defined in the DEIS. No example has been cited (163) of construction of this type of liner in a facility of the size proposed with the slopes anticipated. Bentonite presents significant construction problems if the soil mix is not of uniform particle size, if it rains, if the moisture content is a bit too high or too low, etc. These problems should be highlighted in the DEIS and a plan proposed to conduct extensive field testing, including a pilot test, to be sure design (164) specifications can be met. The DEIS does not indicate who is responsible for proper construction of the liner. Will Exxon or its contractor bear the responsibility if specifications are not (165) met? What type of supervision will the DNR provide during construction to be sure everything is done properly. Once it is covered over by waste, it will be impossible to assess whether liner failure was due to construction problems. The DEIS should discuss this issue, and present a plan for how DNR will document proper construction.

A long list of chemical reagents which will be used during the project is found at Table 1-5. Since the industrial and waste water sludges will be stored in the MWDF, many of these chemicals will end up stored in the tailings mass. The Table presented does not identify any dangers of these chemicals, and no analysis is provided as to what their effect will be on (166) leachate quality. The amount of chemicals used adds up to millions of pounds per month; and without an analysis of the danger, or lack of danger, of these substances in the reclaim pond and water treatment sludges, the impact prediction is incomplete. Just saying that the amounts of sludges are small relative to the amount of tailings does not answer the question.

Exxon also proposes to store sodium sulfate sludge (up to 11 tons per day) by putting in a berm or dam in the upper corner of each pond (p. 25). Sodium sulfate (a salt cake) is a by-product of brine evaporation from the reverse osmosis part of the water treatment system. This waste is marketable in the paper (167) industry. If it cannot be sold at a particular time it should be stored outside the tailings ponds and kept separately from the other wastes. Salt cake is highly soluable in water and would present problems if put in the tailings ponds. What happens to the cake after the pond is filled? No details are given on how this "berm" or dike attached to the side of the pond would be (168) constructed, but any failure presents a threat to the groundwater.

The DEIS is unclear as to how long water treatment facilities would be available after closure to treat leachate (169) from the ponds. It is conceivable pumping would still be necessary after the water treatment plant is closed at year 32 (Figure 1-15). If the on-site treatment facility is gone, what back-up is there to treat leachate (p. 29)?

What is the effect of dumping all of the reclaim pond sludge (170) (140,000 cubic yards) into T4? These sludges are the product of holding recycle process water over the life of the mine and mill and would be a significant source of contamination.

While Exxon remains responsible for the care of the pond for a maximum of thirty years after closure, it is clear there could be significant environmental effects after that time. The (171) Company's ability to take care of problems during closure and long-term care will be documented through proof of financial responsibility, NR 182.16 and NR 182.17, Wis. Admin. Code. How much protection does the bond or proof of financial responsibility provide? The DEIS does not deal with this issue.

A related issue are the fees which Exxon must pay into the Waste Management Fund, NR 182.18, Wis. Admin. Code. How much (172) money will these fees generate if the waste tonnages predicted by Exxon are correct? The funds are not segregated for the use of this site but are part of the trust fund and may be spent at the

DNR's discretion for the purposes listed in sec. 144.441(6)(d)-(g), Stats. Some comparisons should be done of clean-up costs on other sites versus the amount to be collected by these fees to (172) determine if there is sufficient money available for possible problems.

The whole issue of the groundwater standards beneath the MWDF is neatly sidestepped in the DEIS (p. 117). NR 182.075, (173) Wis. Admin. Code, says federal levels are a minimum, but the DNR can set standards to protect the resource. The impacts of the standards to be used are not addressed. The baseline aquifer quality is very good (p. 53-54). Will the standards permit degradation of the aquifer?

After the groundwater recovers to pre-mining levels, an (174) estimated thirty years, what contamination may result from the soils that were dewatered being saturated again (p. 115)? This problem is not evaluated and is important since Exxon's responsibility ceases at that time.

The surface water bodies which will receive these contaminants are Hemlock Creek, Creek 11-4, and Creek 12-9. No (175) impact analysis is done on the effect of the contaminated groundwater discharge into these streams (p. 142). Swamp Creek will also receive a portion of the flow once baseline gradients are re-established. No analysis is done on these effects.

SANITARY LANDFILL (MRDF)

The disposal of non-tailings mine waste gets scant attention with most of the analysis focusing on why tailings disposal is a bigger issue (p. 113). A design seepage of 500 gpm which could be several times larger is not a no-impact scenario. More (176) analysis is needed on the special problems of control, monitoring, design life, etc. If the landfill were proposed alone, it would receive much more attention than the DEIS provides. Just because other dangers are a greater threat, the MRDF cannot be ignored.

WETLAND IMPACTS

Wetlands are an integral part of the water system in the project area, yet their role in the natural water system is virtually ignored in the DEIS. The project area includes 1.5% of (177) the total wetlands in the Upper Wolf River watershed (p. 68), and the DEIS, without substantiation, says the "majority" of the wetlands are perched. This conclusion is crucial in evaluating drawdown impacts so the authority for it must be stated (p. 68).

The DEIS never clearly differentiates the drawdown impacts (178) on wetlands and proposes no mitigation for any effects. Without mitigation, some wetlands will be completely dewatered

(p. 121). While changes in vegetation and water quality are generally mentioned, the changes are not described (p. 121).

Further confusion is added when it is stated 600 acres of stream-side wetlands will be affected by gradual shifts in vegetation but no analysis is undertaken (p. 130-131). How (179) important are these wetlands to the streams? Will they recover after drawdown? What about the effects of drawdown on the wetland north of the mine near Swamp Creek? Until the different types of wetlands are identified along with their role in the water system, the impacts of drawdown cannot be known.

(180) Erosion impacts on wetlands are not evaluated in any way in the DEIS.

Another omission in regard to wetlands is possible quality (181) impacts from the mitigation water which will be added to the lakes and streams.

Several of the special natural areas to be impacted are (182) wetland areas (p. 69). What will be the effect on the Swamp Creek Cedars, the Burr Oak Swamp, and the Upper Pickerel Creek Cedars and Pines from drawdown and other project effects? These areas are omitted from the impact analysis.

AIR QUALITY

The air quality impact analysis is incomplete in several important respects. At several points it is mentioned that (183) chemical stabilizers or water would be used to control dust (p. 27, 30). What chemicals would be used and what are their effects? Are these measures voluntary or will they be permit requirements?

The major operations air problem would be heavy metals dust from the operations and the tailings ponds (p. 34). The (184) possibility that asbestiform minerals or asbestiform particles could be emitted has not been analyzed (p. 51, 32). Since these substances pose serious health concerns, an impact analysis should be conducted.

The tailings dust contains several human carcinogens so that it is crucial for emissions to be kept to a minimum (p. 156). (185) The DEIS discounts tailings dust as a source of these emissions, but does not state how DNR will guarantee there will be no tailings dust (p. 146). This is a significant problem at many tailings disposal sites.

The DEIS concludes air emissions will have no effect on the quality of lake water (p. 139). Skunk Lake is omitted from this (186) analysis. Further, these effects are not analyzed in conjunction with water quality effects from mitigation pumping. What are those combined effects?

No analysis has been done in the area regarding special populations which may be at a higher risk due to the carcinogens in the dust. For instance, the Potawatomi community east of the site has a large number of children who may be more at risk. (187) Elderly populations also have special risks. The impact analysis, using only national averages, is not attuned to the people in the area who will be breathing this heavy metals dust (p. 156).

The baseline work on air quality (p. 75-76) is deficient since it lacks any relevance to the project area (p. 76, Table (188) 2-20). Apparently no field work has been done to establish metals deposition rates in the project area. No asbestiform background data is provided.

NOISE/VIBRATION IMPACTS

Noise impacts are predicted to be substantial and the area (189) will no longer be a quiet rural area (p. 73). Table 3-25, p. 149 shows these impacts but no mitigation is proposed. Also there are predicted noise impacts on wildlife, including bald eagles and osprey (p. 147). Since the noise will be continuous, it is (190) unlikely the animals will return to the area as the DEIS suggests. Measures to protect these sensitive species should be proposed.

The vibration impact is also substantial. The DEIS notes that charges could be fired simultaneously but omits any analysis (191) of this "worst case" scenario (p. 152-153). Unless Exxon is precluded from simultaneous firings, the impacts have not been adequately analyzed.

WILDLIFE

The project area is rich in wildlife resources including Wisconsin endangered, threatened, and watch species (p. 71-72). These species receive no attention in the DEIS in terms of their sensitivity to project impacts. A plan should be proposed to preserve as much habitat as possible for the wildlife in the (192) area, especially those already legally-protected. The DEIS does not address the habitat requirements of these species nor does it analyze how much of that habitat will be lost or affected (p. 134). A total loss figure of 858 acres does not tell the reader anything about the effects on individual species. The entire life cycles of the animals should be considered, not just nesting needs (p. 147).

RISK ASSESSMENT

The description of risks found at p. 189-193 of the DEIS is conclusory, inconsistent, and totally lacking in any serious (193) intention to assess risks. The attitude manifested in this section is simple: if a risk is not identified, no contingency

planning will be required. This approach is both logically and legally inadequate.

No actual industry experience is cited in any of the scenarios to support whether the risk is high or low. It is ridiculous to suggest reagent spills, full spills or concentrate spills would occur only once in 10,000 years (p. 189). Where is (194) the industry support for that conclusion? None of these incidents must be reported to the State. Such a requirement should be basic to any contingency planning.

Risks peculiar to mining, i.e., tailings leachate failures, embankment failures, subsidence, leaching from the abandoned (195) mine, etc., are only mentioned rather than assessed (p. 190-191). Where is the mining industry data on these risks? Why are (196) the reclaim pond embankments not analyzed separately from tailings pond embankments? The failure of these dams presents risks of very serious damage yet no plan to deal with failure is presented. The public is entitled to know what measures could be (197) taken if these events happen. The DEIS does not provide even a clue. For instance, how could a piping failure be remedied? (p. (198) 192). If the abandoned mine contaminated the groundwater, how could the aquifer be saved?

About halfway through the "risk assessment", the DEIS stops trying to quantify risks by the system described on p. 189 (p. 193). Are these risks unknown or did DNR just forget to quantify them? This omission is most glaring in regard to water treatment (199) system failures (p. 193). Such failures are commonplace. The DNR says the removal of one cell of the reclaim pond will have no effect on water treatment (p. 193). That statement is inconsistent with other information in the DEIS on the operation of the water treatment system (p. 18).

The only risk of erosion control failure is identified is (200) soil loss (p. 193). What about water quality impacts from such a failure? What is the risk of failure? How could it be remedied?

CUMULATIVE IMPACTS

While the DEIS mentions that the permitting of the project could result in the mining of nearby ore-bodies (p. 189), it (201) fails to identify the additional environmental harm which could result. Some estimate based on the known quantities and types of ore should be done.

A possible cumulative impact which is ignored is the effect on Wisconsin's air quality if the concentrate is refined or (202) smelted in the Upper Peninsula of Michigan. Unless this can be ruled out in some way, an impact analysis should be done.

MONITORING

Since many of the project impacts have a significant degree of uncertainty, the plan to monitor the project effects becomes pivotal. Unless there is adequate pre-project data on existing conditions and a plan for gathering and comparing project effects, the DNR cannot fulfill it statutory obligation to enforce permit conditions and protect the environment. Monitoring the complex environment in the project area is not a simple proposition, especially since drawdown will complicate the groundwater picture. A commitment should be made to intensive and extensive monitoring until impacts have been established. Monitoring schedules could be revised later if impacts are as expected.

The DEIS at p. 35-45 presents a general description of the monitoring plan for the entire project. These proposals cannot be adequately evaluated until the impacts are fully disclosed regarding the project activities. Therefore, the comments made earlier in this response are all relevant to the adequacy of how to monitor effects. The disclosure of impacts is a necessary first step before adequacy of monitoring can be addressed.

There are some comments, however, that are pertinent to the measures listed in the DEIS. The purpose of the monitoring should be expanded to include data gathering for enforcement of permit conditions and to provide information for possible permit (203) modification. Merely detecting and evaluating changes, p. 35, does not manifest a commitment to use the information gathered to minimize adverse impacts. This information will be the only way citizens will have to proving impacts are project-related.

For some impacts, one year of baseline monitoring may be inadequate (p. 35). The data already gathered on the project area should be incorporated as part of the baseline. The DEIS does not explain how many samples would be taken for each (204) monitoring point to make up the baseline. For instance, just one sample from a private well in the year prior to construction would be inadequate to establish baseline conditions for the well (p. 35).

The groundwater monitoring program ends at thirty years after closure (p. 35). This is obviously inadequate in view of the times it may take contaminants to reach the aquifer. The DNR must make a commitment to continue monitoring after Exxon is no longer responsible or citizens will be without any protection (205) until contamination becomes manifest. By that time, the situation could be irremediable. The groundwater monitoring should form the basis of corrective action even after the long-term care period (p. 38, 41).

(206) The groundwater monitoring is based on compliance boundaries (p. 39). Within the boundaries there can be contamination above

standards so long as the pollution is diluted enough by the time it reaches the boundary. Different boundaries are set for various project facilities, but no explanation is given for why these boundaries were chosen (p. 39). An explanation must be provided as to why these boundaries were chosen. No mention is made of any actions the DNR would take based on monitoring results within the compliance boundaries. For instance, will DNR require action at certain levels of contamination within the boundary even if the pollution has not reached the boundary wells?

The use of piezometers and lysimeters for MWDF monitoring (207) should be explained (p. 39). How reliable are these devices and how long do they last? Leachate sampling is to be done only on (208) an annual basis (p. 40). This is clearly insufficient especially during the operation of the first tailings pond. No provision is made for sampling the tailings themselves to see if acidic conditions exist in the tailings mass. Such monitoring should be (209) conducted during operations and especially before the cap is placed on the pond.

No discussion is included regarding the effect of drawdown in the groundwater monitoring program. The difficulties imposed (210) by drawdown should be explained so the adequacy of monitoring during mine pumping can be evaluated.

There are special problems in monitoring the reclaim ponds since the bentonite-amended soil liner will absorb leaks so that the performance of the plastic liner cannot be evaluated (p. (211) 41). Since the water which will be held in these ponds is extremely hazardous, the DEIS should explain how liner performance will be evaluated.

The mine-mill site during drawdown cannot be monitored through water sampling (p. 41). How does the DNR propose to monitor contaminants in the soils which will contaminate the (212) aquifer after the water levels rebound? One way would be to require reporting of all reagent spills, fuel spills, etc., so that soils could be evaluated for contamination levels.

The surface water monitoring program begins with the sampling of the effluent going into Swamp Creek (p. 36). The three sampling points do not allow monitoring of the quality of (213) intercepted groundwater before it gets to the lagoons (p. 36). This might be important to evaluate treatment and to determine quality for mitigation water. A point within the intercept system should be established for determining quality. Why are (214) different parameters measured at each of the three points? (p. 36, Table 1-13). Very few parameters are measured at the outfall (215) and there is no temperature measurement at all (Table 1-13). How is the twenty-four-hour composite done? The public needs to know how DNR defines an exceedance for permitting purpose.

(216)

217 No information is provided on how the sanitary waste stream will be monitored (p. 36). It should be separately monitored to allow for segregating problems before they get to the lagoon.

218 219 The actual sampling of the water bodies is not fully explained. How do the indicator parameters work and what are their limitations? How much of the total data is verified by 220 221 DNR? (p. 37). The biological monitoring is inadequate (Brooks). Only two sites are monitored and a five-year interval 222 223 is too long (p. 36-37). Will any elemental analysis be done? What about animals in the food chain other than fish?

224 Bottom sediment samples should be taken further downstream. The DEIS does not clearly indicate the parameters to be monitored (p. 36-37).

225 Monitoring of the mitigation/contingency plans is analyzed at p. 43-44. The distinction between what is considered 226 "mitigation" and what is "contingency" is not well-explained (p. 43). The impacts triggering sudden rushes of water into streams is not explained. Will this have adverse effects on fish? Will 227 temperature be monitored as part of the mitigation? Under what conditions will lake levels or reduced stream impacts be considered "not mine related"? (p. 43). No mention is made of 228 how water quality impacts of mitigation will be measured. Some way of sampling both the discharge and the water quality of the 229 surface water must be included.

Sampling of vegetation should follow the protocol used to establish baseline conditions (p. 70), as well as the measures described in the DEIS (p. 41). The frequency of the sampling 230 should be stated. An explanation of how infra-red aerial photocopy can be used to detect plant stresses should be provided (p. 41). No monitoring is planned for special plant species in the area such as wild rice (p. 67).

The air quality monitoring proposed does not include sufficient coverage in the area downwind of the tailings ponds 231 (Figure 1-25). The asbestiform monitoring should be required for more than two weeks in years 4 and 5 of tailings pond operation (p. 42).

There is essentially no monitoring proposed for noise and 232 vibration impacts although these may be substantial (p. 42, 148-154). Exxon should be required at least to keep records of its blasting activity (charge, delay, time) so that citizens who suffer damage will have those records available.

No socio-economic monitoring of either baseline or project 233 conditions is proposed. This monitoring is necessary so that the MIB can determine priorities and "mine-relatedness" in its grant program. Public expenditures due to the project are probably the area which most requires measurement.

SOCIO-ECONOMIC IMPACTS

Socio-economic impacts are explicitly required by the "full disclosure" requirement of sec. 1.11, Stats. In addition to this requirement, sec. 144.85, Stats., which defines the requirements for the issuance of a mining permit, mandates that DNR make a finding that "The proposed mine will not result in a net substantial adverse economic impact in the area reasonably expected to be most impacted by the activity." Sec. 144.85(5)(a)1.e., Stats. Therefore, the analysis of these impacts in the DEIS is of double importance; not only must it disclose the impacts but it must provide the basis for the determination of "substantial adverse economic impact" under the mining permit law. To do less cheats the public in that costs and benefits are obscured.

The DEIS fails in regard to both these goals because it does not reasonably describe the likely economic impacts, omits 234 significant information about certain important impacts, and fails to provide any analysis for its conclusion that "the preponderance of economic effects of the mine would be positive," (p. 189).

Rather than discussing in detail all the possible effects, which would lead to the confusion the DEIS generates, there should be some prioritization of which factors are the most crucial in determining the economic impacts to the public. Once some prioritization is done, there should be a thorough analysis of these crucial factors, including significant uncertainties 235 associated with the effects. Once that is done, the important factors should have been drawn together and a cumulative evaluation of the combined factors could have been prepared. This would have set a reasonable basis for what should be in the "Alternatives" section. Unfortunately, the DEIS does not take this approach, but rather presents a mass of data somewhat indiscriminately which leaves the non-expert reader at a loss to figure out the basis for DNR's position on these impacts.

The original workplan for study of socio-economic impacts included an objective of studying the effect of shutdown or slowdown impacts of the social and economic factors considered. 236 This has not been done and represents a lack of an objective hard look at the project since the mining industry is fraught with discontinuous operations problems.

A. Employment

The possible employment opportunities the Project may bring to Wisconsin are without doubt a significant impact to be 237 analyzed. A basic failure in the DEIS is that there has never been any attempt to seriously quantify the number of Wisconsin residents who may be employed by the Project by looking at the

(237) job qualifications needed by Exxon and then comparing these qualifications to what is available in the local study area. Denver Research Institute (DRI), DNR's consultant, estimates are much lower than the sixty percent (60%) estimated by Exxon. DRI also reported that Exxon's figure has "no basis" and said no supporting analysis has never been provided for the Exxon estimate. (Final Socioeconomic Impact Analysis, DRI, April, 1986, p. 26.) If this data is not available in the public records, it could have been generated by either Exxon or DRI.

(238) DNR, apparently based on DRI's work, estimates twenty-eight percent (28%) of construction jobs would be filled by local residents (DEIS, p. 161). For the six hundred twenty (620) operations jobs, DNR estimates fifty percent (50%) would be filled by study area residents (DEIS, p. 162). The DEIS fails, however, to analyze how the lower estimate is derived. DRI is more explicit in acknowledging the basis of the estimate:

> The difficulty in both the EMC and DRI analyses of confidently projecting personal job preferences, job mobility, and the composition of skills education and experience in the study area work force needs to be frankly acknowledged. The more conservative (i.e., lower) estimate of local resident employment in the construction phase is clearly more reasonable when one considers that all of the prospective employees from the study area are assumed to come from the ranks of the unemployed. Under both the EMC and DRI analysis, direct Project jobs filled by existing study area residents are assumed to be filled by unemployed persons currently residing in the study area and thus occasioning no new employment-related in-migration.[1] It is also assumed by DRI (and implicitly in the EMC analysis) that EMC and EMC's construction contractor and related subcontractors will be predisposed to hiring local residents for the indicated jobs in Table 5 and will not adhere to or pursue recruitment and hiring policies leading to a transference to the study area of their existing employees on assignment elsewhere or promoting the in-migration of job seekers with the requisite skills, education, and experience. All of these assumptions warrant careful examination since the skills and experience of the unemployed in the study area may not match those associated with the indicated jobs in Tables 5 and 6. The importance of these assumptions relating to the Project's employment benefits are discussed further in Chapter III.

(Final Socioeconomic Impact Analysis, DRI, April 1986, p. 27.)

Therefore, it is reasonable to conclude that the DNR estimates contained in the DEIS are based on Exxon's assertion that it will "diligently pursue" local hiring practices (an

assertion which can only be taken on faith) and that a skills match (unproven by either Exxon or DRI) exists between the local work force and the requirements of the Exxon contractors. Even where there is a skills match, DRI states that a preferential hiring program would be required to give local persons opportunities against qualified in-migrants (Final Socioeconomic Impact Analysis, DRI, April 1986, p. 126).

The DEIS has not previously analyzed the likely increase in local employment opportunities. While it is only common sense to say there will be more jobs, and more jobs means more money, the question is not that simple. The DEIS must substantiate its estimates by something more than unemployment rates and Exxon's (239) job qualifications. What are the estimates if a preferential hiring policy is not pursued? What has been the historical experience in other large projects in the United States? What are the characteristics of the pool of available workers in the Upper Penninsula of Michigan and northern Minnesota and Wisconsin which might compete for these jobs? What specific differences may exist if a union versus a non-union contractor is chosen?

These questions become significant when the "Alternatives" section of the DEIS is considered. DNR has no suggestions for employment policies other than "... carefully targeting employment announcements in terms of both geography and skills levels." (DEIS, p. 240.) For the operations period, DNR suggests the State should help bring new business to the area (DEIS, p. 240). While it does suggest the possibility of employment strategies for the local Native American communities, (240) it does not explain why these should be necessary only for the non-white communities (DEIS, p. 241-242).

If an adequate impact analysis had been performed, the "Alternatives" section would be much different. For instance, (241) the promised "local preference" should be suggested as an alternative, not as an assumption of impact analysis. If a skills match or mismatch were identified, required training programs could have been considered.

Since increased employment is consistently and publicly treated by Exxon as an overriding beneficial impact of its proposed activity, the DEIS should examine it with the eye of an expert so the public could be truly informed on how to get and keep these employment opportunities in the State. In addition, the job opportunity impact is truly significant and has been inadequately examined for purposes of aiding the later analysis to come pursuant to sec. 144.85, Stats., when Exxon seeks its mining permit.

B. In-Migration

An issue closely related to employment opportunities and other project impacts is the number of new people coming into the

area as a result of the Project. In general, the smaller the number of new people, the fewer adverse impacts on public expenditures, housing, social dislocations, etc. Also, fewer in-migrants also means more local employment. The issue is further complicated because the construction period will probably have a larger number of in-migrants than the operations period.

(242) The DEIS estimates a sustained growth in population of 1,600 people (DEIS, p. 159). This figure is apparently based on Exxon's projections but the basis for this in-migration estimate by Exxon is never stated. What are the assumptions underlying this figure?

(243) The most significant effect on in-migration will probably happen during the construction period. The construction in-migration is very large, reaching 2,076 during the third year of construction (DEIS, p. 160, Table 3-32). The assumptions behind this estimate are not stated, but assuming it to be reasonable, the DEIS does not analyze the impact of this peak in-migration with the increase in costs and services occasioned by the increased population in the local study area. That calculation could have been made to arrive at a total expenditure estimate before dividing the in-migrants into various communities.

(244) The sum total of projected additional public expenditures during construction is, therefore, not adequately calculated. The DEIS estimates ninety million dollars ($90,000,000.00) in additional public expenditures over the life of the project, with seven million dollars ($7,000,000.00) during the construction period (DEIS, p. 167). No analysis is provided for how the construction costs were derived, but it appears close to a proration of the ninety million dollars. The basis of the construction public cost estimate is not stated in the DEIS.

(245) The lack of support for the in-migration estimate leads to inadequate consideration of the public costs and timing of the costs of the in-migration and alternative strategies for mitigating these impacts. The Mining Investment & Local Impact Board (MIB) will have inadequate funds to mitigate construction period public costs, but no analysis of how bad this shortfall could be is considered. Since in-migration is a pivotal impact factor, the DEIS must explain its estimates, their uncertainty, and the public cost impacts under <u>different</u> in-migrant scenarios. Only then will it be possible to consider alternatives to contain the impacts.

C. Public Costs

(246) This projection gets to the heart of economic analysis: how much could it cost the public to have this project go forward? DNR estimates that number to be $90,000,000.00 over the life of the Project (DEIS, p. 167). That estimate is unreasonable, because it is based on current service levels in the area which

are documented to be inadequate as to several crucial service sectors elsewhere in the DEIS. This makes the estimate unreasonably low and therefore not a full disclosure of the probable project costs.

What should have been done was a comparison of state per capita costs in various service delivery areas rather than local per capita costs estimates. The mental health system, for example, is stated as being inadequate in the study area (DEIS, p. 89). Yet, the impact scenario only carries forward these inadequacies. Also, no factor is added for the fact that transient populations, such as the construction work force, may have special service needs in areas such as mental health, alcohol and drug abuse, etc.

(247) The ninety million dollars is a non-conservative assumption. The DEIS states that it is a "minimum impact" scenario. Minimum impact is not full disclosure and is not an adequate basis for the consideration of alternatives. Across the board comparison to state average costs resulting in scenarios other than a best case is required.

D. Public Revenues

Coupled with the "best case" cost approach described above, the DEIS does a "best case" public revenue analysis which overestimates the revenue-generating potential of the Project. What results is a skewed picture of benefits and costs.

(248) The majority of the DEIS' analysis of public revenues focuses on the net proceeds tax. Chapter 2 omits an adequate description of how the tax is computed, especially a listing of the large list of deductions Exxon can take from this tax on its profits. The flexibility of the Company to reduce the profit on which the tax is computed represents a significant uncertainty which carries through the modeling assumptions.

(249) The modeling results presented are based largely on Exxon-furnished data and assumptions. Since this is the case, it is only natural that optimistic forecasts are generated. Metals prices are the most important factor, yet DNR never does an analysis on <u>current</u> metal prices to determine when and how much tax would be generated.

(250) An examination of the modeling assumptions, (DEIS, p. 170), shows another glaring fault. No shutdown or slowdown scenarios are modeled. The history of mining in the U.S. leads to the conclusion that such an assumption is unreasonable. The continued public funding problems which could result from periodic shutdowns should be fully analyzed.

(251) Without independent data, it is not possible to assess the uncertainty attached to the seventy-one million dollars in impact

funds the MIB may get during the life of the project except that it is based on very optimistic metals prices. Even if this amount is correct, only forty-seven million dollars (after the mandated payments) will be available for the discretionary grant program. This amount must fund project related public expenditures, including possible environmental degradation, over a thirty-year period when it is clear that the costs will probably be incurred early when there will be no funds (251) available. Therefore, except for the five municipalities which receive mandated payments, the earliest some funds would be available would be five years after construction begins. At any less optimistic metals price forecast or if there is a shutdown, the funding problem could be significantly more severe.

The property tax generated by the Project suffers from the same lack of analysis of the time lag problems. The costs will be incurred prior to the collection of the property taxes. An (252) explanation should be given of how the project property is assessed, when it can be taxed, and an estimate provided of the increase in property tax collections as a result of the project property in the four taxing jurisdictions concerned.

The corporate income tax projection fails to reveal a crucial point. Under Wisconsin law if Exxon operates the Project as a subsidiary versus operation as an independent concern, the tax could be totally different. The DEIS projection of a hundred million dollars in corporate income tax over the life of the (253) Project (DEIS, p. 170), is based on an assumption that Exxon will create a separate entity to operate the mine. Since Exxon has the option of mining without creating a separate entity, and having its tax liability offset by the losses of the parent corporation, the estimate of corporate income tax should be so qualified (Final Socioeconomic Impact Analysis, DRI, April 1986, p. 137-138). None of the assumptions underlying the income tax projections are stated so it is not possible to evaluate the figure even on a "stand alone" basis.

E. Transportation

The DEIS does not separately consider transportation of (254) reagent chemicals to the area (DEIS, p. 46). This presents a special consideration since local governments or the State may bear the cost of accidents.

The costs to townships in the project area of additional road maintenance and repair should be estimated. This is one of (255) the greatest costs borne by town taxpayers, and a great percentage of study area roads are the responsibility of towns. The only analysis done is for Forest County costs.

The safety problem of STH 55 in the vicinity of the Mole (256) Lake Reservation requires further attention. If highway

improvements are needed on this highway under impact conditions, what are the estimated costs and how will it be paid?

F. Summary of Socio-Economic Impacts

The DEIS attempts to draw together its economic analysis on page 189. There is a listing of six factors, without any evaluation and analysis of each factor, and a conclusion is (257) reached that "the preponderance of economic effects" would be positive. The DNR's reasoning behind this conclusion is totally lacking and therefore the conclusion itself is meaningless. The DEIS must disclose how it made this evaluation and does not do so.

The summary also states that the positive economic benefits would accrue relatively early (p. 189). This is certainly inconsistent with the earlier tax analysis and cost data. How is (258) this statement supportable based on the analysis in the DEIS? It is certainly more logical to conclude that the project must continue for the full thirty years without stopping in order for the benefits to be realized.

No analysis is made of possible adverse impacts of the (259) project to the existing economic base, especially tourism. What are these effects on the negative side of the ledger? Will the project discourage economic diversification in the area?

ALTERNATIVES

The "Alternatives" section of the DEIS should be firmly grounded in a complete disclosure of impacts. Without that disclosure, the necessity or desirability of alternatives does not present itself. This section is supposed to be a rationale for some environmental decision-making, but it cannot do that unless the facts (impacts) have been analyzed.

Due to the criticisms stated above, the adequacy of the alternatives cannot be fully evaluated at this time. One area of great concern is the tailings processing analysis (p. 224). The (260) analysis does not explain the relevant considerations in an understandable fashion: what is the cost of the proposed disposal method, what is the cost of the alternatives, and what are the environmental effects of the alternatives? NR 182.11(2)(f), Wis. Adm. Code.

There may be alternatives to the handling effluent discharge into Swamp Creek in relation to mitigation water availability (261) which have not been analyzed. Until the sources and quantity of the mitigation water is decided, such an alternative cannot be addressed.

There may also be alternative tailings ponds designs that (262) may provide greater environmental safety. Given the groundwater

(262) danger which exists, alternative designs including thicker bentonite-amended soil, increased pipe spacing, clean-out devices for piping, and modification of the drain layer.

DRAFT ENVIRONMENTAL IMPACT STATEMENT

EXXON MINERALS CORPORATION ZINC-COPPER MINE
Crandon, Wisconsin

REVIEW OF THE ASSESSMENT OF IMPACTS ON THE GROUND WATER SYSTEM AT CRANDON

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May 27, 1986

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EXECUTIVE SUMMARY

After reviewing the portions of the DEIS and the supporting documentation related to potential ground water impacts at Crandon, I would categorize the main impacts as:

1. declines in ground water levels in the vicinity of the mine during its operation,

2. changes in flow and water levels of lakes and streams near the mine (caused by the decline in ground water levels), and

3. ground water contamination from mine activities and waste disposal.

In my opinion, the analysis of the magnitude of these impacts presented in the DEIS is varied in quality.

It is:

1. adequate on the prediction of the extent of declines of ground water levels,
2. inadequate on the assessment of the effects of mine pumpage on lake and streams, and
3. totally inadequate and seriously misleading on the potential for contamination of ground water.

My judgment of the adequacy of impact analysis is based largely on whether the DEIS has correctly identified the worst possible impact that can occur. Proper identification of the worst possible case is crucial because the design of the monitoring system and the mitigation and contingency plans are based on it. If the worst case is not recognized before a project is approved, then it (263) is entirely plausible that the monitoring, mitigation and contingency plans will be inadequate to deal with it. The DEIS has not presented a worst case analysis for either the impacts of pumping on lakes and streams or the contamination of the ground water. Therefore the plans presented in the DEIS to deal with these impacts are inadequate.

INTRODUCTION

Purpose of this review

The purpose of an environmental impact statement is to identify those aspects of the environment that may be affected by a proposed project. In the case of the proposed mining operation at Crandon, Wisconsin, by Exxon Corporation the potential impacts are broad. It is the purpose of this report to review those which relate to the effects of the project on ground water quantity and quality.

After potential impacts have been identified, it is also the function of the environmental review process to approximate the magnitude of the impacts and to ascertain whether mitigative actions are possible which would reduce the impact to tolerable or even negligible levels. In Wisconsin the environmental review process is used to protect the public from a violation of their right to a clean environment and from having thrust upon them the responsibility of cleaning up messes made by others. In that light, I have been retained by the Public Intervenor of the Wisconsin Department of Justice to review all materials cogent to possible impacts on the ground water at the Crandon site.

This report presents my findings as of May 30, 1986. It is based on the May, 1986, DEIS made public by the Wisconsin DNR and on the materials upon which that DEIS is based. It will concentrate on these questions:

1. Are all likely impacts on the ground water system at Crandon identified in the DEIS?

2. Are the maximum possible risks to the public associated with those impacts correctly identified?

3. Are the mitigation and contingency actions proposed in the DEIS adequate to deal with the maximum risks?

4. If the answer to 3 is no for a particular impact, then:

   a. What part of the risk may have to be borne by the public?

   b. What will be the consequences of improper mitigation of that impact?

Summary of review conclusions

The DEIS identifies three major potential impacts of the Crandon Project on the ground water system:

1. water level declines (drawdowns) in the vicinity of the mine caused by mine dewatering,

2. changes in the conditions of lakes and streams near the mine caused by the decline in water levels, and

3. ground water contamination from mine operations and waste disposal.

With the addition of some secondary impacts caused by proposed mitigation actions, these represent a reasonable assessment of the spectrum of impacts to ground water which will occur.

The method used to predict the magnitude of specific impacts relies very heavily upon computer models. In general terms, the modeling process requires first that existing ground water conditions at the site of interest be measured as completely as possible. Then a model is constructed which reproduces those observed ground water conditions as closely as possible. Finally the model is perturbed (modified) to include conditions like those expected when the project is underway. The results of these perturbed model runs can then be compared to present-day conditions to ascertain the extent of the impact of the project on the ground water system. At Crandon, the DEIS uses computer models to predict the magnitude of each of the three primary impacts listed above.

In more specific terms, a ground water model is a set of mathematical equations written to approximate natural processes, be they ground water flow or lake seepage or contaminant transport. Solution of the equations requires three site specific inputs:

1. Inclusion of physical parameters which represent the properties of the material through which the water flows (these can include hydraulic conductivity, porosity and dispersivity, among others),

2. Mathematical definition of the boundaries of the ground water system (locations where ground water flow originates or stops), and

3. The starting (or initial) conditions of the phenomenon being modelled.

Once these impacts have been defined, then they are used as constraints on the solution of the mathematical equations of the model, and that solution is the result (or output) of the model. Typically ground water models will be designed to produce ground water levels or flow vectors or chemical concentrations as output.

It is important to note before any review of the ground water models used at Crandon, that any model's results are only as good as the inputs provided to it. The adage "garbage in, garbage out" is absolutely true. In addition, the model cannot produce meaningful results if the equations which comprise it are wrong. Thus the results of a ground water model can be no better than the weakest link among its three major inputs and its equations.

Generally the inputs cannot all be measured as accurately or as frequently as would be ideal for a model. Therefore a process known as calibration/verification is used to test the model's validity. Real observations of water levels or chemical concentrations are made at the site of interest and then the model is run to simulate these existing conditions. Physical parameters (such as hydraulic conductivity) are varied at sites where they haven't been measured until the model results reproduce real observations--the calibration step. Next the model is run against another, independent set of observations. This time no changes in the physical parameters are made. If the model correctly simulates the second set of observations, its calibration is verified and it is ready for use as a tool in predicting the consequences of human changes in the system.

It is important to realize that proper adherence to the above procedures can produce a model which reasonably represents nature. However, the accuracy of that representation has limits which are imposed by the accuracy of the inputs and the precision of the mathematics. Suffice it to say that, in general, one should not expect a model to produce a single, exact value as a result. Rather, ground water models are best at producing a range of values which could occur.

The purpose of this review of the DEIS for Crandon has not been to construct alternative models to those developed by Exxon and DNR, but rather to assess whether the models used have been constructed and tested properly and whether they produce a valid range of expected impacts. It will also address whether the DEIS properly recognizes the upper end of that range as the worst possible impact and then whether the mitigation and contingency action designs are adequate to deal with the worst possible case.

The Crandon DEIS has relied heavily upon the modelling work done by Exxon's consultants (particularly D'Appolonia/IT) with some auxiliary efforts on lake seepage and contaminant transport by the DNR. For the three primary ground water impacts listed earlier, the DEIS concludes that:

1. The drawdowns near the mine will be tolerable impacts,

2. There will be significant impacts on lake levels, lake seepage and stream flow around the mine, but that the mitigation actions proposed are sufficient to reduce them to tolerable levels, (the mitigation will also change lake quality, but within tolerable limits), and

3. There will be no significant impact on ground water quality.

In my opinion:

1. Conclusion 1 is reasonable.

2. Conclusion 2 is questionable and has not yet been adequately resolved. There is a potential flaw in the model analyses of lake seepage which can bias the results and misidentify the worst possible case.

3. Conclusion 3 is without scientific basis at this time. As will be shown later in this report, the contamination picture presented via model has been neither calibrated nor verified, nor have critical parameters even been measured on the Crandon site. If the model results have any validity, they probably show the best possible impact picture rather than the worst, because modelling decisions have consistently been made in favor of conditions which prevent the spread of contamination. The dismissal in the DEIS of ground water contamination as a serious concern is unjustified.

Therefore, in terms of mitigation:

1. On drawdowns, none is proposed and this is reasonable.

2. On lakes near the MWDF, assessment of the ability of the mitigation design to overcome lake impacts is inappropriate until such time as

the worst possible case of lake seepage is properly identified. No clear statement is made in the DEIS as to how long Exxon will operate the mitigation plan nor on how responsibility and costs will be assigned if the mitigation plan is inadequate.

3. Because the DEIS argues there is no ground water contamination problem, no contingency has been proposed. Any error in this assessment probably means that the State of Wisconsin will bear the cost of cleanup because Exxon will leave the site and abandon monitoring in year 66 even though their own modelling efforts show the potential for ground water contamination will persist much longer.

II. COMMENT ON CHAPTER I OF DEIS--PROJECT DESCRIPTION

A. MWDF Design

The design has at least two potential weaknesses which could affect ground water impacts:

1. The use of geomembranes and filter fabrics in the MWDF cap and liner is virtually untested. Note that these are fancy names for plastic sheet and cloth, respectively. The plastic sheet will be 0.04 inches thick at most, and, as pointed out on page 212 (DEIS), the longest one has been in use in Wisconsin has been only since 1984. Yet the geomembrane at the MWDF has been assumed to function with no more than 10% failure for the entire active mining period (38 years) and then for 9,000 years into the future during the modelling process. What possible justification is there to assuming a plastic sheet will last longer than the Egyptian pyramids have been in existence? (264)

2. The drain layers beneath the MWDF currently have no means for clean out. Chemical precipitation and the growth of various microorganisms in leachates are commonly observed phenomena. What will prevent these from occurring and clogging the drainage system at the MWDF? If clogging occurs, many assumptions made later in the impact assessment chapter fail and many conclusions on impact become questionable. (265)

B. Ground Water Monitoring

The description of the monitoring program presented in the DEIS is insufficient to allow assessment of the program's adequacy. Monitoring is the method by which real measurements of the impacts of the mining activity will be made. An inadequate monitoring program will not provide sufficient data to determine if the predictions of the computer models were correct. To be adequate, the monitoring program must cover the impacted zones sufficiently in both space and time to detect the worst possible impacts. If it doesn't, the monitoring results will be incomplete and can then be misleading.

For the Crandon monitoring program, these issues must be resolved:

1. In what hydrogeologic units and at what depths are the wells shown in Figures 1-21 and 1-24 located? This is important for determining both water level and quality effects. If all the wells near Duck and Deep Hole Lakes are in the deep part of the glacial sediments, they will be useless for determining whether mine pumping is affecting the lakes. On the other hand, chemical modelling shows that the spread of contaminants near the MWDF will be greatest in the deeper glacial sediments. For lake impact monitoring, shallow wells are needed; for contaminant impact deep ones are also needed. Will both exist? (266)

2. Why is monitoring stopped at Project Year 66? D'Appolonia's model shows it will take 900 years for sulfate concentration of 2,000 ppm to reach the water table below the MWDF (p. 17, DEIS). Even though I (267)

will later take issue with that modelled result, the question of consistency in the DEIS remains. Monitoring wells will not detect contamination until after it reaches the water table. Yet, the monitoring program may be stopped long before the worst contamination will reach the water table. How can such a monitoring system perform its function?

3. Along those same lines, on p. 40 the DEIS states that Exxon would only be responsible for the MWDF for 30 years after closure. In fact, they "may apply for termination of responsibility 10 years after site closure." According to Exxon's own models, 10-30 years will be insufficient time for contaminants to reach the water table. Therefore, the monitoring well system will have failed to detect any contamination within that period and Exxon will be absolved of responsibility. Should contamination occur later, presumably State of Wisconsin taxpayers will have to clean it up. (268)

4. Early detection of the leaching of contaminants from the MWDF will depend on lysimeters--devices for collection of samples from the unsaturated zone. What will prevent the clogging of the lysimeters by chemical precipitation and microorganisms? How will the person doing the monitoring be able to distinguish whether the absence of contaminants in a sample is due to a clogged lysimeter or the actual absence of contamination? (269)

5. After pumping in the mine stops, water levels will rebound, bringing that water into contact with freshly exposed sulfide minerals. In southwest Wisconsin, those conditions have led to oxidation of the sulfides and an increase in sulfates and some metals in the ground water. There it has taken many decades after mine closures for the problem to appear. Yet at Crandon, wells near the mine will only be monitored for 34 years after closure and 28 years after the main recovery of water levels. That time may be insufficient to detect a problem which Wisconsin has already seen happen before. (270)

C. Mitigation of pumping impacts

Each lake or stream which may be impacted by pumping at the mine will be monitored. An on/off trigger has been established which will control mitigation activities. If water levels or flows drop below a trigger level, Exxon will be required to augment the water in that lake or stream. However, Exxon can request not to activate or even install the facilities to obtain that water if the flow reductions aren't mine related.

All the above is quite legitimate except for one detail. The monitoring system as presently defined will never be adequate to decide whether flow reductions are mine related or not. All the monitored water bodies are inside the impact zone. Some control monitoring sites are needed outside the zone of mine influence. If water levels or flows there remain steady while those inside the mine influence zone drop, then the impact is probably mine related. (271)

III. COMMENTS ON CHAPTER II OF DEIS--AFFECTED ENVIRONMENT

Throughout this chapter (and consequently in subsequent ones too), the DEIS presents an inconsistent and ultimately misleading picture of the interaction between lakes and the ground water system. As a result, the DEIS tends to downplay the significance of the possible impacts of pumping on lakes near the mine site.

The issue is whether Duck, Deep Hole, Little Sand, Oak and Skunk Lakes are "perched" or whether they are "seepage" lakes. The former means that the lake is essentially unconnected to the ground water system and thus largely immune to ground water changes. The latter means that water from the lake flows to the ground water system and increased pumpage of the ground water will generally cause a loss of water from the lake. Thus the latter type of lake is susceptible to significant impact by a project such as Crandon.

Historically, both the DNR and Exxon initially called all five lakes perched. Field measurements and water budget models by Wisconsin Geological and Natural History Survey, USGS, Dames & Moore, and DNR have all shown that only Oak Lake, among the five in question, is perched. And, in fact, the DEIS (on pps. 58-60) properly labels each of the lakes.

My concern is that except for changing the labels, Chapter II persists in interpreting all these lakes as perched and thus only slightly connected to the ground water system. Figure 2-6 shows a perched lake as typical even (272) though Oak is the only one. Figure 2-4 implicitly treats all five lakes as perched because it shows no mounding of the water table beneath them. The water table contours go right through these lakes, unaffected by their presence. In contrast, the contours at Ground Hemlock and Rolling Stone Lakes are controlled by the lake. These latter lakes are ground water discharge lakes, and the originator of Fig. 2-4 has treated their surfaces as extensions of the water table, while drawing the other five lakes as isolated from the water table. This is clearly a bias, one that is not substantiated by any field data, and one that is not fully understood by the writers of the DEIS.

This bias surfaces subtly throughout the remainder of the DEIS, but always in a fashion which may mislead the reader on the impact of pumping on the lakes. Perhaps the most blatant is on p. 52. "Lakes and wetlands, especially (273) those perched [sic] above the regional water table, are constant but minor sources of recharge [to ground water]." In fact, all the lakes for which DNR itself has done a water budget model currently produce seepage recharge in excess of 7.5 in/yr (Table 1). That recharge rate is the middle of the 5-10 in/yr range quoted as normal in the Crandon Mine area. In other words, the lakes produce ground water recharge at a greater rate than non-lake areas and that cannot be dismissed as minor. Skunk and Deep Hole provide over 40 in/yr of recharge at present (Table 1). Even Exxon's consultants show that all the lakes produce seepage at greater rates then 7.5 in/yr (Table 2). And under their maximum impact conditions, the DNR shows that lake seepage rates will exceed recharge by from three to seventy-five times!

TABLE 1

LAKE SEEPAGES FROM DNR MODEL COMPARED TO REGIONAL RECHARGE

	Present Conditions		Maximum Impact	
Lake	Seepage (in/yr)	Seepage/ Recharge	Seepage (in/yr)	Seepage/ Recharge
Duck	22.17	3.0	24.64	3.3
Deep Hole	45.25	6.0	76.93	10.3
Little Sand	8.20	1.1	67.8	9.0
Skunk	44.48	5.9	562	74.9

Note: Present and impact condition values use WDNR2 lake bed permeabilities; impact assumes no ground water mounding. Recharge value is taken to be 7.5 in/yr, the average rate quoted in the DEIS. Lake areas from DNR model.

TABLE 2

PRESENT LAKE SEEPAGES FROM EXXON CONSULTANTS COMPARED TO REGIONAL RECHARGE

	IT Model Using WDNR2		Dames & Moore Water Budget	
Lake	Seepage (in/yr)	Seepage/ Recharge	Seepage (in/yr)	Seepage/ Recharge
Duck	22.00	2.9	18.60	2.5
Deep Hole	40.82	5.4	8.75	1.2
Little Sand	8.54	1.1	8.51	1.1
Skunk	7.65	1.0	127.8	17.1

Note: IT results from GEOFLOW using WDNR2 permeabilities. Recharge value is taken to be 7.5 in/yr. Lake areas from DNR model.

My own review of DNR's model (letter to N. A. Ostenso of March 10) indicates that the DNR impact seepages could be as much as 60% low.

Clearly the four lakes in question are not perched or isolated from the ground water. Yet despite the relabelling, they are still being treated as (274) such. This issue will become much more important in the final two chapters of the DEIS where pumping's impact on these lakes and the mitigation plan for that impact are covered.

IV. COMMENTS ON CHAPTER III OF DEIS--ENVIRONMENTAL IMPACTS

A. General discussion of ground water models

The DEIS relies heavily upon the results of digital computer models to predict the impacts of the mine project on ground water levels, lakes and streams and ground water quality. Such models can be very useful and valid predictive tools if (and only if) their use meets the following criteria:

1. That they use mathematically correct approximations of natural phenomena (their equations must be mathematically and physically correct),

2. That the hydraulic variables put in them be measured on site using proper techniques,

3. That the boundary and initial conditions imposed on the system be hydrologically correct,

4. After 1, 2 and 3 have been put in the model, that it then be calibrated against real, unbiased field observations made at the site being modelled,

5. That the calibrated model then be verified against an independent set of observations, and finally

6. That the model then be used to predict only within its limits.

   a. It should be used to predict into the future no longer than any assumptions made in 2 and 3 are reasonable,

   b. It should be applied only within the limits of mathematical correctness,

   c. It should be used only within the area for which calibration and verification worked, and

   d. It should not be used to predict a single value, but rather a range of impacts consistent with the uncertainty built in through steps 1-5.

The models used to predict flow and water level impacts in the DEIS generally satisfy 1, 2, 3, 4 and a, b and c. Specific comments will follow, but in general, I believe that the ground water flow system is modelled well enough that the predicted impacts are reasonable in a relative sense (but the absolute values may be questionable). One major area of concern is the validity of the models in the vicinity of the lakes near the MWDF, a subject discussed in my criticism of the lake seepage modelling.

In contrast, the models used to predict ground water contamination fail to satisfy criteria 2, 3, 4, 5, 6a, 6c, 6d and probably 6b. No evidence has been presented by any of the modellers to show why their model is valid despite failing to meet eight of nine critical conditions. Therefore I conclude that the projections of contaminant transport and impacts on ground water quality

are without scientific merit. They cannot be treated as meaningful predictions.

B. Comments on specific Crandon models

Drawdowns and lake seepages at Crandon have been predicted by D'Appolonia/IT using GEOFLOW. In addition, the DNR developed its own water budget model for lake seepages. These models have been reviewed in detail in Cherkauer (1986a, 1986b, 1986c).

Contaminant transport models have been developed by both D'Appolonia/IT and USGS/DNR. The former use GEOFLOW as their base. A one-dimensional vertical model predicts movement of leachate from the MWDF to the water table. At that point the one-dimensional vertical model output (chemical concentrations through time) is used as input to both a two-dimensional vertical and a two-dimensional horizontal model. These both predict flow and then couple contaminant transport to the ground water flow to predict the distribution of contaminants in a vertical section and a map view respectively. All these models are linked together with a serial connection from the one-dimensional to the two-dimensional versions. This point is important because any errors or biases in the one-dimensional model automatically are fed to the two-dimensional versions as input.

The USGS/DNR model is a separate effort. Flow in the unsaturated zone is assumed to be instantaneous so there is no need for a one-dimensional vertical version. Results are only presented in a two-dimensional vertical version. Based on a telephone conversation with Ken Wade of the Wisconsin DNR on April 30, 1986, it is my understanding that the USGS/DNR results shown in the DEIS are being revised considerably.

1. Drawdown modelling (D'Appolonia/IT)

   In my opinion, this effort is satisfactory and the predicted drawdowns are reasonable. The model is programmed to underestimate the amount of water seeping from the lakes near the MWDF which, in turn, causes over estimation of drawdowns near the lakes. For the assessment of drawdown impact, this is a conservative bias (it overstates the impact). It is not conservative for estimates of lake seepage, however.

2. Lake seepage modelling

   GEOFLOW (D'Appolonia/IT) has a bias built into it at Duck, Deep Hole, Little Sand and Skunk Lakes. The water table configuration assumes no influence from the lakes (no mounding). In turn this has caused GEOFLOW to underestimate lake bed hydraulic conductivities and thus the increases in seepage due to mine operation. The DNR seepages, which are much higher than those originally estimated with GEOFLOW, may still have some vestiges of this bias built in.

   Users of both the GEOFLOW and DNR models proclaim that for a given set of conditions their model can predict a single seepage value rather than a range. Both these models have substantial uncertainty built into them because of uncertainties in their input data. Thus both should be used to predict a range rather than a single value. In two earlier reviews (Cherkauer 1986b, 1986c), I have shown that this fixation on a single

value coupled with the underestimation of lake bed hydraulic conductivity could mean that both models underestimate the worst possible impact by as much as 60%.

The DEIS uses the DNR model results for the expected case as indicative of impact. Instead DNR's worst possible case plus 60% should be used. Because the worst possible case isn't used, the mitigation plans discussed later are inadequate to deal with the entire range of possible impacts. No provision is discussed for expanding mitigation.

(276)

3. Contaminant transport modelling.

I have already stated my general distrust of these models. The reason for that distrust is the failure of these models to meet most of the simple criteria I set out for judging a model's validity. Specifically the problems are:

a. The single most critical variable in the transport of contaminants at Crandon (as shown by IT's own sensitivity analysis) is dispersivity. Dispersivity was never measured at the site. Instead values were pulled from the literature from sites which were hydrogeologically unrelated to Crandon.

(277)

b. The contaminant transport parts of the models were not calibrated. Because there has been no contamination at Crandon, there are no data against which to calibrate. Therefore, there has been no test of the models' validity at Crandon. Furthermore, a simple calculation using D'Appolonia's own flow data indicates it should take water about 40 years to flow from the MWDF to the compliance boundary. Yet Fig. 3-8 in the DEIS shows that the two-dimensional vertical model shows the sulfate carried by that water takes over 9,000 years to travel the same distance (arrival of a sulfate concentration of 1,000 mg/l would indicate the midpoint of the leachate front had reached the boundary). Sulfate is assumed non-reactive and its apparent movement is slowed only by dilution. Is there sufficient dilution to explain this huge discrepancy between a calibrated flow model and an uncalibrated transport model? Or is the latter in error? Neither the DEIS nor its supporting documentation provides sufficient information to assess the dilution calculation used, but my opinion is that the transport model is wrong.

(278)

c. In fact, the transport models were not even tested at other sites where contamination has occurred to show that they can reproduce observed conditions.

(279)

d. The models were, of course, not verified because that step follows the missing calibration.

(280)

e. Three boundary/initial conditions built into the GEOFLOW models are questionable:

1) These models are run to steady state (9,000 yrs) and the assumption is made that the MWDF cap remains 90% functional for that time period. In Wisconsin, no similar geomembrane has been in existence for more than two years (DEIS, p. 212). How is it possible to assume that one will last 4,500 times that long?

(281)

2) All runoff from the cap drain is entered to the model as ground water recharge at the MWDF boundaries. This move implicitly assumes there will be no evapotranspiration losses from the deepened drain area into which this water flows and that that receiving area will be adequate to hold all the cap drainage. If the latter is untrue, water will overflow the drains and spill to the surface where runoff and evaporation will remove some of it. This reduces the amount of water entering the ground water, reduces the dilution and speeds up the migration of contaminants in the model.

(282)

3) The models assume that the underdrains on both the cap and the liner will continue to function fully for 9,000 years--with no maintenance after 66 years. Clogging of the drains causes either assumption 1) or 2) above to fail and either generates more leachate or less diluting recharge. Either will increase the rate at which contaminants migrate from the MWDF.

(283)

f. Along these same lines, the D'Appolonia/IT models have consistently been programmed in a non-conservative fashion (to produce a prediction which is not the worst possible case). Table 3 shows the parameters or assumptions which have been built into the one-dimensional and two-dimensional vertical models. When actual conditions are unknown but a range of possible values is available, D'Appolonia/IT has chosen to select the least conservative value (the one which minimized contaminant transport in the model) or something close to it in almost every instance (Table 3). The result is a strong bias toward the best possible contamination picture.

(284)

The one-dimensional vertical model predicts the slowest possible delivery of contamination to the water table. That delivery rate is input to the two-dimensional vertical model which then is automatically biased away from the worst case. Additional non-conservative inputs are made in the two-dimensional model so that its results simply bias the picture still further.

(285)

TABLE 3

ANALYSIS OF THE CONSERVATIVENESS OF ASSUMPTIONS AND PARAMETERS USED IN SOME OF THE CONTAMINANT TRANSPORT MODELS

Parameter or assumption	Most conservative end of range	Least conservative end of range	Value used by D'App/IT	Value used for results shown in DEIS
One-dimensional Vertical Model				
Unsaturated zone thickness	8m	13m	8m	8m
Till properties	heterogeneous	homogeneous	homogeneous	homogeneous
Degree of cap membrane failure	100% failure	100% failure	100% failure	100% failure
Duration of cap membrane integrity	0 yrs.	9,000 yrs.	9,000 yrs.	9,000 yrs.
Two-dimensional Vertical Model				
Longitudinal dispersivity (α_L)	5m	60m	60m	60m
Dispersivity ratio (α_L / α_T)	1,000	5	50	5,20,50 & 1,0
Amount of cap drainage assumed to recharge at MWDF boundaries	0%	100%	100%	100%
Inclusion of dilution beyond MWDF boundaries	Model ignores	Model includes	Model ignores	Model ignores

The DEIS has chosen to parrot all of the non-conservative assumptions of D'Appolonia/IT (Table 3) except that on the dispersivity ratio. For that parameter, model results for all the tested values are shown (Figs. 3-6 and 3-7). However, the end result of these assumptions is that the vertical distributions of contaminations shown in the DEIS are almost the best possible case. Moreover, the DEIS grossly underestimates the rates of delivery of contaminations to the compliance boundary and strongly misrepresents the distribution of concentrations of sulfate at any time.

(285)

g. Finally, the contaminant transport models have not been used to predict the full range of possible contaminant distributions. Instead they have been used to show what in my opinion is about the smallest impact possible. They have failed to show the worst possible case or anything close to it. Consequently they provide a totally inadequate base from which to predict possible ground water impacts. The DEIS's proclamation that there will be no significant ground water contamination is without foundation. Its failure to address contingencies in the event of ground water contamination is unjustified.

(286)

The contaminant transport models used in the DEIS have not been shown by DNR, by D'Appolonia/IT or by the DEIS to have any ability to correctly predict contaminant movement at Crandon. They apparently have been used in an attempt to capitalize upon policymakers' and regulators' enthrallment with computer results, and perhaps even to overwhelm the non-technical public with computer predicted chemical patterns. The ploy has been successful in the former instance because the results are presented as fact in the DEIS rather than highly uncertain, even erroneous, guesses. The writers of the DEIS have indiscriminatly accepted the transport model results and have used them to proclaim no ground water contamination impacts of significance will occur. That point remains absolutely unproven.

(287)

The DEIS makes the point that agreement between the IT and DNR/USGS models indicates the validity of the models. Nothing could be further from truth. First, DNR/USGS have withdrawn their initial modelled results (the ones quoted in the DEIS) because of subsequently discovered errors. Secondly, both DNR/USGS and IT used the same basic framework for modelling (similar boundaries and assumptions; similar lack of calibration or verification). The correspondence of their results merely shows that two separate models fed the same data will yield similar results. It is proof that two mathematical schemes will solve the same equations and get the same result--a verification that the mathematical solution techniques are good, not a verification that the models resemble reality.

(288)

C. Other comments on impacts

1. The statement made on p. 112 (DEIS) that "In the final cover remained intact, any percolating water would probably not contain sufficient DO [dissolved oxygen] to decompose the pyrite in the tailings" seems misstated. In fact any percolation will contain DO regardless of the status of the cap, and that DO will cause oxidation of pyrite to sulfate. The integrity of the cap will, however, control the amount of DO and thus the amount of sulfate generation.

(289)

2. On p. 113 (DEIS), it is stated the D'Appolonia found that "no significant changes in permeability resulted" from running simulated MWDF leachate through liner material.

(290) a. What does "significant" mean? Because the precision of hydraulic conductivity measurements is not high, it is possible that changes of up to 25% might remain undetected.

(291) b. Because D'Appolonia only ran a limited amount of leachate through the liner material in a short time (a few days), it is questionable that their results can be extrapolated to the 9,000 years of integrity needed according to the DEIS.

3. Relative to impacts on water wells, the DEIS (p. 115) states that "If other water wells are affected [by drawdown] they would be replaced or deepened as appropriate." (292) No mechanism is described whereby identification of such wells is possible. How will they be recognized? How will effects from the mine be separated from natural effects on water level?

4. In the discussion of the possible impact of mitigation pumping on water quality in lakes near the MWDF (p. 122-126), the DEIS provides no interpretation. It merely presents the projected water qualities at Deep Hole and Little Sand. It provides no judgment as to whether these qualities are good or bad or as to what criteria were used to make that judgment. Implicit in the absence of interpretation is (293) that these changes must be all right. Yet the water in these lakes will become harder and more alkaline during mining. It will contain more nitrates and dissolved solids. Then after mining has stopped, the water will slowly return to its original quality. Can the organisms in these lakes tolerate those two changes? How long will a return to original quality take? Why are these questions not addressed in the DEIS?

At Skunk Lake, mine effluent will be the source of mitigation water. That effluent will contain sulfate which is over 200 times more concentrated than the current lake water. Surely that change will impact the biota. How? Why isn't it discussed? Why are no (294) projected water qualities provided for Skunk Lake? How is it possible for a reader of the DEIS to ascertain whether the impacted water quality meets the criteria set in Table 3-9? The effluent exceeds the water quality criteria in Cr, Se, SO4, Fe and TDS; therefore it is possible for the final lake water also to exceed these standards.

5. The analysis of mitigation impact on lake water quality only examines the expected case. It does not consider what the impacts would be if mitigation had to deal with the worst case. Given my already expressed concern that the "worst case" (and even the "expected case") impacts on lake seepage presented in the DEIS may be low by as (295) much as 60%, it is obvious that the DEIS may be painting a much rosier picture of water quality impacts than is warranted. How do the lake qualities change if sufficient mitigation water is added to meet the DEIS's "worst case"? ... to meet that worst case + 60%? (Tables 3-7, 3-8 and 3-9 all need to be expanded to include these other cases.)

6. The analysis of MWDF seepage on surface water quality (p. 142-143) is inadequate:

(296) a. It relies on the chemical transport model results for sulfate deliveries. These models have already been shown to produce results which, if they have ANY validity, show only the minimum delivery of sulfate likely.

b. A single impact value of 6.9 mg/l sulfate for Hemlock Creek is cited in the DEIS (p. 143). Given all the variables that affect the water quality in such a calculation (ground water flow, stream flow, stream quality, ground water quality under impact and all the assumed conditions that went into the model to (297) produce it), it is difficult to understand how a single value rather than a range of values can be presented. It is even more difficult to understand how all surface water contamination from the MWDF can be dismissed on the basis of that one value.

(298) 1) How was the mixing calculation done? What ground water concentration of sulfate was used? What model did it come from (USGS or D'Appolonia)? What conditions were assumed for the model run?

(299) 2) If the model predicted a sulfate concentration delivered to the stream that is too small by a factor of 10 or 100 (as is quite possible with the inadequacies of these models), how would that change the impact on the stream?

3) All the variables used to calculate the final mixture concentration of 6.9 mg/l have inherent uncertainties or errors. Therefore the 6.9 mg/l must be expressed as 6.9 $\pm$ error. What is the range of that uncertainty and why was it not expressed in the DEIS? Unless the uncertainty range (300) is less than 2.1 mg/l, the upper end will exceed the 9.0 mg/l criterion used for Hemlock Creek. If that occurs, then negative impact IS possible. Since the transport models are incapable of predicting ground water concentrations to better than $\pm$ 100%, such impact is likely.

7. Is Exxon required to continue the mitigation of lake and stream (301) impacts for the 30 year period needed for ground water levels to return to pre-mine heights? If not, why not?

V. COMMENTS ON CHAPTER IV OF DEIS--ALTERNATIVES

A. Facility design

1. The discussion of liner materials makes it clear that economics dictated the choice of a plastic sheet over clay. As is stated on p. 212 (DEIS), no geomembrane has been in use in Wisconsin since before 1984. Therefore the reliability of such devices in untested. (302)

2. Cleanout pipes beneath the MWDF are discussed but are not included in the design. Why were they rejected? The precipitation of calcium sulfate and metallic hydroxides plus the growth of microorganism may possibly clog the underdrains. The entire impact analysis of the MWDF is predicated on the continual functioning of these drains over 9,000 years without maintenance. That seems an unlikely assumption on which to base the model. (303)

3. Similarly the geomembrane is assumed to remain 90% effective for 9,000 years. The possible causes of membrane failure have not been addressed. How will differential compaction or settling of the containing layers affect it? Will wetting and drying of the bentonite-amended soil cause problems? (304)

B. Monitoring

As discussed earlier in this report, the monitoring design needs to be expanded to include some control sites. Otherwise litigation on whether the mine or nature is the cause of water level declines will be frequent and scientifically unresolvable. Another alternative that should be explored is lengthening the monitoring period to be consistent with the length of time predicted as necessary for ground water contamination to occur. (305)

VI. GENERAL COMMENTS ON MITIGATION PLANS

One of the purposes of this review of the DEIS is to ascertain whether the mitigation/contingency plans proposed are really adequate to handle the worst possible impacts at Crandon. If they are, then the site plan is adequate. If they aren't, the the DEIS has failed to adequately address site impacts.

Three major potential ground water impacts have been identified:

1. drawdowns of ground water levels near the mine,

2. changes in lake and stream systems because of 1, and

3. ground water contamination from MWDF seepage.

I rate the mitigation/contingency plans for these impacts as follows:

1. The DEIS adequately identifies the potential magnitude of drawdown impacts but needs to better define how the effects of the mine operation on specific wells will be recognized.

2. The DEIS has not adequately defined the worst possible case impacts on lakes and streams. It has probably underestimated them. Therefore, the mitigation plans are all potentially too small (I estimate by 60%). It's not at all clear that the present mitigation wells could provide 60% more water if it were needed. Furthermore, the secondary effects of such an expansion have not been addressed. In my opinion, approval of the project in the form presented in the DEIS could lead to a situation in which the impacts of mine pumping on lakes and streams overwhelmed the mitigation system. Lake levels and streamflow would drop accordingly. Presumably Exxon would bear the costs of redress because this problem would occur while they were responsible for the site. Exxon's responsibility in this regard is not clear in the present mitigation plan. (306)

3. The DEIS unjustifiably claims there will be no ground water contamination from the MWDF. Therefore, no contingency plans for cleaning up contaminated ground water are even discussed. In my opinion, the work reported in the DEIS has merely identified the low end of the spectrum of possible contamination. The high end - the one for which contingency plans would be needed - has been ignored. Therefore, the DEIS is totally inadequate in this respect. (307)

   Storage of large volumes of contaminants (mine wastes) for long periods of time in a humid environment (such as Crandon) without some form of environmental contamination has NEVER been successfully accomplished in the United States. Therefore, it is unrealistic to claim, on the basis of some highly questionable computer model results, that such contamination will not be a problem at Crandon. Furthermore, history has shown us that contaminated ground water systems take many, many years to develop. At Crandon, if significant contamination were to occur, it is quite likely that it would occur after Exxon had abandoned the site. At that time, it seems likely the State of Wisconsin would be responsible for the cleanup because state agencies had issued the necessary permits and approved the monitoring plan.

VII. REFERENCES

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Cherkauer, D.S., 1986c. Review of Lake Water Budget Model of Wisconsin Department of Natural Resources for the Crandon Mine Site: April 14, 1986.

Cherkauer, D.S., 1986d. Review of Projections of the Transport of Chemicals for the MWDF to and Through the Ground Water System at the Crandon Mine Site: May 20, 1986.

Comments on the DEIS' Description of
Water Impacts of the Crandon Project

by

Dr. Arthur S. Brooks

June 1986

INTRODUCTION

This report on the Draft Environmental Impact Statement for the Exxon Minerals Company's proposed zinc-copper mine in Crandon, Wisconsin was prepared at the request of Trout Unlimited, Wisconsin Wildlife Federation, Sierra Club and Audubon Society, through the Public Intervenors' Office. I am an Associate Professor of Biological Sciences and an Associate Scientist at the Center for Great Lakes Studies at the University of Wisconsin-Milwaukee. I received my PhD in Environmental Biology in 1972 from the Department of Geography and Environmental Engineering at the Johns Hopkins University in Baltimore, Maryland. The research for that degree concerned the impact of industrial effluents on aquatic ecosystems. My Master's Degree in Zoology was granted by the University of Vermont in 1967 where I conducted research on the effects of temperature, stream flow and water quality on aquatic insects in a Vermont trout stream. My Bachelor's Degree is in Biology from Washington and Jefferson College, Washington, Pennsylvania.

Since coming to Wisconsin, I have taught university courses in limnology, invertebrate zoology, and advanced seminars in aquatic ecology and environmental pollution. My research, which has resulted in numerous scientific publications, has involved studies of the basic ecology of algae, zooplankton and water quality in Lake Michigan. I have also investigated the toxicity pollutants to aquatic organisms. My most recent research has involved studies of the incorporation of cadmium and selenium in aquatic organisms and the sublethal effects these elements have on individual organisms, populations and aquatic communities.

I am a member of several national and international professional societies and am an Associate Editor of the Journal of Great Lakes Research. I have also served on the Mayor's Task Force on Non-Point Pollution in Milwaukee and am presently a member of the North Shore Technical Advisory Committee on Shore Erosion.

This review is based on information presented in the Draft Environmental Impact Statement (DEIS) prepared by the Wisconsin Department of Natural Resources. Pertinent sections of the Exxon Environmental Impact Report and DNR documents have also been reviewed. All comments on the DEIS, however, are based on data and information contained in that document, since it is the official public document describing the environmental impacts of the project to the public.

My objective in reviewing this material is to assess the adequacy of the DEIS insofar as it describes the surface water impacts of the Crandon Project. I have attempted to review both the direct and indirect effects of the project on surface waters and on the biological systems they support. Since the DEIS is the beginning of the review process of this Project, I anticipate that I will continue to be involved in reviewing the surface water issues through the permitting process.

The aquatic environment to be impacted by the project is located in northeastern Wisconsin in Forest and Langlade Counties. The ore body is located 5 miles south of the City of Crandon. The Environmental Study Area, defined by DNR as an area within 5 miles of the ore body and proposed mine

structures, lies within the Wolf River drainage system. The perfect site is in a northern hardwood forest with interspersed wetlands. The surface waters of the study area and project site are illustrated in Figure 1-2 of the DEIS. The lakes, streams and wetlands of the area, with few exceptions, are intimately connected to the groundwater underlying the site. The chemical quality of the surface waters is determined to a large degree by the relative contributions of groundwater and surface drainage to a specific water body. The groundwater tends to be hard and alkaline with a relatively constant temperature averaging 45°F. The surface drainage is softer, more acidic and tends to follow atmospheric temperatures on a seasonal and daily basis. The biota of a particular lake or stream is strongly influenced by water chemistry and temperature, which is determined by the mix of water sources supplying it. Warm, softwater lakes and streams tend to support a warmwater fishery, while colder, hardwater alkaline waters will support trout.

The information presented in the Draft Environmental Impact Statement indicates that there will be four major impacts on the surface waters of the region. The first will be the exposure of large areas of open soils and mined materials to erosional processes. The transport of these materials to nearby streams and lakes would have a significant detrimental impact on the surface water bodies if erosion control measures were not rigorously enforced. The second will be the effects of groundwater drawdown and mitigation on the physical, chemical and biological environment of the surface waters. The third impact will result from the effects of metals and other pollutants on organisms living downstream from the wastewater discharge to Swamp Creek or in areas receiving contaminated mitigation water. The fourth impact will be the long term effect of seepage from the mine waste disposal facility (MWDF) on the aquatic environment during operation and after project closure. Each of these major impacts as well as others will be discussed in the following sections.

SOIL EROSION AND SEDIMENTATION OF LAKES AND STREAMS

The removal of vegetative cover and the exposure of topsoil, glacial till and mine wastes to erosional processes poses a significant threat to streams and lakes within the project area. The Draft states, "Potential impacts of soil erosion include . . . coverage of adjacent soils, wetlands and vegetation, and reduced water quality," but no analysis of these possible impacts is provided. The environmental impact of these effects would be minimized, according to the Draft if (and this is a very big if) the proposed
308 erosion control plans are properly implemented. The DEIS describes the plans which have been proposed to reduce siltation of streams and lakes, however, if they are not meticulously implemented or if there is any breach of the sedimentation ponds, siltation barriers or curtain walls, the effects on trout habitat could be devastating. Gravel beds essential for trout reproduction and the growth of suitable food organisms would be quickly smothered by such a break. Reduced stream flows resulting from groundwater drawdown would further aggravate the situation by reducing velocities and particle carrying capacity, thereby reducing the ability of the stream to recover naturally. Lakes receiving sediments would be permanently effected as no natural cleansing process would remove added solids.

The literature is replete with studies of the effects of siltation on stream flora and fauna and the filling of wetlands. The destruction of vast areas of prime aquatic habitat can be accomplished in a matter of hours if

proper erosion controls are not implemented. Gravel surfaces required for fish spawning and by many stream insects can be covered by soft materials eliminating these habitats from an impacted stream. High turbidity associated with the erosion of fine materials reduces oxygen transport efficiency at gill surfaces, reduces visibility and, therefore, the feeding ability of visual predators such as trout and other fish species. Shallow wetlands used for fish spawning and nursery areas can also be filled by soil eroded from construction or reclamation zones. (308)

The areas most likely to be impacted by soil erosion are stream reaches downstream from construction sites. The construction of utility right-of-ways across or under stream beds, the building of bridges and culverts for the access road and rail spur and the installation of the wastewater discharge structure on Swamp Creek will produce the greatest direct disturbance of surface waters. Construction alternatives which minimize these crossings should be given high priority. Major construction of the mine-mill site, the mine waste disposal facility, associated roads, and pipelines would also increase siltation rates.

Other potential sources of sediments, not identified in the DEIS, include well drilling for mitigation water, construction of mitigation discharge structures, and other dispersed construction activities. As much care must be exercised to control erosion at these locations as is described for the major construction areas.

The short and long-term impacts of an accidental breach of the soil erosion control measures must be addressed and a contingency plan for dealing with such a breach must be developed and included in the final Environmental Impact Statement. Adequate on-site staff should be provided by DNR to ensure proper implementation of the specified soil erosion abatement measures and to initiate remedial action if required.

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GROUNDWATER DRAWDOWN AND MITIGATION

The pumping of groundwater from around the mine works will create a cone of depressed ground water elevations which will reduce water levels in nearby lakes and reduce flows in streams. The effects of the drawdown on surface water levels and flows are projected in the DEIS, however, the environmental impacts of these changes for the period of operation and following closure are not adequately addressed.

Whereas the direct physical effects of groundwater drawdown on lakes and streams are described, many questions about the impacts of these changes and mitigation remain unanswered. If only basic physical and chemical variables are examined, it is obvious that major changes in water quality will result from mitigation. During summer and winter when mitigation pumping occurs the temperature difference between surface waters and the groundwater used for mitigation will be the greatest. The possible alteration of natural temperature cycles, which often serve as cues for biological events such as fish spawning and insect development, should be documented thoroughly. The effects of discharging water either warmer or colder than ambient temperatures on stratification and mixing cycles in lakes receiving mitigation water should also be investigated. It is stated in the DEIS that mitigation pumping would be "triggered" by a specified low water level. The sudden discharge of water (309)

of different physical and chemical quality could adversely "shock" organisms which are acclimated to normal surface water conditions. The impacts of such events should be addressed. (310)

Chemical differences between mitigation water pumped from ground water aquifers or taken from the water treatment system and surface waters must also be considered. The range in groundwater quality values listed in Tables 2-2 and 2-3 is significant relative to surface water conditions. It is important that the specific source and quality of mitigation water for a particular lake or stream be specified and matched with surface water quality conditions as closely as possible. The depth of the mitigation wells must not extend into aquifers with high mineral content such as these listed in Table 2-3. It should be demonstrated that ground water reaching the surface and coming in contact with oxygen, which may have to be mechanically enhanced, will not form mineral precipitates in the receiving water body. Oxidized iron, for example, can form deposits which will significantly alter the bottom substrate of a lake or stream making it uninhabitable for many organisms. (311)

Little Sand Lake may be used as an example of how the addition of mitigation water to a surface water body could alter the natural chemical balance. The lake is described as an unstratified seepage lake containing soft water with a mean hardness of 11 ppm and an acidic pH averaging 5.4. Table 3-7 projects that the effects of mitigation pumping will increase the hardness over six fold and the pH will rise to 6.6. These projections are based on the expected situation and have not been presented for the worst case conditions which could arise. Although the expected changes are within the limits of water quality criteria, they do alter the natural chemistry of the lake significantly and would result in changes in the species of organisms inhabiting the lake. The environmental impact of such changes are not disclosed in the DEIS nor are the water quality and biological impacts which would result under the worst case conditions. (312)

Plant nutrients such as nitrogen and phosphorus will also increase in Little Sand Lake because the range of concentrations of these elements in the groundwater is greater than those cited for the lake itself. Increased algal productivity could result from this change further altering the ecology of the lake and the quality of the water flowing from the Lake to Creek 12-9 and on to Rolling Stone Lake. Other chemical constituents in the mitigation water, such as heavy metals, would also raise the concentration of these elements in the lake (Table 3-8 DEIS). If treated mine water is used for mitigation in addition to groundwater, the expected concentrations cited in Table 3-8 would be higher still. The specific effects of metals contamination on the surface water ecology will be discussed in more detail in the following section. (313)

The net effect of mitigation pumping will be to alter the natural flow of groundwater and to disperse toxic metals from the project site through a diffuse system of streams and lakes. The ecology of these systems will each be impacted, while the monitoring of the impacts will be a complex task. The general effects described above for Little Sand Lake would be similar for other water bodies receiving mitigation water, the quality of which differs from ambient surface conditions. A more detailed analysis of the data from the "pumping tests" on Duck Lake should be included to provide information which would be useful in evaluating the impacts of mitigation on surface waters.

It is noted that terrestrial vegetation will encroach on wetland areas as water levels drop, however, there is no plan presented for the restoration of these areas when pumping ceases and water levels return to normal. If extensive terrestrial vegetation develops along the margins or lakes and streams, subsequent flooding will kill trees, which may be 30-40 years old, (314) and large amounts of organic debris will be submerged beneath the reformed lakebed. Such a situation would be aesthetically unpleasing and would create stagnant backwaters which would be slow to recover by natural processes. A plan for avoiding this situation or for restoring the wetlands and lake shore after closure must be addressed in the final EIS.

DISCHARGE TO SWAMP CREEK

The discharge of waste water from the Crandon Project to Swamp Creek could result in the bioaccumulation of heavy metals in aquatic organisms and changes in the natural species composition of the area. The environmental impacts to Swamp Creek from such effects are not adequately revealed in the DEIS. It is assumed that the constituents in the effluent will remain in solution, will not accumulate in bottom sediments and will not be bioconcentrated in the aquatic food chain. All of these assumptions should be considered to be false in determining the impacts to Swamp Creek and the Wolf River.

(315) The DEIS assumes that aquatic life will be protected if the water quality is suitable for sensitive zooplankton species. This is a reasonable assumption if the criteria which have been developed to protect these organisms are sound. The water quality criteria used in the DEIS are based on acute toxicity data determined by observing the lethal effects of short term exposures of an organism to a toxicant dissolved in water under laboratory conditions, Table 1-8, fn. 1, DEIS. In nature, the toxicant may initially enter the environment dissolved in water, but it may be rapidly absorbed onto particles in the water or be incorporated into the cells of algae and bacteria. In this particulate form, a toxicant is subject to ingestion as food by invertebrates and small fish which in turn incorporate the toxicant into their tissues. For many toxicants, including metals, the concentration is magnified with each step in the food chain. Hence, a fish eating an invertebrate could receive a toxicant in a much more concentrated form than was present in the water. This phenomena is referred to a bioaccumulation or biomagnification.

Bioconcentration factors for copper, zinc and cadmium in invertebrates are cited in the DEIS to range from 1,000 to 4,000, yet no adverse impacts are projected to occur. This statement appears to be based on the assumption that metals will remain in solution at concentrations which would not lead to excessively high levels in benthic animals or fish. Although the suspended solids concentration in the effluent itself is expected to be low, there is no reason to assume that metals in the effluent will not adhere to suspended organic and inorganic solids in the creek and become incorporated into food particulates or into bottom sediments of the creek. Once in the particulate form, the metals would be more readily available for incorporation by invertebrates and eventually fish.

The incorporation of metals by algae, bacteria and rooted wetland plants must also be addressed as a route for food chain contamination. Bioconcentration factors of metals in algae are as high as those cited above

for invertebrates. The direct incorporation of metals by plants at the base of the food chain could significantly increase the level of contaminants in higher organisms consuming the plants as food. The large populations of foraging minnows in Swamp Creek would readily consume this type of food and pass contaminants contained therein to predatory fish and waterfowl in the area.

The water quality criteria which have been applied to this effluent and others within the project area are based on acute, lethal effects resulting from direct exposure of test organisms to the substance in water. The effects of alternate routes of incorporation, such as the food chain, or sublethal (315) effects on a population or community of organisms have not been considered in establishing the water quality criteria in the DEIS. It is, therefore, not adequate to rely solely on published water quality criteria to determine the potential environmental impacts at a particular site. A thorough examination of bioconcentration through the food chain must be considered in determining environmental impacts. Further, sublethal effects, such as altered behavior patterns and reduced reproductive potential of aquatic organisms, must be included in the final impact assessment. The projected lack of impact must be substantiated with hard data from the field and laboratory to prove whether or not the metals will remain in solution and not be incorporated into the food chain to produce detrimental effects on the surface water ecology.

LONG-TERM IMPACTS FROM THE MINE WASTE DISPOSAL FACILITY

The long-term effects of the MWDF must be addressed in more detail. The significant differences in results between the different groundwater models applied to the area raises questions concerning the ultimate distribution of toxic materials released from the facility. As was the case with the erosion control plans discussed above, there are some important questions surrounding the stability of the material in the containment ponds. If the geomembrane does not stand the test of time or if the leachate collection system (316) malfunctions in some way, the projected impacts could be much different than those presented. A plan should be presented for continued interception and treating contaminated leachate if the closure of the MWDF does not function as planned. The true long-term impacts of the disposal site should be addressed beyond the period of closure and monitoring when groundwater flows may be different and the capacity of the soils to retard the flow of toxicants may be exceeded. Future problems stemming from this site should not be thrust on the public long after the responsible parties have gone. The potential impacts on surface waters are great and must be thoroughly understood now to avoid future problems.

MONITORING

The monitoring procedures adopted for this project must be incorporated in (317) an approved USEPA quality control quality assurance document. This is essential so that appropriate quality control checks can be verified and all data can be traced to a specific analyst and calibrated method.

The specific methodology to be used for chemical and biological monitoring should be referenced in the DEIS to assure that appropriate techniques are being used to assess the impacts. (318) The continuous monitors at the discharge lagoon should be tied to the plant control room so that a malfunction of the

wastewater treatment system could immediately be detected and the flow of effluent to Swamp Creek be stopped. There is no indication in the monitoring plan presented as to how such remedial action would be implemented either at the main discharge site or at other points of discharge. (318)

The biological and chemical monitoring in Swamp Creek above and below the discharge should be improved. Additional bulk sediment analysis should be incorporated in the plan to monitor the accumulation of metals in the sediments. The schedule for collecting benthic organisms from artificial substrates should be specified and be frequent enough to determine the effects of the discharge on the life stages of all species present. In addition, benthic organisms must be collected from natural substrates and subjected to elemental analysis to determine the rate of metals incorporation. These collections should include plant as well as animal material. The samples should not be stored for later analysis, as is stated in the DEIS, but should be analyzed as part of the regular monitoring schedule. The monitoring of biological material for toxics accumulation should also be conducted near the points of mitigation water discharge and where leachate from the MWDF may enter a surface water body. (319)

Intensive monitoring should be conducted for two to three years before operation and a period of five years after full operation before a reduced monitoring schedule is approved. This would be necessary to account for natural environmental fluctuations and to allow sufficient time for effects to be manifest in organisms with long life cycles. A control lake-stream system should be established in the vicinity of the project but outside the area of environmental impact to monitor any long-term natural variation which may occur. This would provide essential information to access the effects caused by the mining operation. (320)

It is stated in the DEIS that if monitoring indicates any adverse effect, the DNR would decide if any steps would be taken to correct a problem. Some definite limits must be established now, and corrective actions defined, to avoid a lengthy debate in the future concerning an "appropriate action."

ADDITIONAL IMPACTS

The impact of the project on waterfowl has not been adequately addressed in the DEIS. It is noted that 36 species of migrant marsh or waterfowl use the area. Open water is attractive to such birds and the MWDF and reclaim ponds could draw birds to the ponds. The impact of waterfowl using ponds containing highly toxic wastes should be addressed and an appropriate plan presented to eliminate any adverse impacts. A similar statement should be developed for other animals which might be attracted to the ponds for water or food if vegetation develops within the dikes. (321)

Various types of dust suppressants and herbicides will be used over the project site. The amounts and types of these chemicals must be specified and an approved application plan or alternative measures presented. The impact of these chemicals on the environment must be presented in the final EIS. (322)

SUMMARY AND CONCLUSIONS

Beneath the glossy cover and between the colored art work, the Draft Environmental Impact Statement for the Exxon Minerals Company's proposed

zinc-copper mine in Crandon, Wisconsin does little more than to restate data from the Exxon Environmental Impact Report. Several potentially significant environmental impacts are not addressed or are considered to have no detrimental impact on the surface water environment.

The principal environmental impacts of the project which are not adequately addressed in the DEIS are as follows:

(1) The impact of soil erosion and the siltation of streams, lakes and wetlands, which if allowed to occur unabated, will destroy valuable aquatic habitat and the species residing therein.

(2) The bioaccumulation of metals by organisms inhabiting areas near contaminated discharges which can lead to altered populations of invertebrates and fish.

(3) The alteration of natural surface water quality conditions by groundwater drawdown and mitigation pumping which will lead to changes in natural species assemblages in affected lakes and streams.

(4) The long term impacts of leachate from the MWDF which could contaminate ground and surface water with unacceptably high concentrations of heavy metals and other pollutants.

The final EIS should synthesize the total impact of the Project on surrounding lakes and streams and not concentrate exclusively on those systems within the site boundaries which will be directly impacted. Lakes and streams of particular concern are the upper and lower reaches of Swamp Creek, Hemlock Creek, Rice Lake and Rolling Stone Lake with its northern tributaries. The effects of all impacts of the mining project must be integrated into a concluding section of the final EIS. Such a section should consider the cumulative effects of the impacts discussed here as well as those resulting from atmospheric inputs and underground activities. Each potential impact cannot be considered as a separate, isolated effect but must be assessed in relation to the total environmental impact of the project.

8445H

COMMENTS & RESPONSES

JUN 30 1986

The State of Wisconsin
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June 26, 1986

Mr. Howard S. Druckenmiller
Director, Bureau of Environmental
Analysis and Review
Department of Natural Resources
Post Office Box 7921
Madison, Wisconsin 53707

Re: Draft Environmental Impact Statement Comment/Crandon Project

Dear Mr. Druckenmiller:

Enclosed is a copy of a review of some of the socio-economic impact analysis done by the Department on the Crandon project. The review was done by Professor Alenen at the University of Wisconsin. Professor Alenen's remarks have great pertinence to the Draft Environmental Impact Statement, especially since the statement does not analyze mine shutdowns and their effect on communities. I am submitting Dr. Alenen's comments as supplemental DEIS comments on behalf of the Public Intervenor's office.

Sincerely,

Waltraud A. Arts

Waltraud A. Arts
Public Intervenor

WAA:pl

cc: William Tans
Professor Alenen

JUN 30 1986

DEPARTMENT OF LANDSCAPE ARCHITECTURE • SCHOOL OF NATURAL RESOURCES
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June 13, 1986

MEMO TO: Waltraud A. Arts, Assistant Attorney General

FROM: Arnold R. Alanen, Professor and Chairman

SUBJECT: Comments on Denver Research Institute, "Preliminary Socioeconomic Impact Analysis of Exxon's Proposed Crandon Project"

This review, by necessity, is brief, and is directed almost entirely to certain socioeconomic and cultural considerations that have proved to be important throughout the entire Lake Superior region, both in previous years and at present. The comments are an outgrowth of the author's long-term interest in the historical development of this region.

Mining activities have occurred in the Lake Superior region since the mid-1840s when copper deposits in northern Michigan began to be exploited. Copper mining was followed by the initiation of iron ore extraction on the Marquette Range (Michigan) in 1846, Menominee Range (Michigan) in 1877, Gogebic Range (Michigan and Wisconsin) in 1884, Vermilion Range (Minnesota) in 1884, Mesabi Range (Minnesota) in 1892, and Cuyuna Range (Minnesota) in 1911. Today, only one copper mining operation--at White Pine, Michigan--is active. Likewise, virtually all of the high grade iron ore mines have closed, although the processing of low content taconite ores has allowed mining activities to continue in areas of Michigan and especially Minnesota. Consideration of specific phenomena within the region can at least provide additional questions (if not the answers) that were not addressed completely in the PSIA for Crandon.

I. Though the PSIA mentions the need to identify the implications of a premature closure or suspension of the project during its construction and/or operational phases, the impacts are perhaps understated (p. 153). (323) Disruptions to personal and business income and to public finance are mentioned, as are the resulting commercial failures, layoffs, and out-migration of individuals that will occur. These are very likely and real possibilities, but little mention is given to the actual social costs that will result from such occurrences.

The history of the Lake Superior mining region is replete with examples of boom and bust cycles of mining activity. During previous eras laborers simply accepted the fact that mining activities could shut down on short notice. Individuals either attempted to get by on limited resources during periods of unemployment and recession, sought out other jobs in the area (such as farming the cutover land), or moved to employment areas elsewhere.

Today, unemployment compensation and other programs afford some protection for people working in the mining industry, but the impacts of layoffs and shut downs are no less onerous than in the past. In White Pine, Michigan, where employment figures have varied from several hundred to several thousand persons since operations began in the 1950s, recent declines in copper prices resulted in the complete shut down of activities during the 1980s. Only when the operation became an employee-operated concern in 1985 did the copper mining and processing activities commence again--but at much reduced levels. When massive layoffs began, those individuals who wished to leave the area were faced not only with long-distance moves, but also with disposing of their real estate. Since many had purchased their homes during periods of prosperity, housing prices at that time were driven upward; during the most recent period, when mining operations actually shut down, there was a pronounced deflation in housing prices, and some people who sold their units actually experienced a net monetary loss.

In Minnesota, where a recession in the steel industry has resulted in severe employment reductions in taconite mining and processing, the impact has been similar, but at a much larger scale. Internal Revenue Service data indicate that from 1981 to 1984 the Minnesota mining region lost 6.1 percent (17,000 persons) of its 1980 population base. In addition to the Twin Cities, major destinations for the out-migrants included the Pheonix and Los Angeles metropolitan areas, as well as Alaska and Houston; for those laid-off workers who have stayed, the alternatives have been food stamps, welfare payments, and low-paying, part-time work. In addition, people who emigrated to the area during the boom period of the late 1970s or who formed households at this time paid premium prices for their homes; today, the housing market is depressed throughout the region and for sale signs are evident everywhere.

II. The PSIA for the Crandon project also makes an effort to assess the geographic area that will be impacted by the introduction of a new employer--i.e., the mining operation (p. 33). In their estimate, EMC considered the area within a one-hour commute as forming the primary employment shed for the project. Previous and present experience in the region indicates that people will travel long distances in search of jobs (324) that are relatively high paying. In the White Pine area, for example, a large portion of the work force commuted from other counties in northern Michigan and Wisconsin to the site. Commuter bus service was provided from centralized pick up points; this daily movement of employees to White Pine occurred even though a new town had been built to house a portion of the work force.

In Minnesota rather precise data from the mid-1970s exist for the commuter sheds that developed around two taconite mining-processing operations of the Reserve Mining Company.* The mine site at Babbitt employed 1,640 workers. Of these, 43 percent lived in Babbitt itself, while 33 percent commuted from Ely, situated some 25 miles away. The amount of movement between the two towns was sufficient to support two bus companies in the 1970s. The taconite processing plant at Silver Bay, with a 1975 work force of 1,430 people, derived 62 percent of its employees from the community; another 19 percent commuted from Two Harbors, located 35 miles from Silver Bay.

*Barton-Aschman Assoc., Inc. Draft Environmental Impact Statement: Reserve Mining Company's Proposed On Land Tailings Disposal Plan, 1975.

One in four of all employees at both operations resided more than 20 miles away from the place of employment. For some the distance was considerably longer. A total of 75 Silver Bay employees came from Duluth--a distance of over 50 miles--while smaller numbers were from even more distant points. These individuals commuted on either a daily or a weekly basis.

III. The issue of public services is addressed in the PSIA to a fair extent. Obviously a sudden influx of workers and their families can place severe pressures upon local facilities. If efforts are made to (325) expand services during this period, they can prove to be excessively expensive to operate if the population or economic base eventually shrinks. Though the magnitude of scale and the duration of time have been significantly greater in Minnesota, that area of the region does provide some cautionary evidence for future developments in Wisconsin.

The communities of the Mesabi Range, which are closely spaced along a distance of some 75 miles, developed separate service systems--i.e., municipal buildings, sewer and water, schools, etc.--over the span of several years. Today, much of the infrastructure is redundant, if not inadequate, and in various states of disrepair. While each community fiercely guarded its independence over the past decades, now these towns are finding it necessary to share and consolidate services to an extent never deemed feasible in the past. Nowhere is this more evident than in the case of the school systems where significant consolidations have occurred during recent years. This means, of course, that several of the large, well built educational edifices are under-utilized, if at all.

IV. Implications: Though past will not necessarily be prologue when considering the Crandon area as a possible reflection of the entire Lake Superior mining region, some phenomena undoubedly will be repetitive. The most obvious occurrence is likely to be pronounced fluctuations in mining activity. The production of ore is highly dependent upon the quality and quantity of the resource, but changes in demands, technology, and national-international events also play a significant role. There (326) certainly is more than a 50 percent chance that the Crandon project, once it commences, will encounter the very same fluctuations in production demands; therefore the Mine Impact Board probably will have to consider such possibilities throughout the entire lifetime of mining operations. To avoid the sudden disruption generally associated with mine closings or cutbacks, the state and the communities may wish to request representation on the local corporate operating unit that will oversee the Crandon project. In this way some preliminary indication of major changes could be determined by the community at large before the full impacts are experienced.

Local communities and governmental units will have to plan for a range of new or expanded requirements that they will encounter once mining begins. Sharing of personnel, facilities, and services might be considered to a much greater extent than they have in the past. Coordination of school facilities could permit under-utilized buildings to accommodate overflows in other communities; and planners, engineers, and technical staff could be shared by several communities or counties. At the very least, the units of government in the area must develop a basic level of mechanisms that will permit them to deal with a range of uncertainties they will encounter for many years.

The State of Wisconsin
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JUL 7 1986

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July 3, 1986

Mr. Howard S. Druckenmiller, Director
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Madison, WI 53707

Re: DEIS Comments

Dear Mr. Druckenmiller:

The following are additional DEIS comments for the record based on comments made orally at the hearing and on comments filed by other participants in the DEIS public comment period.

Contaminant Transport Modeling

As an alternative to the modeling presented in the DEIS, the (327) DNR should re-run the model with conservative assumptions for each parameter. The present modeling really represents a "best case" contaminant transport picture since seven (7) of the nine (9) variables chosen in the modeling are the least conservative variables. In addition, contingency measures should be proposed (328) for ground water contamination from the project site, especially the MWDF.

MWDF

The design of the facility depends on neutralizing the acid generation potential of the tailings by the addition of lime. No calculation is included on how much lime or water treatment (329) sludge would be necessary to prevent acid formation. What is the volume of lime, either added lime or as part of the water treatment sludges, would be necessary to assure the ph would remain above 4?

The operations plan for the tailings does not insure that pyrite oxidation will not occur. If the ph drops due to oxidation, thiobacillus could become established which would result in further drops in ph. It is easy to see how the (330) reactions could become self-sustaining. Since the bentonite-amended soil liner will lose its ability to contain the wastes in an acid environment, the presence low ph conditions present the risk of a major failure of the liner. How does the Department

plan to insure that acid conditions are not generated in the tailings other than by monitoring of the leachate? By the time the leachate is monitored, significant acid formation could already have taken place.

What possibility is there of piping in the bentonite-amended (331) soil liners under the MWDF, reclaim ponds, and other project facilities? Piping failures are common problems which can lead to ground water contamination.

If, for some reason such as less than expected mine inflow, the water treatment plant does not produce the expected volume of (332) sludges with neutralizing capacity, will the applicant be required to provide additional lime? How will the acid (333) conditions in the tailings mass be monitored during operations? Has any calculation been done to estimate whether the expected sludge volume would neutralize the tailings? How much lime would (334) be required and would this amount of lime change the sizing requirements of the ponds?

The public should be informed that if the ph drops in the tailings mass, the waste and leachate would be incompatible with the bentonite-amended soil liner. Furthermore, acid conditions (335) would result in the classification of the waste as hazardous. Since the design does not meet federal requirements for hazardous waste containment, the generation of acid in the tailings could render the design ineffective to prevent leachate from reaching the ground water, especially during operations.

The DEIS does a very poor job of explaining the concept of (336) directing precipitation to the tailings pond perimeters so it will infiltrate the outer edge of the tailings mass. What is the purpose of this infiltration since standard design practices call for directing water away from the facility after closure? What is the potential impact on embankment stability of having this (337) water directed into the embankments? This represents a change from the applicant's original closure water handling plan. What is the reason for the change?

Since the MWDF cap will have to remain an effective barrier to water entering the tailings in perpetuity in order to prevent (338) ground water contamination, it is reasonable to assume that repair or replacement of the cap will be necessary at sometime. What is the known life of the geomembrane which forms the first barrier to precipitation? In current dollars, what would it cost (339) just to replace the geomembrane? Since it is foreseeable that the cap will have to be replaced, the DEIS should include an estimate of the cost and probable timing of cap replacement.

The constructibility of the MWDF liner is based on low permeabilities which were achieved in the lab. EPA no longer relies on lab permeabilities as evidence of what field (340) permeability will be since the field data is often one to three orders of magnitude higher than the lab data. A test fill of at least 100 sq. ft. should be required to determine if the projected low permeabilities can be achieved in the field. The data on permeabilities in the DEIS should be qualified as lab data subject to a significant variation in the field.

The potential of acid generation from waste rock storage and waste rock used as rip rap is not adequately addressed. These (341) materials are subject to the same oxidation and acid production problems as the tailings. Since an estimated 400,000 T. will be used as rip rap, there is a significant problem. Will the applicant be required to use non-waste rock rip rap on stream (342) crossings, culverts, discharge structures, etc. What volume of acid run-off will go into the tailings ponds from the pyritic waste rock? The liner of the pre-production ore pad does not (343) include a leachate collection system. Will the acid run-off from the waste rock make this liner ineffective to protect the ground water?

The estimated 525,000 T. of coarse fines to be used as mine (344) backfill are not analyzed in terms of their capacity to pollute the ground water after the abandoned mine is filled with water. What is the potential for acid drainage especially in the 2-3 years it will take the mine to fill with water?

Socio-Economics

I am attaching a 1983 memo from the Wisconsin Department of Health and Social Services outlining some of their concerns regarding the lack of health-related data in the DEIS. Many of (345) the comments made parallel my concerns about the lack of information in the DEIS on the toxicity of certain materials being brought to the mine site. The Department had this memo for over three years before it issued the DEIS, but I see no attempt to deal with the issues in the DEIS. These questions should be answered in the FEIS.

Mitigation Plan

After closure of the mine, pumping will be halted but it will require many years (up to 30) for the ground water gradients (346) to return to their pre-mining patterns. When is the proposed mitigation be halted? The effects on surface waters will not

terminate when pumping stops, but there is no provision in the DEIS for continuing water supplements until the gradients are re-established.

Water Quality

The Department has not provided any guidance to the public on what ground water standards will be used under various project (347) facilities in the DEIS. Which facilities, if any, will be covered by NR 140, Wis. Adm. Code? Will Exxon be permitted to (348) pollute to federal maximum limits even though it would degrade present quality of the ground water, NR 182.075, Wis. Adm. Code?

In the surface water area, the Department has not stated whether it will consider arsenic a human carcinogen. EPA has set surface water limits for arsenic at .190 microgram/liter (chronic) and .360 microgram/liter (acute). The Wisconsin limits (349) are .290 microgram/liter (chronic) and 1.480 microgram/liter (acute). The EPA criteria were issued in September, 1985, as part of a Health Advisory on Arsenic. Does DNR intend to change the surface water criteria for arsenic based on EPA's new numbers?

Sanitary Landfill (MRDF)

Will the Department use NR 140, Wis. Adm. Code, ground water (350) standards under the MRDF? All other sanitary landfills in the State are regulated by NR 140, Wis. Adm. Code.

Will the MRDF be covered by the closure and long-term care (351) requirements of NR 132.09, Wis. Adm. Code or the provision in sec. 144.441, Stats?

(352) Will an air curtain destructer be required for the burning of wastes as part of the MRDF operation?

How will the storage of water treatment sludges during site (353) construction be handled? The DEIS does not describe where these sludges will be stored until they can be placed in tailings ponds.

(354) Will the leachate generated by the MRDF be compatible with the proposed bentonite-amended soil liner?

Section 144.44(2)(nr). Stats. defines the need and design (355) life requirements for sanitary landfills. Will these provisions be used to regulated Exxon's proposed MRDF? If not, what

(355) provisions of need and design life does the Department intend to apply to this facility?

The negotiation-arbitration process found in sec. 144.445(12)(d), Stats., applies to all solid waste facilities, (356) and gives affected municipalities the opportunity to participate in the process. Will this statutory provision be applied by DNR or will Exxon be exempted?

NR 180.13(3)(a)6., Wis. Adm. Code, creates a prohibition on placing solid waste disposal sites within critical habitat (357) areas. There are several critical species within a five mile radius of the MRDF. Will the Department require Exxon to seek an exemption under NR 180.13(3)(b), Wis. Adm. Code?

How many soil borings has Exxon done within the MRDF fill (358) area to define the soil, bedrock, and ground water condition at the site? NR 180.13(6)(c) 3.a., Wis. Adm. Code. It appears the site has not been adequately defined in compliance with the minimum requirements of the Code. How is the test pit seepage (359) noted in the MRDF feasibility report explained and does the seepage indicate serious problems with the site?

What recycling will be done by Exxon of its non-tailings (360) waste? Scrap metal and other construction wastes could be recycled.

How does the Department propose to separate the ground water (361) contamination caused by the MRDF from the contamination caused by the MWDF or by the reclaim ponds? How do the compliance and intervention boundaries of these facilities inter-relate?

Will the MRDF be included in the reclamation plan required (362) by NR 132.08(1)(e), Wis. Adm. Code?

I hope these comments will be useful to the Department in preparing the FEIS.

Sincerely,

Waltraud A. Arts

Waltraud A. Arts
Public Intervenor

WAA:tjm

Enclosure

State of Wisconsin \ DEPARTMENT OF HEALTH AND SOCIAL SERVICES

DIVISION OF MANAGEMENT SERVICES
WILSON STREET STATE OFFICE BUILDING
MADISON, WISCONSIN 53702

MEMORANDUM

MAR 2 3 1983

DLOM
SE

DATE: March 21, 1983

TO: Howard S. Druckenmiller, Director
Bureau of Environmental Impact
Department of Natural Resources

FROM: Richard C. Hanson, Deputy Administrator
Division of Management Services
Department of Health and Social Services

RE: Review of the Exxon Environmental Impact Report and the RPC Report on Public Facilities and Services Analysis Methodology

The referenced material relating to Exxon's proposed Crandon Mining Project has been reviewed by staff of our Division of Health with particular attention to matters of environmental and occupational health.

The attached report states the concerns of staff and points to apparent omissions of health-related data which should be included in a comprehensive environmental impact statement.

We appreciate the opportunity to review the Exxon material and trust that our comments are of help to you. We look forward to continuous involvement in the EIS process, especially the review of the balance of Exxon's socioeconomic study due for release this June.

RCH:sl

cc: Richard DeMarse
Kenneth Rentmeester

Attachment

CORRESPONDENCE/MEMORANDUM — STATE OF WISCONSIN

Date: March 15, 1983

MAR 15 1983
WIS. DEPT. OF HEALTH & SOCIAL SERVICES

File Ref:

To: Richard C. Hanson, Deputy Administrator
Division of Management Services
Department of Health and Social Services

From: Kenneth Rentmeester, Administrator
Division of Health
Department of Health and Social Services

Subject:

I requested Dr. Henry Anderson of our Bureau of Community Health and Prevention, Section of Environmental and Chronic Disease Epidemiology to give the Exxon EIR a cursory review with an eye for environmental and occupational health related information needs. He has not previously been included with the review group headed by Mr. Doug Murray of the Bureau of Health Statistics, which has been providing assistance since the project began. Dr. Anderson has raised a number of points I would like to share with you. His comments are directed at omissions rather than inaccuracies.

A medical consulting firm or group was not readily identifiable on the Exxon Project Consultant List (Table 1.1-1). This may account for the minimal health related information in the report. In order to write the EIS, DNR will need to know the potential health effects of the raw products, bulk reagents used, (363) byproducts, and finished products. No information on the toxicology of these materials is provided. It will be important to know whether any cancer causing agents will be used, produced, or be unwanted byproducts. Are any materials mutagenic or teratogenic? Are there certain groups of individuals more sensitive or susceptible to the effects of any of the material? If groups such as children, the elderly, or pregnant women are at greater risk, then the report should describe how many "high risk" people are in the community. It is important to learn whether the materials are biodegradable, cumulative in the soil, or bio-concentratable in animals and humans. While the report makes it clear that the plans will meet all state and federal regulations under normal operating conditions and none of the materials will reach the community at levels which would be of concern, more information is needed to assess the potential public health impact of an equipment failure or an accidental event such as an explosion, train (364) derailment, etc. Depending on the characteristics of the contamination from such unplanned events, the consequences could range from only a nuisance to a major catastrophe. If the latter is possible, the impact on emergency government, evacuation plans, etc. need to be indicated in the DNR EIS. The RPC report does not contain the necessary health impact information to make such an assessment.

Additional information about the contents and potential toxic effects of the tailings, tailings ponds, etc. are needed. Will there be an odor? Will the pond waters be sufficiently toxic that skin contact is dangerous? Will rain and snow water runoff dissolve and transport chemicals? If so, are these dangerous to humans? For the EIS to address these types of questions, the report will need to include the needed information.

AD-75

The mine facilities are described and emergency training and equipment is mentioned. However, no mention is made of a mine medical program or the types of staffing planned. Will the mine have a full-time occupational medicine (365) physician and support nurses? If not, are there qualified physicians in the community with sufficient time to adequately assume such a task? The current patient load of the local physician community should be better reported. The report should summarize the extent of any current local expertise in health or environment fields which specifically relate to the mining activity.

The report states that more specific information is provided in some of the permit applications submitted. These were not available for review. If the toxicology and health effects information is contained in these however, the report should also discuss it. Such information will be critical to the preparation of the EIS. From the public health perspective it would seem appropriate that the report should provide this type of information. If it does not, DNR will need to acquire this information elsewhere.

KR/jml

State of Wisconsin \ DEPARTMENT OF TRANSPORTATION

JUL 17 1986

July 9, 1986

BUREAU OF ENVIRONMENTAL
AND DATA ANALYSIS
4802 Sheboygan Avenue
P.O. Box 7916
Madison, WI 53707-7916

Mr. Howard S. Druckenmiller, Director
Bureau of Environmental Analysis and Review
Department of Natural Resources
P.O. Box 7921
Madison, WI 53707

Mr. Druckenmiller:

We have reviewed the Draft Environmental Impact Statement (DEIS) for the Exxon Minerals Company Zinc-Copper Mine, Crandon, Wisconsin. We believe the discussions of transportation impacts and mitigation measures are overstated and offer the following comments:

1. Page 176 Traffic System Impacts

A. Paragraph 4 - This paragraph should emphasize that the effects described represent the "worst case" which could occur only during the summer months at the peak hour (shift changes) in the third year of construction. Moreover, we would also consider the traffic effects in the City of Crandon as a "worst case" transitory occurrence which would require attention only for the period of its existence. (366)

Lines 6 and 7 of the fourth paragraph states that truck traffic "... would tend to slow vehicle movement in the area and cause congestion." We believe this leads the reader to an incorrect impression given the number of trucks predicted to visit the site daily as illustrated in Table 1-24, p. 47. (367)

We recommend this paragraph be rewritten in the Final Environmental Impact Statement (FEIS) to reflect the fact that it is a worst case discussion. We suggest the rewritten paragraph should emphasize that the mine traffic would have relative significance only during the third year of construction. We would eliminate the word "congestion" for being too "loaded" and non-specific to accurately reflect the effects of mine-induced traffic. (368)

B. Paragraph 5 - The first sentence of this paragraph should be rewritten to emphasize that capacity problems directly attributable to the mine would only occur in the third year of construction during the summer months at the peak hours (shift changes). (369) We believe the rest of the paragraph should also be rewritten to more realistically portray the discussion of accidents and accident rates. (370)

We believe it is pure conjecture to state there would be either increases or decreases in accidents or accident rates. There has not been a statistically significant number of miles sampled on highways of similar class for us to confidently state whether or by how much the mine traffic would affect the existing safety on S.T.H. 55. We believe that all that could be stated is that the "critical accident rate" on S.T.H. 55 from Mole Lake to Crandon is a high 1.38 and that the added traffic would only serve to emphasize existing safety deficiencies. (371)

C. Paragraph 6 - It is not clear to us why Forest County's road department would need the funds shown in this paragraph. Our Transportation District 7 office in Rhinelander has estimated the cost of improvements to C.T.H. "S" to be about $500,000, with or without the mine being developed. The development of the mine would simply serve to accentuate the work needed. (372)

We suspect the Forest County figures may reflect an estimate of equipment and personnel costs for all county improvements, including those to C.T.H. "S", that might be needed during the mine's development. We believe this should be clarified.

2. Page 239 Mitigation of Transportation Impacts

We concur on the list of mitigation measures shown in this discussion. We recommend, however, that it be made clear that the list is a range of potential measures that may be used if the situation so warrants. It is our opinion that the most probable sufficient solution to mine traffic-induced effects would be manual traffic direction at shift change periods along with the addition of turn lanes on S.T.H. 55 at the mine entrance road. Furthermore, we would underscore that only during the worst case would manual direction of traffic be needed. (373)

We would also recommend that the discussion of impacts in the first paragraph be tempered by indicating that the effects would be most noticeable during the third year of construction in the summer months at peak hours (shift changes). (374)

Thank you for the opportunity to review and comment on this Draft Environmental Impact Statement.

Cynthia A. Morehouse
Director

JBN:10709864

CC: Don Revello
Transportation District 7

DEPARTMENT OF HEALTH AND SOCIAL SERVICES July 8, 1986

JUL 09 1986

TO: Bob Ramhurter
Bureau of Environmental Analysis and Review
Department of Natural Resources

FROM: Richard DeMarse, WEPA Coordinator
Division of Management Services

RE: Exxon Mining Project: Review of Draft Environmental Impact Statement

Attached are comments from Department of Health and Social Services staff on the Draft Environmental Impact Statement for the proposed Exxon mining project at Crandon. Please note Dr. Henry Anderson's concerns that there is little written regarding the possible health effects directly resulting from the construction and operation of the mining project. Dr. Anderson also expresses concern regarding the added burden on the health care system in the Crandon area resulting from the introduction of the mining project.

I hope these comments prove helpful in your final review of the DEIS. For your convenience, I have also attached a copy of the March 15, 1983 letter referred to by Dr. Anderson.

Please contact me at 266-9863 if you have any questions.

RD:bd

Attachments

cc: Greg Robbins
Henry Anderson, M.D.
Gerald Berge

164wp.rd

State of Wisconsin \ DEPARTMENT OF HEALTH AND SOCIAL SERVICES

DIVISION OF HEALTH
MAIL ADDRESS:
1 WEST WILSON STREET
P.O. BOX 309
MADISON, WISCONSIN 53701

MEMORANDUM

Date: June 27, 1986

To: Richard Damarse, WEPA Coordinator
Office of Planning and Operations

From: Henry A. Anderson, M.D., Chief
Bureau of Community Health and Prevention
Section of Environmental and
Chronic Disease Epidemiology

Re: Exxon Mining Project: Review of Draft Environmental Impact Statement

Recently, ECDE was requested to review the Draft Environmental Impact Statement (DEIS) prepared by the Department of Natural Resources regarding the proposed Exxon mining project at Crandon, Wisconsin. This draft is an updated version of a similar document that myself and my staff reviewed in March, 1983. Please refer to the memo from Kenneth Rentmeester, Division of Health, to Richard Hanson, Division of Management Services dated March 15, 1983. In that memo I outlined possible areas of concern regarding occupational and environmental health.

As noted previously, the DEIS deals only indirectly with possible health effects directly resulting from the construction and operation of the mining project under the section "Impact to the Socioeconimic Environment." (375) There is little written about the potential health effects of toxicology of the raw products, bulk reagents used, by-products, and finished products. No description of the potential carcinogenic, mutagenic or teratogenic effects associated with the raw or finished products or the by-products of production is given. In summary, health effects are not directly considered.

An additional concern relates to the added burden to the health care system in the Crandon area. Are the present facilities and providers adequate to care for the health care needs of those involved in the construction and operation of the mine? (376) Does Exxon plan to incure that health care providers skilled in matters related to occupational and environmental exposures associated with Zinc and Copper mining are available in the Crandon area.

I hope the above comments will be of assistance to you in reviewing the DEIS.

cc: Kathryn Morrison
Division of Health

William Schmidt
Division of Health

CORRESPONDENCE/MEMORANDUM — STATE OF WISCONSIN

Dr. Henry Anderson
Room 325

Date: March 15, 1983 File Ref:

To: Richard C. Hanson, Deputy Administrator
Division of Management Services
Department of Health and Social Services

From: Kenneth Rentmeester, Administrator
Division of Health
Department of Health and Social Services

Subject:

I requested Dr. Henry Anderson of our Bureau of Community Health and Prevention, Section of Environmental and Chronic Disease Epidemiology to give the Exxon EIR a cursory review with an eye for environmental and occupational health related (377) information needs. He has not previously been included with the review group headed by Mr. Doug Murray of the Bureau of Health Statistics, which has been providing assistance since the project began. Dr. Anderson has raised a number of points I would like to share with you. His comments are directed at omissions rather than inaccuracies.

A medical consulting firm or group was not readily identifiable on the Exxon Project Consultant List (Table 1.1-1). This may account for the minimal health related information in the report. In order to write the EIS, DNR will need to know the potential health effects of the raw products, bulk reagents used, byproducts, and finished products. No information on the toxicology of these materials is provided. It will be important to know whether any cancer causing agents will be used, produced, or be unwanted byproducts. Are any materials mutagenic or teratogenic? Are there certain groups of individuals more sensitive or susceptible to the effects of any of the material? If groups such as children, the elderly, or pregnant women are at greater risk, then the report should describe how many "high risk" people are in the community. It is important to learn whether the materials are biodegradable, cumulative in the soil, or bio-concentratable in animals and humans. While the report makes it clear that the plans will meet all state and federal regulations under normal operating conditions and none of the materials will reach the community at levels which would be of concern, more information is needed to assess the potential public health impact of an equipment failure or an accidental event such as an explosion, train derailment, etc. Depending on the characteristics of the contamination from such unplanned events, the consequences could range from only a nuisance to a major catastrophe. If the latter is possible, the impact on emergency government, evacuation plans, etc. need to be indicated in the DNR EIS. The RPC report does not contain the necessary health impact information to make such an assessment.

Additional information about the contents and potential toxic effects of the tailings, tailings ponds, etc. are needed. Will there be an odor? Will the pond waters be sufficiently toxic that skin contact is dangerous? Will rain and snow water runoff dissolve and transport chemicals? If so, are these dangerous to humans? For the EIS to address these types of questions, the report will need to include the needed information.

The mine facilities are described and emergency training and equipment is mentioned. However, no mention is made of a mine medical program or the types of staffing planned. Will the mine have a full-time occupational medicine physician and support nurses? If not, are there qualified physicians in the community with sufficient time to adequately assume such a task? The current patient load of the local physician community should be better reported. The report should summarize the extent of any current local expertise in health or environment fields which specifically relate to the mining activity.

The report states that more specific information is provided in some of the permit applications submitted. These were not available for review. If the toxicology and health effects information is contained in these however, the report should also discuss it. Such information will be critical to the preparation of the EIS. From the public health perspective it would seem appropriate that the report should provide this type of information. If it does not, DNR will need to acquire this information elsewhere.

KR/jml

JUN 26 1986

Division of Community Services

June 24, 1986

To: Richard De Marse
WEPA Coordinator
Office of Planning and Operations
Division of Management Services

From: Gerald A. Berge
Administrator

Re: EXXON MINING PROJECT: REVIEW OF DRAFT ENVIRONMENTAL IMPACT STATEMENT

Thank you for the opportunity to review the latest draft of the Exxon environmental impact statement.

We have in the past raised the issue of the potential adverse effect on lands and bodies of water utilized by the Indian tribes and suggested that the tribes involved should be consulted so that they are fully informed and able to express their views on the proposed mining project. It appears in reviewing the latest draft that Exxon is cognizant of this issue and is attempting to take steps to guard against endangering the water levels and creating pollution.

There is always the potential that if the balance of Nature is disturbed that it could impact on the mental well-being of those who are dependent on the land to make a living. If something would occur to make the land unworkable, we undoubtedly would see a sharp increase in the number of individuals seeking welfare or mental health help. Resultant family problems then tend to heighten the incidences of child abuse and neglect and cases of alcoholism and other drug abuse.

Exxon, based on the feedback they have been receiving since 1983, have been trying to address all issues that have been raised. The Division of Health and Department of Natural Resources are probably in a better position to assess the long-term effect that may take place as a result of this mining project.

cc Greg Robbins

COMMENTS & RESPONSES

University of Wisconsin—Extension

GNHS

WISCONSIN GEOLOGICAL and NATURAL HISTORY SURVEY

M.E. Ostrom
Director and State Geologist

3817 Mineral Point Road • Madison, WI 53705 • (608) 262-1705

JUL 14 1986

July 7, 1986

To: Robert Ramharter, Exxon Project Coordinator
Department of Natural Resources

From: Thomas J. Evans
Wisconsin Geological and Natural History Survey

Re: Formal Review of Draft Environmental Impact Statement, Exxon Mineral Company Zinc-Copper Mine, Crandon, Wisconsin (May 1986)

The following general and specific comments represent the formal review by the Geological and Natural History Survey, University of Wisconsin - Extension, of the Draft Environmental Impact Statement for the proposed zinc-copper mine of Exxon Mineral Company near Crandon in Forest County. The DEIS has been reviewed by several staff members of the Survey: Thomas J. Evans- review coordination and overall document review; Michael G. Mudrey, Jr.- geology, data quality assurance, risk assessment; Stanley Nichols- environmental monitoring,aquatic biology, terrestrial ecology and wetlands; Frederick Madison- soils, reclamation; and Kenneth Bradbury- surface water, groundwater. Questions concerning DEIS review by the Geological and Natural History may be directed to Dr. M. E. Ostrom, Director and State Geologist, or to Thomas J. Evans, Exxon DEIS review coordinator.

GENERAL REVIEW COMMENTS

1. Document Organization and Preparation

(378) The Exxon DEIS is logically organized, generally well-written, and clearly illustrated. However, illustrations are not located next to their first mention in the text requiring the reader to flip several pages forward in order to see the illustration being described in the text. This makes for very awkward reading. Further, the illustrations are not paginated in sequence with the text making reference to a specific illustration difficult.

RECOMMENDATION: Locate illustrations on pages immediately following their first mention in the text in accordance with standard publication practice and paginate text and illustrations consecutively.

UW—Extension provides equal opportunities in employment and programming, including Title IX requirements.

2. Documentation

The DEIS is poorly documented leaving it unclear as to the source(s) of most factual statements in the document. The reader cannot determine if certain statements are simply common knowledge, assertions by Exxon with or without documentation, assertions by the Department of Natural Resources with (379) or without documentation, assertions by third parties communicated to the DNR, or as often appears to be the case, simply opinions of individual preparers of the DEIS.

Numerous consultant reports, memoranda, and letters have been used by Exxon to prepare its Environmental Impact Report and the DNR has used these, its own studies and the studies of its consultants, as well as independent reports, memoranda, and letters. These references could be cited in support of factual statements wherever appropiate and listed in a bibliography or "References Cited" section or some summary paragraph identifying in a general fashion the sources of the information used in preparing a particular section of the DEIS.

The DEIS is not a scientific treatise nor is it a decision document for the numerous permits necessary for the proposed project; however, the reader should be able to ascertain the source(s) of the numerous facts included in the preparation of the DEIS and have the opportunity to independently evaluate the information upon which the determinations of environmental impact have been made.

RECOMMENDATION: Review and rewrite the DEIS to incorporate supporting documentation for statements of fact supplied by Exxon and its consultants, by the DNR and its consultants, or by third parties in official communications to the department. Include a bibliography or cited references section to clearly and fully identify supporting documentation.

An alternative to the above would be a summary statement with each relevant subsection of the DEIS chapters identifying the source(s) of the factual information used in preparing the subsection. The general statement could identify the origin of the information and the type of format the information was prepared in (memoranda, formal reports, meetings among professional staff of the DNR and Exxon consultants or other officials), as well as the location of such information should the reader wish to review the information sources directly.

3. Risk Assessment

This section of the DEIS is wholly inadequate and misleading. No general statement of risk, risk assessment, or risk management is presented that allows the reader to evaluate the semi-quantitative assertions of "low" risk made in this section. Accepted standards of risk assessment and risk management should be identified and incorporated into this section. Risk may (380) usefully be considered as the product of the probability of an event actually occurring and the consequence(s) of an event should it occur. The probability of an event occurring can be ascertained from records of underground metal mine operations in the United States by reference to documentation available from the U. S. Mine Safety and Health Administration. For example, the probability of an event such as a reagent spill is close to or at 1.00, that is, the event is certain to occur during the life of the mine operation. However, the probability of an accident resulting in a worker's death when operating a diesel-powered vehicle once the mine is in operation is probably

less than 1.00. The statistics for metal mine operation kept by MSHA are a readily available source for such information. The consequence of an event that occurs must include mitigation measures (both passive and active measures) that are available to minimize a particular event. (For the purpose of this discussion on consequence, it is assumed that consequence of an event is the sum of the consequence to the general public, the consequence to the general environment, the consequence to the worker, and the consequence to the working environment.) MSHA records are the best source of information concerning the consequences of certain events for which a risk assessment may be desirable. By way of example, the consequences of a reagent spill in a modern mine/mill facility is minimal due to the ready procedures to contain and clean-up such a spill; however, the consequences of an accident involving humans operating a diesel-powered vehicle in a underground metal mine can often be extremely serious.

RECOMMENDATION: Incorporate some expression of risk or risk hazard, such as: Risk for a particular event, R_e, equals the probability for that event to occur, P_e, times the consequences or adverse impacts should that event occur, C_e. Thus, $R_e = P_e * C_e$.

The risk or risk hazard of a particular event may well be expressed as "low" or "moderate" or "high", but these qualitative descriptors should be based upon verifiable and fully quantitative expressions of the probability of an event occurring and the consequences of that event once it does occur.

This section should be completely redone and specifically incorporate and fully reference accepted practices for risk assessment and risk management as applied to the modern metal mine operating environment.

4. Environmental Monitoring

The Environmental Monitoring section adequately describes a sampling scheme, but fails to identify the target values which are indicators of (381) concern, nor what specific measures would be necessitated by concern. An action plan, such as further sampling or required mitigative actions, is not identified.

RECOMMENDATION: Describe and and reference an action plan to carry forward environmental monitoring that includes target values that trigger specific actions.

5. Soils and Reclamation

The sections dealing with soils in the Project Area and the reclamation measures proposed for the Project are generally well done and represent state-of-the-art material. However, the correct identification of the principal soils in the area (Iron River Stony Loam and Monico Stony Loam) (382) raises concerns concerning the ability to actually accomplish the proposed reclamation plans when dealing with topsoil that is 15% to 35% (by volume) stones. This large percentage of rocks is going to cause difficulties in terms of stockpiling topsoil and subsoil. These soils are also very thin (less than 24 inches) and the amount of these materials actually available may not be adequate to accomplish even such items as the landscaping.

RECOMMENDATION: Sections on soils and reclamation plans should be rewritten to fully account for the limitations that stony soil phases will impose on the proposals for reclamation described in the DEIS. (382) These revised materials on soils and reclamation plans should be referenced in some manner to allow the reader to evaluate the proposals more completely.

SPECIFIC REVIEW COMMENTS

6. Page iv, Paragraph 1 (EIS Summary):
The range of sulfate concentration in tailings leachate at the compliance boundary (45 to 1100 mg/l) may never exceed the 250 mg/l groundwater quality standard. Therefore, the statement that "between 500 and 2,000 years would be required before the 250 mg/l groundwater (383) quality standard could be exceeded" should be modified to reflect the possibility that sulfate concentrations may never exceed even 45 mg/l or, alternatively, clarify these statements about concentration ranges over time.

7. Page 30, Paragraph 3 (Waste Rock Radiological Properties):
The gamma-ray scintillometer survey by the Geological and Natural History Survey confirmed only that the radioactivity from the large-diameter drill cores did not exceed a minimal threshhold level. (384) No comparison with "values in the soils and granitic outcrops in the area" was made by GNHS personnel, though some samples bedrock were monitored in the GNHS study. See memo from Evans and Scott to Edwarde May, dated September 29, 1980, for complete details on the survey of cores, equipment used, and protocol followed.

8. Page 32, Paragraph 1 (Waste Rock Asbestiform Mineralization):
Geologists of the GNHS did not analyze "bulk samples from drill cores of the ore", but did examine thin-sections of bedrock from verifiable (385) locations in drill cores selected by Exxon personnel. See memo by Greenberg and Brown, dated November 14-15, 1979, for a description of GNHS verification of petrographic asbestos analysis of Crandon samples.

9. Following Page 32, Figure 1-18:
This figure shows "areas potentially requiring special erosion control", but there is no definition of such areas in the text that explains how these areas have been identified and how these areas (386) differ from other areas present in the MWDF final configuration. These special areas should be delineated in an objective, quantitative manner.

10. Page 36, Table 1-13:
Alkalinity is another parameter which should be monitored. It will (387) help determine the buffering capacity and carbon content of the water which are determinates in aquatic primary productivity.

11. Page 36, Paragraph 3 (Swamp Creek):
Sampling of Swamp Creek would be "initiated at least six months prior to construction." How will the time when construction begins be (388) determined and how will it be possible to do environmental sampling so far in advance unless the "start of construction" can be specified in some appropiate manner?

12. Page 39, Paragraphs 1 and 2 (Drawdown-Related Monitoring):
See comment #11. How will groundwater sampling "one year prior to (389) construction" be initiated unless the "start of construction" can be specifically delineated in some appropiate manner at least 12 months in advance?

13. Page 39, Paragraph 5 (MWDF):
Monitoring wells are said to be "uniformly distributed" around the MWDF, but the reader is given no idea what uniformly distributed (390) means. This could mean geographically, stratigraphically, depth-wise, and so forth. The distribution of wells shown in Figure 1-23 or described in the text does not appear to be uniform no matter how one defines it. What is meant by "uniformly distributed"?

14. Following Page 40, Figures 1-23 and 1-24:
Why is there no monthly or quarterly sampled well nest in the southwest quarter of the MWDF compliance area, the principal direction of (391) pre-mining groundwater flow? Why the monitoring wells are located where they are should be explained.

15. Page 41, Paragraph 5 (Terrestrial Ecology and Wetlands):
(a) The monitoring scheme is good, however, direct visual examination of the vegetation should be added to detect any pathological or (392) stress-related symptoms. Air photo work can often pick up stress, but direct observation may be able to determine the cause of stress. Some permanent plots to determine community composition and change are also recommended. The community change can be more subtle than is determined by air photos. This is especially the case with sensitive plants such as lichens.
(393) (b) See comment #11 relative to the start of the photography phase of the monitoring program.

16. Page 42, Paragraph 1 (Air Quality and Meteorology):
(394) Particulate monitor sites A,B,C, and U are not shown on Figure 1-25, following page 48, nor is their location given in the text.

17. Page 42, Paragraph 6 (Data Quality Assurance):
No particular protocols or methods for data quality assurance are discussed, nor are documents cited to allow the reader to evaluate the adequacy of the data quality assurance program. There is no adequate (395) discussion of laboratories, reproducibility requirements, accuracy limits, and precision, which are some of the basic elements of a data quality assurance program.

18. Page 43, Paragraph 1 (Mitigation/Contingency Measures):
The discussion under this section is incomplete and no supplemental references are cited that one could use to better understand what the applicant proposes to do. Since mitigation/contingency measures to prevent the "unreasonable detriment of public or private water
396 supplies...(or) public rights in the waters of the state" are crucial to mitigating certain impacts of the mine's operation, this entire section should be expanded to more completely describe the measures beyond what is presented in the DEIS.

19. Page 47, Table 1-22:
Why does the operations work schedule for "mine stope production and
397 development" and "primary crushing and ...hoisting" include only 340 days as opposed to 365 days per year? Is there planned or anticipated "downtime" associated with these work tasks?

20. Page 48, Table 1-27:
398 Total natural gas consumption on an annual basis shown in the table does not agree with the total mentioned in the preceding paragraph. Which is the correct figure?

21. Page 50, Paragraphs 2 and 3 (sections on bedrock geology):
There are some geologic/technical problems in these sections:
399 (a)..The Rhinelander-Ladysmith Greenstone Belt is used in the DEIS as a formal designator, but this terrane is not defined. This may be DNR terminology, but it is not the terminology of the Geological and Natural History Survey nor the U. S. Geological Survey. Reference to published technical literature should be made to clarify the location of this terrane.
400 (b) The term "middle Precambrian" is properly used, however Archaen/Proterozoic terminology would be more appropiate, so that the interested reader can relate to the recent geological literature.
401 (c) There is no evidence in Wisconsin that a mountain-building episode occurred in the state about 1.6 billion years ago. The Penokean orogeny is generally recognized to have taken place 1.9 to 1.8 billion years ago. This period is broadly accepted as the last mountain-building episode in the Lake Superior region.
402 (d) The discussion of the ore-formation process is adequate for this document, but reference to better geologic literature is recommended.

22. Page 51, Paragraph 1 (Orebody Description):
Significantly better descriptions of the orebody have been prepared by Exxon personnel and published in the public, technical literature. These descriptions should be used, since they more clearly explain to
403 the knowledgable reader why the possibility of uranium mineralization is very limited and why asbestiform mineralization has not been identified in these materials. References to minor amounts of gold and silver should include their mode of occurrence in the orebody.

23. Page 51, Paragraphs 2 through 5 (Bedrock Weathering):
What is a weathering "spike?" This is not a term in common use in the relevant technical literatures. The term "argillization" is not adequately defined nor is the process by which argillization has
404 formed. Such weathering zones may not be impermeable as stated in the DEIS as such zones associated with the iron mines near Hurley, for example, are believed to be subject to the ingress of surface water. The assertion of impermeability should be documented.

24. Page 51, Paragraph 6 (Asbestiform Minerals):
The source of the statements concerning asbestos should be identified. All relevant comment on this subject matter that is contained in the November 14-15, 1979 memo by Greenberg and Brown should be included here in some form. The GNHS study dealt with 66 thin-sections of drill
405 core selected by Exxon personnel and did not purport to be a complete or exhaustive asbestos evaluation. The DEIS should identify other sampling and evaluation procedures relevant to asbestos monitoring beyond the GNHS thin-section verification study.

25. Page 52, Paragraph 1 (Radiological Studies):
The radiological monitoring program completed by Exxon and its consultants and evaluated by the DNR, GNHS, and the Department of Health and Social Services adequately addresses the concerns with the possibilities of excessive radiological components to the Crandon
406 orebody and associated rocks. Since uranium enrichment does occur in the Lake Superior region, however, additional information distinguishing the Crandon geology from these other Lake Superior sites would be useful for the general reader.

26. Page 52, Paragraph 1 (Glacial Geology):
Because of the important relationship between the geology of surficial materials and shallow groundwater flow, the description of glacial
407 geologic units, their stratigraphic relationships, and their hydrologic characteristics should be expanded and documented. This will give the reader a better understanding of the complex geologic/hydrologic setting of the project area.

27. Page 52, Paragraph (Study Area):
What evidence has been used to determine that the 20 square mile groundwater study area is a bounded system? Some reference to
408 documents or meetings among involved parties to this determination should be added here.

28. Page 52, Paragraph 7;Page 53, Paragraph 1 (Groundwater Elevation & Flow):
These paragraphs imply that all lake levels in the project area are above the regional water table. While this may be true for some lakes, many lakes in the project area reflect the water table, which is formally defined as the top of the saturated zone. Thus, unless a
409 lake overlies an unsaturated zone, the lake level is also the water table. Lakes which seem to have elevations higher than the regional water table may in fact be mounds in the water table. This misconception of the meaning of the water table is present in Figure 2-4, where lines of equal water table elevation pass beneath lakes

without deflection. As far as I know, only Oak Lake has been shown to be perched, with a true unsaturated zone beneath it. The other lakes are mounded, and reflect the water table. As drawn, Figure 2-4 shows a potentiometric surface, not a water table.

29. Page 54, Table 2-2:
(410) Selenium includes a "range" of concentration from 0.001 - 0.001, which is not a range. This should be corrected.

30. Page 54, Paragraph 1 (Bedrock Water Quality):
(411) (a) The evidence in Table 2-3, page 55, does not clearly define two "types" of bedrock groundwater quality. The text here should include a summary of mean values for the principal parameters so the distinction between the groundwater types can be discerned.
(412) (b) "differ-entiated" should be "differentiated"

31. Following Page 56, Figure 2-6:
(413) This figure depicting the hydrologic cycle contains several errors. First, at the left side of the figure, the water table is elevated along a stream, but the stream is a discharge point. Such a water table configuration is impossible. Second, the "perched" lake in the center of the figure could not occur there because no lacustrine sediments are shown, and no water table mound is indicated. Either a low-permeability layer should be shown or the lake should intersect the water table. Third, recharge from the wetland should be indicated, and a lacustrine layer shown. Fourth, it is unclear what the grey shaded objects above the land surface at each side of the figure represent.

32. Page 57, Paragraph 1 (Water Levels):
(414) Beaver activity is only one of many natural phenomena affecting lake levels. Others should be mentioned.

33. Page 57, Table 2-4:
(415) This table should indicate the period of record and the dates of the extreme lake level elevations.

34. Pages 58-60 (Lake Characteristics):
(416) The use of terms such as "seepage lake," "drainage lake," and "spring lake" are subject to various interpretations. These should be clearly defined, perhaps with a separate illustration showing the differences between these lake types with respect to their relationship to groundwater flow. For example, Oak Lake is referred to as a "perched, seepage lake" which according to some accepted understanding of these terms is an impossible situation. Clarify the descriptors of the area lakes.

35. Page 67, Paragraph 4 (Macrophytes):
(417) There should be concern about the potential impact of sulfates and sulfides on wild rice. On page 184, the DEIS indicates treated mine water will be discharged to Swamp Creek and on page 67 the presence of wild rice in Swamp Creek is acknowledged. Is there a potential impact?

36. Page 106, Paragraph 1 (Education):
(418) This paragraph is an example of several within this section on Native American Communities that do not clearly relate to the proposed project. Here the statement that there is "considerable dissatisfaction among tribal members with their children's educational experiences at the Crandon schools" has no clear relationship to the proposed mine. The paragraph on reservation traffic (page 108, paragraph 5) is another example of an apparent concern but no clear relationship to the Project. This entire section should be rewritten to clearly relate these significant concerns with what the DEIS has been written to evaluate--the proposed Exxon zinc-copper mine. Alternatively, these statements should be tied to those sections in the DEIS where such concerns are related to the Project (see,e.g. page 187 concerning increased traffic on Route 55).

37. Page 112, Paragraph 6 (MWDF leachate characteristics):
(419) Reference to supporting documents for these assertions of the sources of dissolved constituents in pore water should be added.

38. Page 117, Paragraph 1 (Contaminated Transport in the Groundwater System):
(420) The DEIS should mention that dispersivity is a poorly understood parameter in contaminant transport models, and that all possible dispersivities were not tested by USGS/DNR or be D'Appalonia. Also, the dispersivity ratios shown in figures 3-6 and 3-7 are not the same as used in figures 3-10 and 3-11.

39. Page 131, Paragraph 1 (Impact to Wetlands):
(421) Depending on exact conditions, tree growth may be improved if trees don't have to continually grow in cold, waterlogged, and oxygen-poor soils. If dewatering occurred to the point where water stress developed, then the statement in the paragraph is correct.

40. Page 142, Paragraph 4 (Impact to Fish and Aquatic Organisms):
(422) Other than in humans and fish, the problem of bioconcentration of heavy metals is not addressed at higher trophic levels. Of primary importance would be fish-eating birds such as eagles, osprey, king fishers, and herons.

41. Page 145, Paragraph 1 (Facility Impacts to Vegetation):
(423) More creative use of pipeline corridors could be found rather than planting them to grass and mowing them. Perennial, herbaceous cover that is beneficial to wildlife is a much more creative use of these areas.

42. Page 193, Paragraph 7 (Natural Phenomena):
(424) Downbursts are natural phenomena that have occurred with some frequency in recent years in northern Wisconsin. This type of event should be added to the risk assessment section.

43. Page 218, Paragraph 4 (Mine Backfilling):
(425) The minimum standards for metallic mineral mines that include backfilling should be specifically cited. Current Wisconsin administrative codes are not consistent on this matter and until new rules are promulgated, this potential legal difficulty with the proposed backfilling activity should be acknowledged.

JUL 02 1986

MICHAEL HOBBS, *Chairman*
HENRY L. JARON, *Supervisor*
DON McKEAGUE, *Supervisor*

OMER T. LUNDT SR., *Treasurer*
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TOWN OF LINCOLN
FOREST COUNTY
CRANDON, WISCONSIN

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THE TOWN BOARD
TOWN OF LINCOLN
CRANDON, WISCONSIN

DEIS

INTRODUCTION

The Town welcomes the opportunity to participate in the decision-making process by submitting the following written comments. The Town, in general, was very impressed with the DEIS and wishes to applaud the efforts of both the Department and Exxon. The draft document contained an extensive amount of information which provided an excellent base for discussion. These comments were developed as a result of meetings held on May 20th, June 3rd and June 10th, 1986. The June 10th meeting was publicized in an effort to maximize public imput. Additionally, many written comments were submitted to the Town. The following comments represent only the comments of the Town of Lincoln as a political entity; they are not intended to represent the individual feelings or comments of the citizenry of the Town of Lincoln. The Town has encouraged individual citizens to make whatever comments they feel are important.

The Town has identified five major areas of the DEIS which are of particular interest to it. These areas are: (A) NOISE, (B) AIR (DUST), (C) MWDF, RECLAIM PONDS, (D) LAKES AND STREAMS, and (E) SOCIO-ECONOMIC.

COMMENTS

A. NOISE

The DEIS identifies numerous sources of noises ranging from increased traffic noise to explosions. The Town believes that noise could be the most immediate of all environmental impacts to the Ground Hemlock Lake area.

The Town is particularly concerned with the fact that the Department apparently has little or no regulatory authority (426) regarding noise. The Town believes that the extent of the Department's authority regarding noise should be clarified.

Also the Town asks: Will residents of Lake Metonga or Lake (427) Lucerne hear any noise associated with the mine either during construction or operation?

(428) Finally, the Town noted the lack of information regarding mitigation.

B. AIR

Although it is unlikely that dust during construction would have heavy metals, the Town believes that dust during the (429) construction phase could still be a major impact.

With regard to operations, the Town has the same concern.

(429) The Town desires dust be controlled. It endorses all measures the Department approves for dust control.

C. MWDF, RECLAIM PONDS

As noted in previous comments, the Town is interested in various aspects (noise and dust) of the MWDF, and the reclaim ponds. The Town wishes thorough monitoring and contingency measures. The Town would encourage the Department to develop the

(430) most reliable monitoring program. Morever, monitoring only identifies a problem; the Town believes the final EIS should address what happens once the problem is identified, i.e. what course of action will be taken; what corrective measures employed.

D. LAKES AND STREAMS

The Town has been concerned with the impacts (drawdown and water quality) on Ground Hemlock Lake, Hemlock Creek and Swamp Creek. The Town was concerned with potential drawdown impacts on Lake Lucerne and Lake Metonga. The Town's review of the DEIS

(431) indicates the department has concluded there will be no serious impacts to Ground Hemlock Lake, Hemlock Creek, Swamp Creek, Lake Lucerne and Lake Metonga. The department should be sure contingency plans will keep the lakes near normal levels. The department should be sure that the systems work.

E. SOCIO-ECONOMIC

The Town clearly recognizes and welcomes the potential employment and fiscal benefits of the project. The Town also recognizes that the employment benefits are contingent upon hiring policies (pg. 161 and 162 DEIS). Finally, with regard to tax rates, the DEIS identifies that tax rates will rise

(432) substantially during the first two years of construction (pg. 169 of DEIS). How can this substantial rise be mitigated?

Mike Hobbs, Chairman

Henry Jaron, Supervisor

Don McKeague, Supervisor

JUL 0 3 1986

OBSERVATIONS OF THE NORTH CENTRAL MINING IMPACT PLAN COMMITTEE
JUNE 1986

re: An Assessment of the Socio-Economic Impacts Provided in the Draft Environmental Impact Statement, Prepared by the Department of Natural Resources



NORTH CENTRAL WISCONSIN REGIONAL PLANNING COMMISSION

HISTORY

The North Central Mining Impact Planning Committee was formed in 1978 to provide a discussion forum and opportunity for educational exchanges among the member governments, and to address concerns which were raised by the potential of Mineral Development.

In April of 1981 the North Central Wisconsin Regional Planning Commission was selected to review, comment, and assist with local governmental actions regarding the Socio-Economic Study being prepared for Exxon Corporation. The Commissions scope of work is detailed below in three basic stages:

1. Initial Review of Environmental Impact Report (EIR) Socio-Economic Analysis (Forecast of Future Conditions Study)

    * Development of Comments: Areas the Commission felt information may be lacking, questions left unanswered, and additional research/analysis was needed.

    * Presentation of this information to the NCMIPC for discussion, additions, deletions or concerns.

    * Based upon this analysis and discussion prepare a position paper on behalf of the NCMIPC to DNR regarding these concerns.

2. Initial Review of the Draft Environmental Impact Statement (EIS)

    * Develop comments regarding whether or not the concerns raised about the EIR have been adequately addressed.

    * Present comments to the NCMIPC discussion, additions, deletions or concerns.

    * Present the results of this analysis/discussion to DNR for inclusion in the final EIS.

3. Timetable for Local Action: (Impact Management) Information contained in the EIR/EIS, provides us with the best scenario of what will likely occur with mineral development. Meetings will be held with those jurisdictions which will be impacted, the timing and staging of necessary impact management/mitigation techniques will be developed.

PURPOSE OF THIS STUDY

The purpose of this effort is to point to areas where the Commission feels questions may remain unanswered, where there are inconsistencies and where there is not clear accounting for the facts.

CONCLUSIONS

* The Commission finds that there are no adverse Socio-Economic impacts which can not be mitigated through proper management techniques by State and Local jurisdictions in conjunction with Exxon.

* The Commission concludes that the DNR document alone, is not sufficient in providing a linkage from past studies to conclusions drawn, but is suitable when used in conjunction with the previous documents from Exxon and the DNR. The DNR document should site data references from the previous Exxon documents when used.

* There will be two types of expenditure/revenue mismatches throughout the project area. Certain jurisdictions will have a need for immediate, direct expenditures, yet will experience time delays before realizing increases in valuation. Other jurisdictions will experience a need for immediate, direct expenditures, yet will experience time delays in payments from the State Mining Investment and Local Impact Fund Board.

* Because of the nature of the Socio-Economic impacts, and their ability through proper management to be reduced or entirely mitigated, the Commission sees it as imperative that impacted jurisdictions have a standardized monitoring and reporting system to 1.) Provide continual current data to aid in planning and management decisions and 2.) Provide documentation as to the occurrence of mining related impacts.

CONCERNS/OBSERVATIONS: Following are concerns and observations which the North Central Wisconsin Regional Planning Commission; under contract with the North Central Mining Impact Planning Committee, have developed regarding the Draft Environmental Impact Statement.

(433) --page 158, The document states that the Town of Ainsworth is developing a zoning ordinance, this is not the case.

(434) --page 158, the "uncertainties in local zoning and land use regulations" needs to be clarified.

(435) --page 164, In the study it discusses the fact that there is a lower percentage of operational workers going to Langlade County and a higher percentage of secondary workers. What is the reasoning for this?

(436) --page 166, The study assumes that housing will be readily available. There is no discussion on zoning for mobile homes and trailers. Where will people live? In cottages, houses, trailers? How many in each type? New or existing?

(437) --page 173, and 177, There appears to be internal inconsistencies in the document when discussing when issues become a mining related impact. An example of this internal inconsistency is in the discussion of the Forest County Jail versus the discussion of the Elcho Sanitary District

(438) --page 176, The Commission questions the extent to which HWY 55 will be over capacity during the construction and the operational phases.

(439) --page 176, Who pays the $500,000 if the state assumes the responsibility of rebuilding HWY S to US HWY 8?

(440) --page 176, The study states that there will be congestion on HWY 55 at HWY A, HWY T and HWY B but does not state how or with what funds the congestion will be mitigated.

(441) --page 176, The study states that Forest County's Highway Department will need approximately $1.3 million for two or three years but ignores the Highway Departments in Oneida and Langlade Counties. What will the 1.3 million a year be needed to do?

(442) --page 176, The study discusses the congestion that will occur in Crandon but does not discuss mitigating measures or any discussion on capital improvements.

(443) --page 177, The study assumes that landspreading will be the acceptable means of disposing of sludge. What other alternatives are available? Can Exxon get an agreement for sludge disposal?

--page 177, the study seems to suggest that there are many landfills that Exxon can use before theirs is built. However, due to the current nature of landfills in the state this could pose problems for Exxon. Especially considering the fact many unlicensed ones are facing closure and the licensed ones are almost filled.

(444)

--page 183, The study addresses the issue of Native Americans returning to the area looking for employment but does not address non-Native Americans returning

(445)

--page 184, The study indicates that the collection of bur oak that the Potawatomi use for food, medicine and art would not be a problem if they would be allowed on Exxon land. Later, however it states (page 187) that the Chippewa do feel unwelcome on Exxon controlled property.

(446)

--page 189, The study does not discuss what the impacts will be if the mine closes after a short period of time.

(447)

--The study does not discuss the potential of increased land valuations due to the in-migration, or the impacts the increased land valuation will have on local constituents.

(448)

--The study does not address the impact of monitoring and supplying adequate Recreational Vehicle sanitary disposal. Are there existing agreements for treatment plants to accept the waste?

(449)

--The study makes no mention of the positive impacts of recreational activities and the tourism economy generated by the development of the project.

(450)

--Under the discussion of Public Service on page 167 and 168 the transition between cost and actual service is difficult to get at. The topic is discussed again on page 173 which is confusing to the reader.

(451)

--Under the public facility discussion the study states that Forest County will be the only County that will need a new facility. However, does this incorporate the fact that the jail will house prisoners from other counties; or take into account the fact that under State law juvenile facilities will have to be separate from adult facilities.

(452)

--The text raised the issue of the high turn over of the labor pool and wage inflation but did not discuss the issue.

(453)

--The study projected public service costs based on per capita expenditures applied to new in-migrants. The approach is reasonable assuming that the level of expectations for the services provided are the same for in-migrants and current residents.

(454)

CONCERNS/OBSERVATIONS: Following are concerns and observations which members of the North Central Mining Impact Planning Committee have addressed at a meeting on June 26, 1986. These concerns and observations are being submitted in addition to the North Central Wisconsin Regional Planning Commissions at the request of the Mining Impact Planning Committee.

--In the overall conclusions presented to the NCMIPC, NCWRPC staff discussed the potential mismatches which may occur in terms of when expenditures will need to be incurred, and when revenue sources will be available to address such needs. These were broken into two areas, 1) those areas in which expenditures will need to be made, which will ultimately receive project related revenue via increased valuations and resulting property tax, and 2) those areas which will need to make expenditures for which the ultimate revenue source will be provided for through revenues obtained from the project and distributed by/through the State Mining Investment and Local Impact Fund Board (MILIFB).

The staff discussed the potential timing problems particularly for a municipality such as Crandon which would have some increased expenditures yet the source of funding would be the MILIFB. It is possible that the funds available to the Board, would be limited, and under certain profitability scenarios, would be non existant for a number of years. Committee members expressed strong concern over this fact, as well as the fact that they did not feel that "mining related costs" were well defined by the MILIFB which would further complicate timely expenditures. This concern is particularly true regarding the $300,000 payment to the County, which will not be made until one year after the first fiscal year of construction. When it is not clear what will be acceptable "mining related" costs, the unit of government will be reluctant to make expenditures for which it is unsure it will ultimately be able to recover. While the Board can be asked for approval of mining related expenditures at any time throughout the year, concern exists regarding the timing of responses to effectively address the impacts. This is particularly true if such a decision would require a hearing by the Board.

While the operation of the MILIFB is not specifically an item of discussion in the Draft EIS, there is the assumption that this body will serve to mitigate negative fiscal impacts resultant from the development of the project. The Committee has some strong concern given the difficulty of arriving at concensus on such items as: when does an impact truely become mining related, what are mining related impacts, which mining related impacts will be eligible for funding, etc.

Given these concerns, the Committee has grave reservations regarding the assumptions that this Board will have the capability, both fiscally and administratively to address their needs.

455 --page 93, The document states that the Elcho School District capacity is 650. How was this capacity determined?

456 --The document states that Rhinelander is closer to the mine complex than Antigo. This is not the case.

JUL 08 1986

Langlade County

WATER AND LAND USE PLANNING COMMITTEE

Langlade County Courthouse
800 Clermont Street
Antigo, Wisconsin 54409

July 7, 1986

Mr. Howard S. Druckenmiller, Director
Bureau of Environmental Analysis and Review
Department of Natural Resources
Box 7921
Madison, Wisconsin 53707

Dear Mr. Druckenmiller:

This is in response to the release of the draft environmental impact statement for the Exxon Minerals Company's zinc-copper mine near Crandon. Most of the following comments involve technical concerns and do not reflect an official policy of Langlade County towards the proposed project. The following comments are not listed in order of significance but according to references as they appear in the draft environmental impact statement.

457 Page 36 - The last sentence on this page is incomplete or else the balance of the sentence was deleted by mistake.

458 Page 76 - The location of the City of Antigo is given as an air pollution point source 27 miles southwest of the proposed mine. This appears to be an inconsistency between the distance of 45 miles mentioned for the City of Antigo on page iii in the EIS Summary. Our check of the actual road distance between the City of Antigo and the proposed project is closer to the 27 miles cited on page 76 than the 45 miles mentioned on page iii. Also, is not the pulp mill at Rhinelander an air
459 pollution point source that should be mentioned as the other pollution sources in the project area are identified in the report?

460 Page 80 and Figure 2-13 - The report mentions four towns around the City of Rhinelander to be affected by the proposed project. Yet the report shows the Town of Antigo as the only rural area adjacent to the City of Antigo to be affected. We believe the department should review the situation since there are several towns in close proximity to the City of Antigo which have experienced population growth since 1960 at the expense of the city. The Town of Rolling has especially enjoyed



increased population levels from families moving from the city to seek rural non-farm living experiences. A large part of the Town of Antigo includes prime farmland which is protected under the county's exclusive agricultural zoning and offers
460 limited area for rural non-farm housing projects. The Towns of Polar, Norwood, and Rolling have less prime farmland and offer a greater potential for accommodating rural non-farm housing opportunities for project related families.

461 Page 80 - Mention is made of retail trade share for Rhinelander and Antigo. It would be helpful to identify the source or basis of this data.

Page 81 - There appears to be an inconsistency that occurs throughout the draft report. The writers use the term "towns" and "townships" as if they mean the same. Towns and townships are not the same thing. A town is the term used officially
462 in the state as a form of general government while a township is a survey unit and not a governmental unit. It would be appropriate to make sure a report of this magnitude would use the correct terminology when referring to a general unit of government. This comment also applies to the abbreviations used for the towns on all the maps in the draft report.

463 Page 87 - Federal, state, or user fees are in parenthesis. What is the reason?

464 Page 90 - There is a reference to Langlade County Memorial Hospital. The hospital is now known officially as Langlade Memorial Hospital.

465 Page 99 - There's a reference to "seated". I believe the reference should be "ceded".

466 Page 121 - There should be a comma after phosphorus.

Pages 96, 179, and 190 - There is some confusion about the use of words "unapproved" and "approved" solid waste sites. According to the statutory definition
467 of "approved" sites there are no sites in Langlade County that would be considered as "approved".

On page 32 there is a reference to using the City of Antigo landfill for refuse before Exxon's onsite landfill is built. Yet on page 180 the chart indicates that in 1986 the Antigo landfill has one to three years life. If the projected time
468 frame for the mine is correct, the Antigo landfill would not be available for accepting waste from Exxon during the construction period.

469 Page 225: second paragraph - I believe it sould be "more over" not "move over".

Page 231 and elsewhere - There is reference of shipping the ore out via the Soo Line. Yet there is talk about possible abandonment sometime in the future.
470 We believe the report should include some comments on the alternatives if abandonment does occur before or during the mine-mill operation.

471 Page 235 - Under land use alternative there is a reference made to tax "role". I believe it should be "roll".

Page 241: third paragraph - There is a reference made to a county commission-
472 ers organization. What county commissioners organization? If you're referring to the Wisconsin County Boards Association, I believe the reference is incorrect and should be county board members.

These are some comments noted in review of the draft environmental impact statement.

Thank you for the opportunity to review the DEIS on this project which would affect our area.

Sincerely,

Marvin Tessmer
Chairman

MT/jk

Town of Ainsworth Mining Impact Committee
Star Route Box 107BB
Pearson, WI 54462
June 17, 1986

JUL 7 1986

Mr. Howard S. Druckenmiller, Director
Bureau of Environmental Analysis and Review
Department of Natural Resources
PO Box 7921
Madison, WI 53707

Dear Mr. Druckenmiller,

We, the members of the Mining Impact Committee of the Town of Ainsworth, T34N-R12E and T33N-R12E, Langlade County, WI., after reviewing the Draft Environmental Impact Statement (DEIS) released by the Department of Natural Resources (DNR) on May 12, 1986, regarding the Exxon Minerals Company Zinc and Copper Mine near Crandon, WI, have many concerns and questions on several issues brought forth in the DEIS. They are:

1. Groundwater Drawdown.

Groundwater will be lowered due to dewatering of the mine and the use of mitigation wells to supplement area lakes and streams. Figure 2-4 and Figure 3-2 (DEIS) picture existing groundwater flow direction. They indicate that groundwater to Sections 1, 2, 3, 11, 12, 13 of the Town of Ainsworth receives its groundwater supply from the area of the mine and the Mine Waste Disposal Facility (MWDF), consisting of approximately 15 square miles. Located in the Town of Ainsworth are Rolling Stone Lake (Sections 11, 12, 13, 14), the southwest corner of Little Sand Lake (Section 1), Creek 12-9 (Section 1-12), Martin Springs and Creek 11-4 (Section 11-12), Creek 13-2 (Section 12-13), Creek 13-15 (Section 13) and Upper Pickerel Creek (Section 2-3-11), all of which receive surface water and groundwater from the area that will be impacted from the mine dewatering. Possible further reductions caused by the installation of mitigation wells is indicated on page 135 (DEIS):

> This pumping, in turn, causes additional drawdown of the water table and additional (secondary) reductions of groundwater discharges to the surface waters. Analysis of the secondary impacts of the continious pumping of dedicated wells shows that, over the long term, the secondary reductions in groundwater discharge to surface waters being mitigated approaches the amount of pumpage. Thus, the dedicated wells proposed for Pickerel Creek and Hoffman Springs would not be effective in mitigating the projected impacts. A limited analysis indicated the well at Martin Springs would be more effective and probably would be capable of mitigating the projected impacts. Water pumped from this well would be comprised of mostly groundwater which otherwise would be discharging into Rolling Stone Lake. (Emphasis supplied)

The next paragraph also states that the pumping on Creek 12-9 would provide... "adequate mitigation water for 1-3 months of pumping..." Longer than that would draw water from the creek and reduce the effectiveness of mitigation pumping. Further statements on pages 136-137 (DEIS), such as..."Without additional model simulations, using higher aquifer transmissivities, the maximum potential increases in lake seepage from mitigation pumping are unknown...; model simulation assumes groundwater beneath the lakes would rise in response to increased lake seepage...", ..."mitigation pumping would further decrease the amount of groundwater discharging to area streams...; and (page 137, DEIS)..."the effectiveness of the mitigation proposal for impacts worse than the expected case cannot be accurately evaluated without additional analysis..." are of great concern for the Town Board and the Mining Impact Committee of Ainsworth. This is because the Rolling Stone Lake District lies directly south of the Crandon Project, in Sections 10, 11, 12, 13, 14, 15, 22, 23 and parts of 26 and 27, T34N-R12E, and it comprises 39% of the Town of Ainsworth's tax base. (Source: Wisconsin Department of Revenue, 1985). This does not include Sections 1, 2, and 3 which lie between the ore body and the Rolling Stone Lake District. These sections, also affected by the mining, are taxable lands and could adversely affect the township's revenues. Adverse impacts from
473 groundwater drawdown and potential contamination of the groundwater supply from MWDF leakage would have a devastating impact on the economic stability of the town because of the negative impact on private wells. Wisconsin Statutes Chapter 144.855 requires..."towns to supply necessary amounts of water to replace that water formerly obtained from the damaged well or water supply"...until such time as the Department of Natural Resources finds that a regulated activity has caused a residential well or water supply to become contaminated, polluted or unfit for human consumption. This, too, then is an additional adverse impact on the economic stability of the town.

In view of the fact that mitigation wells for Creek 11-4, Martin Springs, and Upper Pickerel Creek has the potential of further water drawdown, and contingency plans of pumping treated mine water and intercepted mine water into the above
474 named creeks and spring in the Town of Ainsworth has the potential of water quality and quantity changes, all private wells located in Sections 11 and 12 of T34N-R12E should be considered in the same way as the private wells in Zone 1 (Fig. 1-19, DEIS). Page iv (DEIS) states,..."Exxon would deepen or replace affected wells"...These private wells should be tested for water quality and water level before construction begins.

Throughout the DEIS, terminology such as "assuming, probably, expected, difficult to predict, cannot be accurately estimated without further modeling" etc. is used when discussing the effects of mine dewatering and mitigation pumping on project area lakes. This leads us to assume that the DEIS was written before
475 adequate accurate data and testing methods of this data were available. This necessitates us to demand as a condition of the permit, monitoring of surface and groundwater in the Town of Ainsworth, Sections 1, 2, and 3, and the Rolling Stone District in order to establish a baseline of pre-project conditions, well in advance of construction.

2. Contingency/Mitigation Facilities:

Page 145 (DEIS) states that "developments for contingency plan implementation would include pipeline corridors to Martin Springs." In Fig. 1-26 (DEIS) is found "Contigency/Mitigation Facilities for the Crandon Project" The key does not
476 show any contingency pipelines. Of particular concern to us is the location of a contingency pipeline to Martin Springs. Where would water be pumped from? Where would the location of a pipeline be? How much wildlife habitat would be disturbed? The Rolling Stone Lake deer yard is located in this area. What impacts would the pipeline have on this?

3. Impacts of Habitat loss to Sensitive Species.

On page 147 (DEIS) is stated:

> Mine construction and operation would not directly affect the hunting territory or nesting habitat for bald eagles.

Located between the ore body and Rolling Stone Lake are two bald eagles' nests
477 (Section 2) near Upper Pickerel Creek and next to Martin Springs (Section 12). Exxon proposes in Fig 1-26 to install a mitigation well as found in Fig. 2-11 at almost the same location near Martin Springs as the eagles' nest. The location of this well must be changed so this nesting area will not be jeopardized.

4. Impacts to Swamp Creek and the Wolf River.

The present plan of piping wastewater into Swamp Creek below the Mole Lake Reservation in Section 32, Town of Nashville, concerns us greatly. This is approximately 2500 feet north of the Town of Ainsworth. As stated on page 17 (DEIS),

> About 1200 gallons per minute would be discharged to Swamp Creek downstream of the County Highway M bridge.

On page 140 (DEIS) is stated,

> The proposed discharge of effluent from the wastewater treatment plant to Swamp Creek would contain a variety of contaminants. Since small aquatic organisms (i.e. zooplankton) are generally most sensitive to changes in water quality and toxic impacts, most of the effluent limits would be set to prevent any short or long term effects on these organisms.

Each element of the natural community is part of an interdependent coordinate whole; destruction of one begins a chain reaction of destruction to the food chain. Why are not all of the effluent limits set to prevent impacts on this
478 natural community, instead of "most"? Several of the contaminants are known or suspected human carcinogens, e.g. chromium and cadmium (page 140, DEIS). Also found on page 140 (DEIS) are the statements,

> Inorganic forms of arsenic are known to cause skin and lung cancer in humans, and
>
> Guidance from the Environmental Protection Agency (EPA) on arsenic levels that are necessary to protect human health is not clear and is currently being re-evaluated.

Again we ask, why are not all of the contaminants to be removed from the waste-
479 water instead of most?

Other statements on page 140 (DEIS) such as

> Small increases above background levels for most of the heavy metals are expected in Swamp Creek below the discharge, and
>
> Little or no change,..in the Wolf River...is expected, and
>
> Sulfate levels are expected to increase in Swamp Creek and to a lesser degree, the Wolf River, and

On page 141 (DEIS) it states,

> It is possible that some of the heavy metals would get tied up with organic materials in the sediments and settle out, and
>
> The heavy metals would not be expected to settle out to any great extent.

These statements are of equal concern to us.

Many residents of the Town of Ainsworth and neighboring townships southeast of us derive their livelihood from tourism and related activities, with the Wolf River
480 being the main attraction. You seem to be asking these residents to jeopardize their source of livelihood and lifestyle for the possible economic gain which the Crandon Project may bring to the area and state. Use of such terminology as "would be expected, expected, little or no change of the Wolf River" is so inconclusive that it is frightening. Again we ask, why are not all of the effluent limits set to prevent impacts on this natural community, instead of most?

5. Impacts to the Socio-economic Environment.

We realize that socio-economic baseline projections and future forecasts of impacts are subject to a series of uncertainties. With this in mind, we ask that Exxon and its contractors' hiring policy will be to include "maximum local representation" for their work force if the decision is made to go ahead with the project. By keeping immigrant growth lower, the negative impacts on local services, school districts, and property taxes would be less. This is most beneficial to towns who are not included in the project's property tax windfall, where fiscal

situations would be problematic.

6. Elcho School District.

The Town of Ainsworth is located wholly in the Elcho School District. As stated on page 174 (DEIS), "the Elcho School District is expected to experience impacts from the project (and) cause a short term rise in the Elcho and Elcho School District tax rates." Since the Town of Ainsworth is located in the Elcho School District, it would also experience a rise in its tax rates. As stated previously, if Exxon utilizes local labor to the "maximum," then it would lessen the negative impacts on the school district and the taxpayers of the district.

There is an error in your data regarding the Elcho School capacity. Table 2-36,(DEIS) (481) shows capacity for 650 pupils. Due to the elimination of three elementary classrooms in order to provide a library and a science lab for elementary students, the capacity of the Elcho School is 525 students. With a current enrollment of 485 students, approximately 20 to 30 more students of high school level could be accomodated, but the elementary school is already at capacity. Therefore, your projected increases in the Elcho School costs are incorrect. (Source—Mr. Paul V. Roberts, Elcho School District Administrator, May 20, 1986.)

7. Transportation Impacts.

As stated on page 239 (DEIS)

> Increased traffic in the vicinity of the mine/mill site could cause increased congestion, areas of slow moving traffic, lines of traffic waiting at intersections, and an elevated accident rate.

This is a major concern of ours, as Highway 55, County Highways T, TT, and K are all projected to have a higher traffic volume, and they all run through our township. Implementation of the Mitigation of Transportation Impacts as stated on page 239 (DEIS) proposes help for the situation. We feel that scheduling shift changes at the mine/mill site so as not to coincide with transportation (482) of school children would reduce traffic backup and incidences of accidents. Upgrading and improving road surfaces to better facilitate the transportation of hazardous and toxic chemicals and explosives to the mine/mill site should be implemented to further reduce the possibility of an accident of environmental consequence.

8. Unbiased Decision.

The statement on page 194 (DEIS), "Without a mining project there would be no immediate source of revenue to the Mining Impact Board (MIB) for loan repayment" gives us concern about the DNR's ability to make an unbiased opinion regarding

the Exxon Project. Also, the extraordinary political pressure put on the DNR to get the DEIS written leaves us to wonder if that pressure accounts for the incompleteness of the mitigation/ contingency plans which this statement contains. We close this comment on the DEIS with a quotation from Aldo Leopold's A Sand County Almanac.

> Like winds and sunsets, wild things were taken for granted until progress began to do away with them. Now we face the question of whether a still higher "standard of living" is worth its cost in things natural, wild and free.

Sincerely,

Town Chairman
Town of Ainsworth
Charles Granitta

Town of Ainsworth Mining Impact Committee

James Jansen, Chairman

Tom Young, Vice Chairman

Dorathy L. Mason
Dorathy Mason, Clerk-Treasurer

Mary Lu Lewis, Member

Gary Haviland, Member

Marilyn S. Chapman
Mining Impact Committee
Ground Hemlock Lake
Protection Association
June 13,1986

Mr. Howard S. Druckenmiller
Director: DNR Bureau of Environmental
Analysis and Review
Department of Natural Resources
P.O. Box 7921
Madison, Wisconsin 53707

Dear Mr. Druckenmiller:

Following review of the Draft Environmental Impact Statement the residents of Ground Hemlock Lake see a potential for
(483) significant impact to the lake because of the proximity of the Mine Waste Disposal Facility, and we question whether the lake has been properly addressed. We strongly urge the DNR to require Exxon, through the permits, to compensate the property owners
(484) for any damage that may occur as a result of the construction and operation of the facility.

Ground Hemlock lake is located 2 1/2 miles directly east of the proposed mine site and only 3/4 miles east of the tailing ponds. The lake is almost fully developed with cottages and year round homes and many of the cottage owners are planning retirement on the lake in the future. The lake has approximately fifty (50) developed properties and an adjusted assessed valuation of approximately two million dollars. ($2,000,000.00)

We take exception to the area outlined in red on the "Vegetation"
(485) map. Figure 2-9 at Page 72. The map shows less than 3/4 of the lake occupied when in actuality the lake is almost 100% developed. Could this be an example of the report underestimating the seriousness of impacts on our lake?

The lakes that your draft addressed in more detail; Little Sand
(486) Lake, Deep Hole Lake, Duck Lake and Skunk Lake are either totally uninhabited or insignificantly developed. In the case of Little Sand Lake, most of the property has been purchased by Exxon and the impacts will have almost no effect on privately owned property. The native americans that reside in the area are addressed in great detail, pages 99 thru 108 and reference to these peoples and their lands are referred to in many of the chapters of the DEIS.
The Potawatomi's live up to 15 miles north of the mine and the
(487) Sokaogan Chippewa's live 2 1/2 miles to the west of the mine. Although the differences in distance are the same between the mine and the Sokaogan's and the mine and Hemlock Lake, the difference
(488) in study done on the two groups of residents is shocking. It would seem to us that the impact in many areas of study would be greater east of the mine as the prevailing westerly wind would be a factor in the effect of noise and dust.
(489) Affects to their lakes have been minimized by diverting the effluents from the mine 6.1 miles downstream to protect Mole Lake, Bishop Lake and Rice Lake, whereas the Hemlock Lake area could be adversely affected by the close proximity to the tailing ponds. Figure 1-3 - following page 8.

We see a potential for ground water contamination which may result in contaminated wells and contamination of the lake itself.
The DEIS Table 2-4 shows the ground water flow from the tailing ponds toward Hemlock Creek, but it does not indicate that there
(490) is flow in the direction of Hemlock Lake. At a DNR informational meeting at the Nashville Town Hall, August 18, 1984 I was shown a flow map that indicted that ground water from the tailing ponds would enter Hemlock Lake at the northeast and southeast corners of the lake. Because the lake is totally spring fed (with no inlet) I doubt that it would have the capacity to flush contaminates from the lake without damage being done.

The proposed mitigation for Hemlock Creek (again the lake was not addressed) is: "A well may be constructed adjacent to Hemlock Creek to augment stream discharge during mine-induced low flow conditions." It appears that to mitigate the creek the intent is to draw water
(491) from the ground water table, which in effect could draw from the source of the lake springs. Will this result in a draw down condition for Hemlock Lake or will this result in a draw from the ground water east of the lake?
If this mitigation well is installed will the wells of property owners on the lake be affected by the draw down?

It should be noted that Exxon has leases and options to purchase a sizable portion of land to the south and east of Hemlock Lake.
(492) (surrounding 3/4 of the lake). What use does Exxon propose to make of this land, and why wasn't a more comprehensive assessment done on Hemlock Lake and the surrounding area in light of these anticipated purchases? Figure 1-3 following Page 8.

On page 119, Table 3-10, it seems that the treatment of impacts to
(493) drainage lakes is rather sketchy. Predictions of what will happen are subject to error, and what if the impact on the level of Ground Hemlock Lake is greater than predicted? What protection do we have?

We request that the DNR re-evaluate the alternative sites for the Mine Waste Disposal Facility and hopefully re-locate this facility
(494) to an area with a less dense population. We can see only potentially adverse impacts to our lake from the Mine Waste Disposal Facility and tailing ponds as well as the infliction of noise and dust that will destroy the quality of life in this now pristine environment.

We live in a time when the DNR is charged with protection and
(495) clean-up of the lakes and streams from point and non-point pollution, acid rain, sewage spills etc. How does the DNR justify the potential damage to this primitive area?

We respectfully request that the DNR work with representatives of the Ground Hemlock Lake Association to discover some method of protection for the lake residents from both monetary and environmental impacts anticipated from this project.

Sincerely,

Marilyn S. Chapman

Marilyn S. Chapman
Mining Impact Committee
Ground Hemlock Lake Protection Association
221 Lawn Street
Hartland, Wi 53029

June 20, 1986

Comments on DEIS, proposed Exxon zinc-copper mine.

From: Robert A. Stillings, Chairman, Mining Impact Committee,
Ground Hemlock Lake Protection Association.

Because of the proximity of Ground Hemlock Lake to the mine/mill site (about 2½ miles) and especially to the MWDF (about 3/4 mile) we will be very vulnerable to adverse noise impacts if the mine is constructed and operated. The DEIS does nothing to allay our concerns. (496) The increased noise levels projected in Table 3-25 make it clear that we can expect a problem. At times the problem would be much more severe than these average numbers indicate, as due to meteorological conditions the noise levels could be as much as 20 dB higher, as pointed out on p. 150. We are not impressed by attempts to minimize the extent of the problem by reference to EPA standards&Generalized Community Responses to Noise Increases (Table 3-24). These may be useful where the noise increases are more of the same kinds of noise as in an urban area, but are not appropriate for our situation, where the background levels are largely the natural sounds - wind in the trees, birds, insects and small mammals, lapping waves, etc. The mechanically generated noise from construction and operation of a mine will be of an entirely different and undesirable character, very disruptive to the quiet, peaceful recreational environment which we now enjoy.

Construction at the MWDF does not end when the "construction period " ends. Because of the sequence of the four tailings ponds, construction and reclamation would be taking place during much (497) of the "operation period". It is not made clear in the DEIS whether this was taken into account in the noise projections.

Our most serious criticism of the treatment of noise in the DEIS is the complete absence of any discussion of noise mitigation possibilities. We feel this is a critical ommission which must be corrected in the FEIS, whether or not the DNR has any legal authority to require implementation of noise mitigation measures. Some mitigation possibilities which deserve consideration include:

(498) Limiting the hours per day and the days of the week during which surface construction activities are permitted.

Requiring accoustical enclosure of the major noise generators at the mine/mill site, such as ore crushers, diesel generators, mine air heaters, air compressors, etc.

Selection of equipment with the lowest noise output.

Accoustical treatment of the mine air exhausts using best available technology to confine or direct noise output. Items such as these exhaust fans which will run 24 hours per day 7 days per week deserve special attention as they would allow no noise-free periods.

We appreciate the opportunity to make our views known by this statement and other statements by members of our association.

Robert a. Stillings

MAY 2 7 1986

Rolling Stone Lake Protection and Rehabilitation District
Star Route Box 85A
Pearson, WI 54462
May 20, 1986

Mr. Howard S. Druckenmiller, Director
Bureau of Environmental Analysis and Review
Department of Natural Resources
P.O. Box 7921
Madison, WI 53707

Dear Mr. Druckenmiller,

We, the members of the Mining Impact Committee of the Rolling Stone Lake Protection and Rehabilitation District, are residents of the Township of Ainsworth, of the Elcho School District, and of Langlade County. The District is in the Township of Ainsworth (#34) and encompasses Sections 10, 11, 12, 13, 14, 15, 22, 23 and parts of 26 and 27.

After reviewing the Draft Environmental Impact Statement (DEIS) distributed by the Wisconsin Department of Natural Resources (DNR) on May 12, 1986 regarding the Exxon Minerals Company Zinc-Copper Mine near Crandon, Wisconsin, we have several issues which give us great concern and doubt. They are:

1. The Elevation of Rolling Stone Lake.

From page 57, Table 2-4 (DEIS) the highest level of Rolling Stone Lake is 1535.3 feet and its lowest level is 1535.0 feet. In order to maintain its normal level, it is necessary that its water sources remain at their present affluences. Our water sources are (1) groundwater as indicated by the arrows in Figure 2-4 (DEIS) showing that it draws from approximately 15 square miles which include Sections 1, 2, 3, 11, 12, 13 of the Township of Ainsworth (#34), Sections 5, 6, 7, 8 of the Township of Nashville (#34), Sections 34, 35, 36 of the Township of Nashville (#35), and Sections 31 and 32 of the Township of Lincoln (#35); (2) waters of Upper Pickerel Creek, Creeks 11-4, 12-9,13-2, and 13-15; and (3) waters from Little Sand Lake, Deep Hole Lake, and Duck Lake. It should be noted that Creeks 11-4 and 12-9 are Class A trout streams.

According to Table 3-5, page 120 (DEIS), there will be significant reductions in lake levels of Little Sand Lake (6.21-8.57 ft.), Duck Lake (.21-.45 ft.) and Deep Hole Lake (.90-3.44 ft.).

499

According to Table 3-11, page 128 (DEIS) there will be a flow reduction in Creek 12-9 (.47 cu. ft./sec.), in Upper Pickerel Creek (.21 cu. ft./sec.) and in Creek 11-4 (.09 cu. ft./sec.).

The mine dewatering process will have negative impacts on these water sources as indicated by the tables previously presented and as stated on page 127, (DEIS),

> Mine dewatering would cause a drawdown in the groundwater level in the region of the mine.

Figure 3-4 (DEIS) shows that the direction of the groundwater flow during the mine dewatering will be toward the mine and diverted away from Rolling Stone Lake. The negative impacts on the water sources of Rolling Stone Lake are of great concern to its residents, and the statement from page iv (DEIS), specifically, "An analysis of the plan's ability to mitigate impacts worse than expected has not been completed" gives us a doubt about the future of Rolling Stone Lake. It is also stated on page 135 (DEIS) in regard to pumping as part of the Surface Water Mitigation/ Contingency Plan,

> This pumping, in turn, causes additional drawdowns of the water table and additional (secondary) reductions of groundwater discharge to the surface waters. Analysis of the secondary impacts of continuously pumping dedicated wells shows that, over the long-term, the secondary reductions in groundwater discharge to the surface waters being mitigated approaches the amount of pumping. Thus, the dedicated wells proposed for Pickerel Creek and Hoffman Springs would not be effective in mitigating the projected impacts. A limited analysis indicated the well at Martin Springs would be more effective and probably would be capable of mitigating the projected impacts. Water pumped from this well would be comprised mostly of groundwater which would otherwise be discharging into Rolling Stone Lake.

The next paragraph states that the pumping on Creek 12-9 would provide "...adequate mitigation water for 1-3 months of pumping." Longer than that would draw water from the creek and reduce the "...effectiveness of mitigation pumping." Again, on page 135 (DEIS) is the statement,

> The pumping also would increase drawdown beneath lakes, thereby increasing lake impacts.

There are continued presentations on pp. 136-137 (DEIS) concerning the pumping operations to maintain water flow to Rolling Stone Lake, but they do not remove any of our doubts about the effectiveness of these plans because the statement on page 137 (DEIS), i.e.

> The effectiveness of the mitigation proposal for impacts worse than the expected case cannot be accurately evaluated without additional analysis

gives us little assurance that Rolling Stone Lake will survive.

The members of the Rolling Stone Lake Protection and Rehabilitation District have put a great deal of time, money, and effort into the reclamation process of the lake for the past ten years, and are continuing to do so. Needless to say, we are duly concerned that what is presently being accomplished can so easily be jeopardized. The reclamation project has been mainly financed and executed by the District and has received minimal financial assistance from the State of Wisconsin. Therefore, we are more than duly concerned about the negative impacts of the Exxon project on Rolling Stone Lake.

Again, in a Status Report of Department of Natural Resources Activities on the Proposed Exxon Mine near Crandon, Wisconsin dated May, 1985 is the statement, page 3,

> The project's potential impacts to lakes, for example, are very important, because DNR, by state law (S.144.855 (3)) cannot issue approval for mine dewatering if the withdrawal would cause an "unreasonable detriment of public rights in the waters of the state." Unreasonable detriment could include loss of fish species and thus fishing, disruption of navigation rights, substantial lake level changes, and other related impacts.

According to the Report (page 4)

> This analysis of measures to mitigate surface water impacts will be included in the Draft Environmental Impact Statement.

However, on page 119 (DEIS) we read,

> Exxon has proposed a plan to mitigate declines in stream flows and lake levels (see Chapter 1). Parts of this plan are not yet fully developed and, as described below, the ability of the plan to completely mitigate all possible lake and stream impacts is uncertain.

The last statement is the one that gives us cause for great concern, because the issue of the negative impacts of the mine dewatering on the lake level of Rolling Stone Lake has not been fully addressed. Thus far, Exxon and the DNR have not given us any answers or guarantees that Rolling Stone Lake will not be impaired in any way. (500)

2. The Quality of Rolling Stone Lake Waters.

On page iv (DEIS) we read,

> Mitigation pumping would cause water quality changes in lakes. Lake levels and stream flows would be slightly below historic averages.

On page v (DEIS) it discusses use of wastewater to replenish surface waters which would need additional treatment. In addition, good water quality includes the

oxygen level of all incoming waters. Is Exxon willing to undertake that expense to provide water of good quality? (501)

Of course, the tailings ponds must be considered. On page iv (DEIS), pertaining to the Mine Waste Disposal Facility (MWDF), it states,

> Leachate seeping from MWDF would enter the groundwater and eventually discharge into area streams.

The design of the MWDF would "...limit seepage into the groundwater system during the operation phase." (page 13, DEIS). We sincerely hope that the construction (502) of the tailings ponds will be as adequate as expected and will not encounter any unexpected break-downs which will cause the leachate to filter into the groundwater or wetlands near the ponds.

3. Our Private Wells.

On page iv (DEIS) we read,

> Pumping water from the underground mine would cause the groundwater table to decline over a large area.

If the mine drawdown will be affecting the level of the groundwater table, as well as the direction of the flow of the groundwater, what recourse do we have if our private wells are affected? As of now, the burden of proof rests on the individual (503) owner, and it will surely be a difficult undertaking to prove that the mining operation is responsible.

4. The Elcho School District.

The Township of Ainsworth is part of the Elcho School District which is, at present, a low state-aid district. Table 3-48, page 175 (DEIS) projects that the Elcho School District will have an increased cost of $3,124,000 due to the Exxon mining project. (504) The township has no predicted income related to the project and, therefore, monies will be coming from taxpayers in the Township of Ainsworth. Indirectly, we will be subsidizing costs related to the mining project.

5. Noise and Vibrations.

The residents of the Rolling Stone Lake area are approximately 2.5 miles southward of the mining area. We, therefore, anticipate that we will be affected by the noise levels.

In regard to the vibrations, on page 74 (DEIS) we find the statement, "...the area is considered relatively free from seismic vibrations." We disagree with this (505) statement. From experience, we have felt air and ensuing earth vibrations during a severe thunderstorm, which indicates that the ground is not impervious to vibrations.

COMMENTS & RESPONSES

6. Dust Pollution.

We have very strong prevailing winds from the north, northeast and northwest. In
(506) our opinion, dust could therefore be a problem during the construction period and also during the following mine operation period.

7. Information Facts in the DEIS.

There is information in the DEIS which we challenge. On page 59 (DEIS) Rolling
(507) Stone Lake is described as having a surface area of 672 acres. However, according to page 194 of the Wisconsin Lakes-A Trophic Assessment Using Landsat Digital Data, a study published by the Inland Lake Renewal Section of the DNR in January, 1983, the surface area is 890 acres. This difference will affect the statistics of Table 3-10, page 127 (DEIS) and other related data. Also of major concern to us is the fact that all Exxon data is based on a 28 year average of 30.71 inches of
(508) annual precipitation and 8.5 recharge rate. However, in the last 28 years, our annual precipitation has been less than 30.71 inches for more than 65 percent of the time. Our worst year was 14.58 inches of precipitation in 1976, and we feel that all data should be based on this figure. (Source—Nicolet Weather Service.)

In addition, the inflow of water to Rolling Stone Lake is listed as a rather low quantity. In a limnological study done by Northern Lake Service, Inc., of Crandon, Wisconsin, and submitted to the DNR in February, 1978, the entire flow into the lake
(509) from its water shed is 33 cu. ft./sec., most of which comes from the mine site area.

8. Terminology Used in the DEIS.

Too often in the impact/mitigation plans do we find words such as probably, uncertain,
(510) could be, not completed, and projected, which puts us ill at ease concerning the future of Rolling Stone Lake.

9. Financial Pressure.

Is the DNR able to be unbiased in its decision about the issuance of the mining permits? We wonder. On page 194 (DEIS) we read,

> (511) A no action alternative would have fiscal implications for the Local Investment and Mining Impact Fund Board (MIB) and the State of Wisconsin. During the permitting period (1983-1986), the Fund paid $100,000 annual block grants to Lincoln and Nashville townships and two tribes (Mole Lake Chippewa and Forest County Potawatomi) in the vicinity of the mine. The source of the funds was through loans authorized by the legislature based on the assumption that the loans would be repaid after mining began. Without a mining project, there would be no immediate source of revenue to the MIB for loan repayment.

It is the last sentence of the quote that gives us cause to wonder, and rightly so. The State of Wisconsin has already incurred huge expenses and the recovery of these monies will depend upon the mine being in operation. Is it, therefore, really possible for the DNR to make an impartial decision regarding the issuance of the mining permits?

Therefore, in conclusion, the Rolling Stone Lake Protection and Rehabilitation District requests that Exxon post a performance bond or some form of insurance
(512) guarantee with the said District, before the project begins, which would guarantee that

(1) the lake level of Rolling Stone Lake be maintained;
(2) the quality of its water be maintained;
(3) private wells which would be affected by groundwater drawdown be replaced without taking court action; and,
(4) land owners be reimbursed for the amount of devaluation of their properties related to the impairment of the lake and groundwater.

A written response prior to the Master Hearing is requested.

Sincerely,

Mining Impact Committee
Rollingstone Lake Protection and Rehabilitation District

Sonny Wreczycki

Sonny Wreczycki, Chairman

Mimi Wreczycki

Mimi Wreczycki

Warren R. Otto

Warren R. Otto

Marianne S. Otto

Marianne S. Otto

Leon Rose

Leon Rose, (ex officio)
President, Rollingstone Lake Protection and Rehabilitation District

Copies

JUL 02 1986

UWEX COOPERATIVE EXTENSION SERVICE • UNIVERSITY OF WISCONSIN-EXTENSION

Oneida County Extension Office
P.O. Box 1208 - Airport
Rhinelander, WI 54501
(715) 369-6160

June 30, 1986

Mr. Howard S. Druckenmiller, Director
Bureau of Environmental Analysis and Review
Department of Natural Resources
P.O. Box 7921
Madison, WI 53707

Mr. Druckenmiller:

These are my comments regarding the DEIS for the Exxon Minerals zinc-copper mine.

- Fiscal Impacts: Several minor civil divisions are predicted to have fiscal impacts that are not in the project area. (P.171). The State Mining Impact Board is indicated as a possible source of funds to mitigate negative effects. Currently there seems to be no consistancy agreeing on what constitutes a Mining Impact. Further expenditures may need to be made prior to any assurance that the State Board would assist the local government. This needs to be explored in the final EIS. (513)

- Environmental Impacts: Some reagents used (Table 1-5) at the mine site appear to be highly toxic and reactive. Considering recent problems in Bohpal, further discussion of toxic leaks and possible toxic gas formation need to be addressed, including response procedures in an emergency. (514)

- Public Facilities: (P.173) No additional facilities are projected as needed for the Rhinelander School District. Yet (P.92) the district has two schools at capacity and the districts enrollment is projected to increase (P.14). Why? Further, if school improvements cannot be approved resident children will face more crowded conditions as a result. (515)

(516) Transportation (P.94): Republic Express has taken the place of Midstate Airlines.

(517) Who will pay for improvements to Co. Hwy B and Co. M & Z if needed as a result of increased resident traffic to the mine site.

- Socio Ecomomic impacts to Pelican Lake (towns of Schoepke and Enterprise) ought to be more carefully considered. Due to the small size of the local economy relatively small numbers of immigrants could significantly affect local government costs relative to short term revenues. (518)

University of Wisconsin, United States Department of Agriculture and Wisconsin Counties Cooperating.
UW-Extension provides equal opportunities in employment and programming, including Title IX requirements.

(519) The mine is likely to become a tourist attraction and this impact is not discussed in the DEIS. Environmentalists will certainly want to see the damage-others would be more generally curious.

- Solid Waste Disposal: (P.179) Oneida County currently has a policy of not accepting solid waste from outside of the county for disposal in the County Sanitary landfill. (Contact the Planning and Zoning Office.) (520) The landfill will receive increased waste due to increased residents but should not be considered for off-site disposal from the mine site.

- Commodity Prices can be expected to fluctuate and Exxon's purpose is to return a profit to their investors. However, there is no (521) discussion of temporary closing of the operation due to low metal prices and the subsequent economic impacts.

I hope these comments help improve the Final Environmental Impact Statement.

Sincerely,

Don Sargent
Resource Agent
Oneida County

cc: Fred Feller
DS/nb

JUL 09 1986

July 7 1986

Mining Impact Committee
Pelican Lake, Wisc 54463
1559 Hwy 45

Mr. Howard L. Druckenmiller, Director
Bureau of Env. Anal + Rev
DNR, Box 7921
Madison, Wisc 53707

The following comments on the EXXON DEIS are submitted by the members of the Mining Impact Committee, Town of Schoepke, Oneida County, Wisconsin

The comments are based on the premise that the DEIS in essence rated the Town of Schoepke as a non-entity, when in reality the location of the Township ranks it as a "back door" to the mine site.

(522)

Sincerly,
Marlin J. White III

Chairman, MIC.

ERC.

Schoepke - 1

Location and Road Access

(Since many of the maps in the DEIS delineate the Town of Schoepke as the Town of Monico, we feel this should be clarified. Bob Ramharter was informed of this inconsistency)

(523)

Schoepke Township, in the S.E. corner of Oneida County, lies immediately west of, and forms said boundary to, the Town of Nashville, Forest County. Schoepke is bisected north-south by U.S Hiway 45, which is a major heavy-weight transportation route from southern industry to the northwoods area.

Oneida County Hwy B forms a west-east link between U S Hwy 45 (Oneida Co.) at Pelican Lake and STH 55 (Forest Co.) 1½ miles north of the proposed EXXON mine access Road

The Town of Schoepke also adjoins the Town of Elcho Two miles north of the unincorporated burg of Elcho. Pelican Lake (unine.) is four miles north of Elcho (unine.) with the Oneida-Langlade Co. line also forming the Town line of each Town

Five miles East on "B", at Jennings, Hwy's "N", "Z", and several other secondary roads are maintained year around. These roads network to provide direct access to Mole Lake, Nashville, and Crandon. These roads are major Local thoroughfares. Going West from Pelican Lake, "B" connects with "G", a major route to Rhinelander. Hwy "G" links Pelican Lake to STH 17 at Parrish, giving rapid access to Merrill, Wausau, & US 51.

The proposed location of the mine access road would make it seem more likely that Traffic would increase on Hwy "B", and to reduce travel on STH 55. The historic "scenic" Nature of STH 55 would make it an unlikely candidate for upgrading. Such upgrading would reduce its Tourist attraction potential.

Recreation.

The Pelican Lake area has been a Major Northwoods recreation site for over a century. The area surrounding the Lake itself has great potential for development. Any additional development by and near the Lake will undoubtedly mandate water pollution abatement facilities in the future.

Housing

The corridor along Hwy B from the Forest County line west to Pelican Lake (mine) sustains a year around population and has considerable potential for greater housing development. Hwy "Z", from Jennings (on Hwy B) south to Hwy "K" in Langlade County also sustains a year around population. This corridor has much property suitable to development and is close to recreational areas along the upper Wolf River, which bisects the town of Schoepke.

School District

524 The DEIS purports to give consideration to "School Districts", yet only the Town of Elcho is mentioned as representing the Elcho School District. Ainsworth and Schoepke are two of the other six Townships in the school district. Both are closer in proximity to the mine site than Elcho. If the trends established during the exploration period continue, Schoepke could shoulder considerable population impact

COMMENTS & RESPONSES

Schoepke - 4

Fire and Safety

Fire protection is provided for the Pelican Lake Fire District by equipment based in Pelican Lake (unincr.) The district serves the towns of Schoepke and Enterprise, comprising approximately 110 square miles. The present fire rating for the district is a "9". It may be necessary to upgrade to an "8".

State licensed EMTs staff an Oneida County Ambulance based in Pelican Lake (unincr.) Normal response area is a 15-18 mile radius, and serves hospitals in Rhinelander, Antigo, Merrill, and Wausau. Staffing the ambulance is currently somewhat marginal. Population changes may require more staff, but may also provide more.

Police protection is currently provided by the Oneida County Sheriffs Department. Changes in population distribution may necessitate a local police force.

Demographic changes will most certainly mandate drastic changes in zoning as a tool for planning.

Schoepke - 5

Summary

We are currently concerned with the impacts of the Exxon project. However, the number of known geologic anomalies within 12 miles of Pelican Lake (Schoepke) mandates further consideration for future development.

JUL 07 1986

July 3, 1986

To: Howard S. Druckenmiller

From: Ground Hemlock Lake mining committee

Although most of our comments concerning the DEIS were already submitted, we feel that we have some additional questions to put forth. We appreciate that we the public can take a vital role in the mining process. Please note the following potential problems not covered adequatly in the DEIS;

525 - Dust control. Since Ground Hemlock is directly West of the NMDF where toxic waste will be moved and sifted by many contruction vehicles, the potential is great for toxic dust clouds to smother and destroy local air quality.

526 - Water Wells. Baseline monitoring of area wells is needed for ensuring continuous good water quality. These tests must be done for providing legal proof so a property will have legal recourse if mine related well problems do occur. Otherwise Exxon may deny responsibility. Well testing should occur at Exxons expense.

527 - How certain is the assumption of the compliance boundry even after the closing of the mine? Groundwater levels may start rising again in the cone of water depression thus drawing contaminents beyond the compliance boundry.

528 Why has no "Plan of NMDF operation" been issued yet? The Town of Lincoln needs this to plan accordingly.

529 - Since the cone of water water depression is round and other lakes that are 3 miles away from the mine are studied for mitigation, why is not Ground Hemlock studied for possible drawdown effects? Our lake should be at least mentioned in detail why a mitigation study isn't needed. We want to know the remedies if problems do occur.

- 365 -

Please take these comments into consideration.

Sincerely,

Lyn Chapman
Bob Stillings
Fred Yatchak

JUL 28 1986

12th District

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19 South, State Capitol
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State Senator
Lloyd Kincaid

Chairman
Senate Committee on Tourism, Revenue, Financial Institutions and Forestry
Legislative Council Committee on Mining

Member
Joint Committee for the Review of Administrative Rules
Committee on Aging, Taxation, Banking and Commercial Credit
Transportation Projects Commission
American Indian Study Committee

July 24, 1986

Bob Ramharter
Department of Natural Resources
101 S Webster Street
Madison, WI 53707

Dear Bob:

530 As you know, many environmental groups have claimed there is widespread opposition to the Crandon Exxon mine project. They claim this opposition goes beyond the concerns of certain environmental extremists, and includes organizations that are concerned primarily with economic issues. In particular, they claim that the tourism industry -- long the backbone of the economy of the north -- will be hurt if the mine is constructed. This assertion is without merit, and is wholly invalid.

As you know, the Legislature divided Wisconsin into seven state mandated, state recognized councils in 1977. These different councils were formed so local business leaders could cooperatively work toward the development and maintenance of a business climate that encourages tourism. As the enclosed documents from 1981 make clear, the Northwoods Council, which represents a wide range of business leaders and Chambers of Commerce in eleven northern counties, has backed the Exxon project enthusiastically for years. That support was recently reconfirmed at the Council's May, 1986 Executive Board meeting.

I respectfully request that this letter and these enclosures be placed in the Final Environmental Impact Statement on the Exxon project that will be published by your department.

If you have any questions on this material, please don't hesitate to contact me.

Sincerely,

LLOYD H. KINCAID
State Senator
12th District

LHK:1
enclosures

COMMENTS & RESPONSES

RESPONSE TO GOVERNMENT AGENCY COMMENTS

Response No. | Response

1 Concentrations of pollutants in the effluent cannot be meaningfully compared with water quality criteria. The appropriate comparison is between the Wisconsin and U.S. EPA criteria values (in ug/l, or parts per billion) shown below:

	U.S. EPA	DNR
Lead		
Maximum	76.4	1,000
Average	3.0	42
Mercury		
Maximum	2.4	2.0
Average	0.012	0.20

These disparities in values result from several differences between the U.S. EPA and DNR methods of calculation. An extensive data base exists on the acute and chronic toxicity effects of heavy metals on fish and other aquatic life. The EPA uses all fresh water species in the United States to establish criteria. The Department screens the data base and uses the toxicity information for only those species found in Wisconsin surface waters. Further screening is then performed for factors such as exposure time and life stages studied. Consequently, some of the limits set for heavy metals in the Exxon discharge are higher than the water quality criteria established by EPA. In addition, EPA methodology for establishing appropriate criteria is different than Wisconsin's; thus accounting for some of the disparate criteria.

The final criteria protect the most sensitive species for which scientific data are available as required in the Wisconsin Administrative Code Chapter NR 102. Wisconsin's approach for toxic pollutant criteria development also is site specific to provide the necessary level of protection for uses in the receiving waters.

In the case of lead and cyanide, all toxicity data for resident Wisconsin aquatic species were utilized to establish monthly average limits for the Swamp Creek discharge. Thus, adequate protection of the aquatic life in the receiving waters should be afforded. In the case of mercury, the monthly average limit was set to prevent exceedance of the FDA action level in fish in order to protect human health. Incidentally, the monthly average limit for mercury (0.0002 mg/l) is near the existing background level in Swamp Creek (0.00017 mg/l).

2 The Department is aware of the concentration addition models referred to by EPA. We also have reviewed the pertinent available literature on additivity effects of heavy metals. Given the current scientific data base on additivity, the Department concluded that the addition models should not be applied at this time. Recent correspondence from the U.S. EPA, Region 5, indicates its agreement with this decision. Some of the additivity models have been shown to be adequate for laboratory analyses. However, in our judgment, their application in a field situation poses numerous problems and is not justifiable or legally defensible.

Tests were conducted by the EPA Environmental Research Lab at Duluth on the additivity of a mixture of six metals (As^{+3}, Cd, Cr^{+6}, Cu, Hg, and Pb). The mixture of these metals was tested at the EPA acute criteria level for Ceriodaphnia and fathead minnows for a period of two days. These results showed a substantial reduction in the growth rate and reproduction for Ceriodaphnia with a lesser impact on fathead minnows (approximately a fifteen percent reduction in growth).

One of the conclusions reached in those studies is that additivity of those metals tested does not affect all organisms equally. Minute organisms such as daphnids appear to be more sensitive to the effects of additivity than do higher life forms like fish. In addition, the mode of action can be different for different chemicals. In other words, metals may not be strictly additive in their effect, unlike certain organics. Thus, for a mixture of metals tested, the effects observed may be a synergistic effect of two or three metals acting together rather than strictly an additive effect of all the metals. The Department does not consider the current scientific knowledge sufficient to explain the joint effects of heavy metals on the survival of aquatic species.

Future studies need to address the mode of action of heavy metals on various aquatic species and evaluate the effect of different toxic mixtures under field, as well as laboratory conditions. As the work at EPA's Duluth lab has shown, the bioavailability of the various heavy metals is an important consideration in determining the effects of additivity.

As additional information becomes available on the effects of additivity, the Department will reevaluate its current position. Until such time as the adequacy of additivity models in surface waters improves to our satisfaction, the Department will require chronic bioassay testing of selected organisms. As part of their WPDES permit, Exxon would be required to perform chronic bioassay tests (in accordance with accepted protocol) to determine if synergistic or additive effects may be impacting the aquatic biota in Swamp Creek.

3 Analytical information for these parameters is limited because they were not included in water model predictions of chemical constituents in water streams throughout the mine/mill complex. To evaluate the probable effluent levels of these parameters, Exxon and its consultant reviewed project pilot plant data, influent and effluent data from a lime precipitation wastewater treatment plant at an operating mine (an operation which would be similar to Crandon) and information from the literature. Based on industry experience and geochemistry, these substances probably would be present at or below the standard detection limits, for nickel (0.02 mg/l), tin (0.02/mg/l) and platinum (0.1 mg/l) and approximately 0.05 mg/l for bismuth (based on literature references).

Acute and chronic toxicity information for fish and aquatic life species is available only for nickel, identified as a priority pollutant by U.S. EPA. Consequently, daily maximum and monthly average water quality based limitations for nickel will be included in the WPDES permit (Table 1-8 FEIS). Some monitoring for tin, platinum, and bismuth would be required to determine the presence of these parameters in the effluent (Table 1-13 FEIS) and for use in establishing limitations if appropriate. Acute and chronic biomonitoring also would be required to determine whole effluent toxicity including contributions from these parameters.

4 The discharge of untreated mine water from shaft sinking operations would not be permitted. Refer to response #128. Contaminated mine shaft water would be contained in the excess wastewater discharge lagoons or the reclaim ponds until the water treatment plant would be operational. The composition of mine shaft water (primarily groundwater seepage) is expected to range between the parameter values presented for intercepted groundwater and the contaminated mine water (Table 1-7 of the DEIS).

5 It is difficult to respond to this comment without knowing at what point the U.S. EPA would not view wetland losses as "excessive." During the planning of each mine facility Exxon was required by state administrative code to explore alternatives that would avoid and/or minimize wetland loss. In selecting a preferred alternative, however, Exxon was required to pick the alternative that had the least overall environmental impact. Wetland loss was only one of the number of criteria used in the final selection process. Because of

this necessity to select the least overall impact alternative, the preferred alternative is not always the least wetland acreage impact alternative. In no case, however, was an alternative selected that caused a significantly higher wetland acreage loss in comparison to alternative choices. Avoiding wetlands whenever possible was an important, but not exclusive, siting criterion used by Exxon and insisted upon by the Department. The DEIS clearly demonstrated that wetlands have been avoided as much as possible in conjunction with meeting the least overall environmental impact requirement (DEIS pages 196-211). Consolidating all the access routes is not practical given the location of roads and the rail line.

The Department does not intend to develop mitigation plans for lost wetlands and will not be requiring Exxon to mitigate unavoidable wetland losses, except in the cases where wetland restoration or creation would be viewed as an appropriate mine reclamation activity. The Department would welcome U.S. EPA and other federal agencies working with Exxon to mitigate unavoidable wetland losses.

6 These comments identify lake impacts if the groundwater drawdown were not mitigated. However, the surface water mitigation would be required to prevent these adverse impacts from occurring by maintaining minimum lake levels as specified in DEIS Table 3-6.

7 So little is known about the ecological requirements of the threatened pondweed species (Potamogeton confervoides), that it is hard to judge whether augmentation water would adversely impact the species or not. However, the lake in which this species had been found (Duck Lake) is not projected to require significant augmentation, so the question is moot.

8 Sensitivity analyses have been conducted for all hydrological modeling. Parameters such as hydraulic conductivity, groundwater recharge, lake seepage, storage coefficient, boundary conditions, dispersivity, and MWDF seepage have been varied in order to provide a range of potential outcomes.

9 The environmental monitoring section in the DEIS outlined the various monitoring activities proposed by Exxon. Many of the monitoring activities would be conducted through Exxon's long-term care period, which is up to 30 years following approved facility closure. By law, Exxon's long-term care responsibilities then would end, and the State of Wisconsin would continue long-term care, including required monitoring, for as long as necessary. The exact nature of the necessary monitoring would be determined at that time.

10 The destruction of 10% of the MWDF cap membrane is a conservative scenario. If such destruction occurred and significant impacts to groundwater were anticipated, the cap would have to be repaired.

11 The specific long-term impacts referred to in this summary comment are addressed in detail in subsequent responses.

12 The long-term environmental protection goals are delineated in relevant state statutes and Wisconsin Administrative Codes for such areas as discharges to surface waters (WPDES permits), air pollution, solid waste and mining waste disposal, mining in general, mine reclamation, high capacity wells and water withdrawal, and wetlands, fish, game, and critical species protection. While many of the project-related environmental protection goals are identified in the DEIS, it is not within the scope of the EIS to delineate all these goals. Contingency plans related to groundwater contamination have been developed for five of the mine/mill facilities. The contingency plan for the MWDF was discussed on DEIS pages 236 and 237.

13 Bonding and insurance requirements are part of the permitting process which will be examined at the master hearing. Their inclusion in the EIS is not appropriate.

Response No.	Response

14 Comment noted.

15 DEIS pages 140-142 discussed the impacts to Swamp Creek and the Wolf River from the proposed discharge, and DEIS Table 3-21 showed projected changes in water chemistry for Swamp Creek and the Wolf River under $Q_{7,10}$ and average flow conditions.

The standards are set to protect fish and aquatic life against acute and chronic toxicity effects from heavy metals in the proposed discharge. The exact fate of the heavy metals in the Swamp Creek ecosystem cannot be accurately assessed at this time. Consequently, the mining permit would require periodic monitoring of the sediments in Swamp Creek and tissue analysis for benthos and fish. Acute and chronic bioassay testing also would be required as part of the WPDES permit.

If there is bioaccumulation of heavy metals in the biota or the results of the bioassay studies indicate there are sublethal or chronic toxic effects to the fish and/or aquatic life in Swamp Creek or in downstream waters, then modification of the effluent limits, as specified in the WPDES permit, would be necessary.

16 The monitoring plan would require periodic fish and benthos monitoring in Swamp Creek. Sampling for a wide range of chemical and biological parameters would begin prior to construction and would continue throughout operation. If significant differences were detected between stations upstream and downstream from the outfall, additional downstream sampling locations would be established in an effort to further assess the differences. If monitoring indicated a problem with bioaccumulation, the effluent limits would be adjusted accordingly.

17 Effluent limitations have been established in the proposed WPDES permit for total metals (DEIS Table 1-13). Total metals include both soluble and particulate fractions which would be contained in the discharge. Because the total suspended solids are in part regulated through the total metals limits, protection of the aquatic ecosystem would be provided.

18 The design of the mine water and process recycle treatment systems include provisions for addition of activated carbon to the neutralization reactors for removal of organics. During the initial phases of treatment, it would be determined whether activated carbon addition would be necessary. In total, the concentration of organic reagents is expected to be less than 1 mg/l in the contaminated mine water even without treatment. A discussion on the ultimate fate of the organic reagents is contained in the FEIS.

19 The design of the mine water and process recycle treatment systems incorporates features for addition of activated carbon to neutralization reactors for removal of organics if needed. Effluent monitoring results would be used to determine the need for activated carbon addition (see response #18).

Use of activated carbon was included as a probable pretreatment component for removal of organics if the alternative ion exchange treatment system section for contaminated mine water was selected. Organics could foul the ion exchange treatment system if not removed. This ion exchange alternative was not Exxon's preferred advanced alternative treatment system.

20 The presence of organic contaminants in the discharge water is not expected, and thus extensive monitoring for organics would not be warranted. The monitoring plan provides for regular monitoring of certain indicator parameters, and the WPDES permit would require more extensive monitoring for the priority pollutants, including organics, every five years in association with permit renewal. If it were determined after start-up that organic contaminants are present in unacceptable levels, the water treatment system, as proposed, has provisions for adding an activated carbon circuit to remove the organics.

21 The reference to cyanide "amenable to chlorination" in DEIS Table 1-13 was made to indicate the test method for monitoring free available cyanide in contrast to total cyanide. Chlorination would not be utilized for destruction of cyanide in the proposed wastewater treatment system design. If treatment for cyanide were needed, Exxon's preferred method would be to retrofit a hydrogen peroxide oxidation system followed by an ozonation system to the selected process wastewater streams containing elevated levels of cyanide.

22 The proposed monitoring frequency is believed to be adequate and is consistent with and more extensive than requirements imposed on other businesses in the state. If after the initial period of annual sampling, the Department determined continued annual sampling would be necessary, the Department could modify the monitoring plan to continue the program.

23 As indicated on DEIS page 146, deposition of dust containing high levels of heavy metals is not expected to be a problem. Nevertheless, the monitoring plan includes periodic sampling and analyses for the heavy metals content of vegetation, small mammals, and soil downwind from the MWDF. Emphasis would be placed on selecting species with a known capacity for bioaccumulating metals. The Department does not believe an expanded program is warranted at this time. If impacts were detected, the scope of the program could be expanded to better define the problem.

Exxon has submitted plans for minimizing the generation of dust from the project. Also, several of the permits and approvals would contain conditions regarding minimization of dusting from various facilities. If significant dusting were observed after operation begins, the operator would be required to modify the dust suppression plan to ensure compliance with the permits.

Monitoring of dust impacts to lakes is not believed to be necessary, since these impacts would be extremely minimal (DEIS pages 39 and 40).

24 Pursuant to s. 144.81(15), Wisconsin Statutes, reclamation is the process by which a mining site is rehabilitated to its original state. If this is physically or economically impractical, or environmentally or socially undesirable, then other uses are acceptable, so long as they provide long-term environmental stability, proper disposal of wastes, and protection of public health and safety.

The statutes are flexible and allow for the determination of higher and better use or "ultimate use" at any time during the project life. Thus, potentially acceptable uses unforeseen during the planning phase are not precluded. However, if acceptable alternative uses do not develop within the active mine life, then the facility must be dismantled and all disturbed areas revegetated with indigenous species.

A reclamation strategy or mitigation technique whereby wetlands are created on site could be utilized. However, it is not the Department's intent to require acre-for-acre replacement of lost wetlands, and Exxon has not proposed a wetlands replacement mitigation plan. At the project site, approximately 82 acres of wetlands are expected to be directly impacted. Of these 10 to 15% would be impacted only temporarily. In addition, wetland vegetation and functions, including site aesthetics would be restored during reclamation to the extent possible. Exxon has committed to restoring some wetlands by preserving hydrology, replacing soil in the original sequence and hand planting vegetation. Wetlands undoubtedly would be created should settling ponds and sediment basins be left in place. It is quite possible that wetlands may be created during final reclamation as well.

25 Comment acknowledged. The use of fine tailings as backfill (addressed on DEIS page 218) would minimally reduce the volume of waste requiring surface disposal and would not offer any apparent operational benefits.

26 The discussion beginning on DEIS page 226 regarding alternatives for the treatment and disposal of wastewater and the section on page 238 dealing with surface water mitigation alternatives are applicable to the issue of treating the excess water to such a degree that it could be reinjected into the groundwater. It does not appear that there is a cost-effective treatment system available to treat the water to an acceptable quality. Given the state's policy of prohibiting the underground injection of wastewater, a more appropriate alternative would be to treat the wastewater and use it to directly mitigate surface water impacts.

27 An analysis of transportation impacts including the potential impacts of rail shipments to and from the site, has been added in the FEIS.

Contingency plans have been prepared by Exxon as required by section NR 182.075, Wisconsin Administrative Code. The purpose of the contingency plans is to specify remedial actions and intervention which would be taken in the event of spills or leaks of potentially contaminating materials or if an analysis of groundwater indicates that a possible violation of groundwater standards would occur. The MWDF contingency plan was discussed on DEIS pages 236 and 237.

A risk analysis of possible accidental health and environmental hazards potentially associated with the project was prepared as required by section NR 132.07, Wisconsin Administrative Code. Contingency measures with respect to those risks were developed. The risk analysis was discussed on DEIS pages 190-193 and has been revised in the FEIS.

Dust releases from rail transportation of concentrates are expected to be minimal. As the concentrates come from the mill, they are not dry but moist. In addition, rail gondola cars would be covered to prevent dusting.

28 During partial or complete shutdown of either the mine water or process recycle water treatment systems, all project water could be contained within the reclaim ponds until full operating conditions were restored. The reclaim ponds would contain sufficient freeboard above the normal operating level to contain mine inflow of 2500 gpm for greater than 20 days.

Temporary shutdown of the mine/mill and storage of contaminated mine water in the mine would be improbable. Contingencies have been identified for potential unplanned water treatment plant malfunctions which could interrupt operations. The potential for long-term shutdowns also would be minimized by selection of reliable treatment technology, routine preventative maintenance, excess treatment capacity and installed spares for critical equipment and design provisions for maximum operating flexibility.

The three separate treatment systems (DEIS Fig. 1-11) utilize proven unit operations. The lime precipitation and clarification processes, representing U.S. EPA's selected pollution control technology for new facilities, are further enhanced by filtration processes. The reverse osmosis and evaporation recycle water treatment system has been demonstrated to be reliable at other operating facilities.

Equipment maintenance and shutdown data indicated the maximum anticipated shutdown of a unit operation would be approximately one week. A preventative maintenance program for the water treatment plant has been designed to keep unplanned equipment failures to a minimum. Normal shutdowns for general inspection, cleanout, filter media replacement and reverse osmosis module cleaning and replacement have been addressed.

Excess treatment capacity, at least 20% above maximum predicted flow rates, has been provided. The reverse osmosis system includes three operating modules and one stand-by module for a safety factor of 33%. Installed spares have been included for all critical items of equipment. For example, a spare high pressure booster pump has been included for the reverse osmosis system. Most reagent feeding systems would have back-up

capacity. The excess treatment system capacity could be used to treat water which might accumulate during system downtime conditions.

29 The contingency plan for the MWDF was presented in conceptual form on DEIS pages 236-237. Neither Exxon nor Department technical review staff believe that one can anticipate all potential problems which might occur. In subsequent years, monitoring data and review of that data by the Department, as well as direct observations, would be the mechanism for defining the need for remedial action plans. At best, contingency plans are conceptual and specific solutions are dependent on the type and nature of the problems.

30 The need for and extent of continued monitoring after the period of long-term care would be determined at that time. Similarly, remedial actions for long-term contamination problems would not be specified until a particular problem is identified and assessed.

31 The two major sources of water to the reclaim ponds are from the MWDF and the tailings thickener overflow. These sources would bring tailings fines which would settle out. In addition, there would be precipitates formed under oxidizing conditions in the reclaim ponds, and these precipitates should be relatively stable under conditions imposed during project life. During project reclamation, the reclaim pond liners, rock slopes protection, and sludge contents would be disposed in MWDF cell T4. The tailings fines and precipitates from the reclaim ponds would be similar to the majority of material disposed in the MWDF cells.

32 Long-term groundwater contamination from the mine-mill complex is not expected. All surface facilities which could contribute contaminants would be lined, and the facilities would be removed at the end of the mining operation. Groundwater flow through the abandoned mine workings would be of such a small quantity compared to groundwater flow through the overlying glacial aquifer that no significant contamination is expected. A contingency plan for potential groundwater contamination from the mine/mill complex has been prepared.

33 A revised analysis of the effectiveness of the mitigation plan is provided in the FEIS.

34 The revised analysis in the FEIS indicates all mine intercept water would be needed for mitigation.

35 Comment noted. Mitigation pumping would provide water to streams at the rate of approximately 25% or less of the stream flows. For lakes, mitigation fluctuations would be about 0.04-0.06 feet. These fluctuations are not expected to cause adverse effects.

36 See response #346.

37 The DEIS addressed this concern on Table 1-8 (see footnote 9). More stringent effluent limits would be applied under reduced stream flow conditions (i.e., assuming no flow mitigation for Upper Swamp Creek), in order to protect fish and aquatic life in the receiving waters.

38 From the data available in the literature, only bioconcentration information is available. Bioconcentration refers to the direct uptake of a chemical from the water column to an organism. Data on bioaccumulation, which accounts for food chain uptake and accumulation is site specific, are not available in the literature.

Consequently, monitoring (tissue analysis) of bioaccumulation of heavy metals in the aquatic biota of Swamp Creek would be required once the discharge commences. Refer to DEIS Table 1-14 for the specifics of the aquatic monitoring program.

Response No.	Response

39 Monitoring of the Swamp Creek sediments below the outfall, once the discharge begins, and as specified in the monitoring plan, is the only accurate way of determining where, and to what extent, the heavy metals are settling out.

After mine shutdown, instream concentrations for the heavy metals in Swamp Creek would be expected to return to baseline conditions. Thus, the rate at which metals move to the sediments from the water column would be expected to revert to pre-mining conditions.

40 Periodic shutdowns of the mining operation would still result in a discharge to Swamp Creek. The uncontaminated mine water would require discharge to Swamp Creek during temporary shutdowns. Lower effluent flow rates would occur, and the predicted changes in water quality in Swamp Creek, as projected in Table 3-21, would be expected to be smaller. After final shutdown of the mine, the discharge would cease, and the water quality in Swamp Creek would return to baseline conditions.

41 A monitoring site on the Wolf River at County "T" was established in 1982 by DNR and would be maintained for the duration of the project. This site is downstream from where Swamp Creek enters the Wolf River and is upstream from the Menominee Reservation. In addition to water chemistry sampling, fish tissue analyses for heavy metals continue at this site.

Because little or no change in ambient concentrations of heavy metals in the Wolf River is expected as a result of the proposed discharge (refer to DEIS Table 3-21), there are no expected impacts to aquatic life (i.e., increased fish tissue concentrations for the heavy metals). Continued monitoring at Station "T" will provide adequate assurance that the aquatic biota in the Wolf River are being protected. No additional testing or sampling would be required.

42 Environmental impacts severe enough to kill fish populations are not anticipated, assuming the project would be constructed and operated as proposed. We agree that if there were a fish kill, the cause would need to be corrected, or else mitigation would have little benefit.

43 Comment noted. The FEIS provides an updated analysis of the mitigation plan.

44 A toxicity evaluation of the chemicals proposed for use in the milling process has been added in the FEIS. Transportation impacts also have been analyzed in the FEIS.

A brief discussion of on-site reagent spills is contained in the risk assessment section. Additional detail is contained in the groundwater quality contingency plan submitted as part of the mining permit application. In addition, Exxon would be required to submit a spill prevention control and counter-measures plan in accordance with U.S. EPA requirements.

45 Comment acknowledged.

46 The risk analysis required by section NR 132.07, Wisconsin Administrative Code, evaluates the likelihood of an embankment failure. It was described on DEIS page 191. The risk analysis is general and does not address the detail indicated in this comment. See response number 29 relating to the general nature of the contingency plan.

47 Refer to the revised analysis on groundwater impacts from MWDF leakage in the FEIS.

48 Comment acknowledged.

49 The analysis of impacts to Rice Lake (DEIS page 127) accounted for the effects of groundwater drawdown and changes in water quality.

50 Comment acknowledged. The Department believes that the proposed monitoring program is adequate to assess any project-related conditions which may have an impact on Rice Lake.

51 This comment appears to be directed at another federal agency. The U.S. Geological Survey (USGS) has been under contract to the Department to assist in the review and analysis of hydrological issues. Also, the DEIS was provided to the USGS for review.

52 The additional monitoring point would not significantly enhance the monitoring plan. The locations of the monitoring stations on upper Swamp Creek and Hemlock Creek should provide coverage, both up and down stream, for stream sections potentially impacted by project activities.

53 Monitoring is proposed at three stations on Swamp Creek above Rice Lake.

54 Monitoring is proposed in Rice Lake itself, pending tribal approval. This program should be sufficient to characterize the Swamp Creek system and determine project-induced impacts.

55 The Department does not believe that specifying water samples be obtained and analyzed by a neutral third party is necessary. The quality assurance/quality control plan would specify the sampling and analytical methodologies to be followed, and the analyses would be performed by certified labs. Further, as indicated in the DEIS, the Department would provide independent verification of the monitoring program. If necessary, the Department might initiate its own monitoring program in addition to Exxon's monitoring activities.

56 The mine permitting and EIS processes have provided ample and timely opportunity for tribal input including opportunities for making suggestions for more effective monitoring. Further, any party to the contested case hearing on the project may present testimony challenging the proposed monitoring plan or may suggest different or additional monitoring provisions. As a result of the testimony, the monitoring plan would be modified if necessary. The Department believes the process established by the statutes and codes provides for an adequate level of tribal involvement in the project, including development of the monitoring plan.

57 Transformers are no longer manufactured with PCB's as a coolant additive. The most commonly used coolant is mineral oil with freon fluid added to inhibit oxidation.

Potential spills and leaks from transformers, especially if a different or hazardous coolant were to be used, and potential leaks from fuel storage tanks would be covered in the spill prevention, control, and counter-measures plan required in the plan of operation.

58 Measures to prevent leakage and spills from underground fuel tanks would be addressed in the spill prevention, control, and counter-measures plan required in the plan of operation. The plan of operation must be approved prior to initiation of construction at the site, but would be completed after the master hearing.

59 Specific organic compound monitoring would be included in the required effluent analysis for priority pollutants and additional parameters after start-up of the mill. Organic priority pollutant analysis would be required as part of each WPDES permit reissuance application. Depending on results obtained, additional monitoring could be required. Daily biochemical oxygen demand (BOD_5) monitoring of the effluent also would provide indicator parameter data on levels of biodegradable organic process reagents. Daily chemical oxygen demand or total organic carbon monitoring of the effluent also would be required as an indicator parameter.

Response No.	Response

60 Periodic acute and chronic bioassay testing would be required by the WPDES permit. The purpose of the acute and chronic bioassays is to determine whether the synergistic effects of the various pollutants in the effluent would be harmful to the aquatic biota of Swamp Creek.

Protocols and test organisms for the bioassays will be established prior to the time of permit issuance and will follow EPA guidelines.

61 The groundwater monitoring associated with the reclaim ponds includes provisions to monitor for certain parameters which would indicate elevated levels of organics. If increased concentrations of these indicator parameters were detected, more extensive monitoring for certain organic constituents would be initiated.

62 Separate reference areas for the terrestrial ecology monitoring program are not believed to be necessary. If the aerial photography indicated impacts were occurring, ground surveys would be conducted to verify and assess the impacts and to determine the cause. In making this determination, the Department would evaluate all available, pertinent information to determine if the impacts were related to the mining activity or to other events. The Department also could conduct additional surveys or monitoring in the area to gather more information.

63 There are no other known mineral resources which would be directly affected by the project. Sand and gravel sources are common in the region. Project requirements for sand and gravel (DEIS, page 26) are not expected to significantly affect the area's sand and gravel resource. Assuming a 20 foot thick seam of well sorted sand and gravel, about 3 acres would be disturbed to provide the needed sand and gravel.

64 See Response #63.

65 The DEIS discussed the relative importance of the proposed mine in terms of U.S. consumption and domestic production on pages 2-3.

66 Groundwater drawdown cases worse than anticipated were considered in the DEIS for streams (Table 3-11) and lakes (Table 3-5).

67 The "maximum impact" analyses are conservative and present a reasonable range of potential impacts. The goal of the mitigation plan was stated on page 43 of the DEIS.

68 The monitoring provisions discussed in this section would not necessarily be terminated after the third year of operation. As indicated on DEIS page 217, these monitoring activities would be reviewed and if necessary the Department could require they continue. Further, these monitoring requirements would be in addition to the surface water monitoring program which would continue throughout operations.

69 Intercepted groundwater might be suitable for mitigation purposes without advanced treatment, but it would depend on groundwater quality and site specific discharge standards. The proposed treatment system for contaminated mine water and intercepted groundwater would allow sufficient space for addition of an advanced treatment system consisting of reverse osmosis and evaporation. Installation of such additional advanced treatment system capacity would be planned if the precipitation filtration treatment system could not meet the proposed or future effluent discharge standards. Installation of an advanced treatment system would allow further consideration of wastewater disposal alternatives, including mitigation and land disposal. Additional feasibility studies would be required to supplement initial investigations of land disposal options such as seepage basins.

70 The contingency plans for the five compliance boundary areas (underground mine, mine/mill surface facilities, MWDF, landfill, reclaim ponds) have been submitted by Exxon and will be reviewed by the Department. The purpose of the contingency plans is to provide responses to short and long-term events relating to construction, operation and closure of the project which have the potential to impact groundwater quality. The basic outline of the contingency plan for the MWDF was presented on DEIS pages 236 and 237. A brief summary discussion for the other contingency plans is included in the FEIS.

71 The landowner periodically stocks Hoffman Springs with hatchery brook trout as does DNR in Upper Swamp Creek. Therefore, hatchery stocks have been introduced into this particular system. DNR policy advocates the maintenance of wild populations in Class I waters. In Class II streams or springs, hatchery stocks may be used to achieve management goals.

Habitat improvement techniques have not as yet been given serious consideration. This management practice may have application in some situations. A method that will alleviate the adverse impacts of groundwater loss in spawning areas is not available.

A Wisconsin study found that trout biomass (lbs./mile) in managed (improved) and adjacent unmanaged stream sections responded positively to flow circumstances. During periods of low flow, declines occurred in both sections. However, trout were more abundant in the improved section. Where applicable, habitat management can ameliorate but not eliminate the unfavorable impacts of low flow.

72 The surface water mitigation plan will be a requirement of the high capacity well approval. Without adequate lake and stream mitigation, the proposed project would not be approvable.

73 Exxon's revised surface water mitigation plan was received after release of the DEIS. The FEIS has been revised to reflect provisions of the current plan.

74 The dominant vegetation (DEIS Table 2-10) includes shrub swamp, swamp conifer, bog and marsh, which are examples of wetland plant communities. Examples of upland types such as northern hardwood forest, old field, agriculture, and urban areas are included on the same table. Wetlands in the environmental study area were discussed on DEIS page 68. While there may be alternative ways to present this information, we do not believe this organization is confusing.

75 It is not necessary to construct a new USGS/DNR vertical model through the new MWDF location. The modeling verified that Exxon's consultant had prepared a suitable simulation of the MWDF seepage and that the USGS/DNR model hydrogeological setting is similar enough to those conditions existing under the proposed MWDF that the results are valid.

76 The adequacy of the surface water mitigation plan under the worst case impact scenario is presented in the FEIS.

77 Comment acknowledged.

78 See response #76.

79 Exxon does not propose to mitigate, either by replacement or enhancement, the loss of wetlands resulting from the project.

80 Several time limitations and permit review requirements are specified in the state statutes. The mining and reclamation plans would be reviewed annually as outlined in section NR 132.12. For substantial changes, Exxon would have to submit a revised permit application. The WPDES permit for the wastewater discharge to Swamp Creek, would be

issued for no more than 5 years at a time (s. 147.03, Wisconsin Statutes). Each reissuance would require the appropriate review. The solid waste operating license would be granted for the design capacity specified in the determination of site feasibility. The Department may formally review the license and plan of operation to determine compliance no more frequently than annually as specified in section NR 182.05.

For the air pollution control permit, section 144.396, Wisconsin Statutes, specifies that construction must begin within 18 months. When operations would begin, Exxon would have 180 days to prove compliance with permit conditions. After the 180 day shakedown period, if in compliance, Exxon would be granted an operations permit. As per section 144.397, Wisconsin Statutes, the Department would be required to review the operations permit at least once every five years but not more than every two years.

For permits the Department would issue under Chapter 30, Wisconsin Statutes (navigable waters, harbors and navigation), there are no statutorily mandated time limitations. However, it is routine practice for the Department to require construction to begin within a 2-5 year period. The Department may propose additional time limitations at the master hearing.

81 Comment acknowledged.

82 There has been continued evaluation of how to mitigate impacts of the groundwater drawdown. The FEIS summarizes the revised mitigation plan developed by Exxon, and analyzes impacts of the expected and worst cases.

83 The entire socioeconomic impact section is keyed to predicted population inmigration to the area for the construction and operations periods. The inmigrating population during these periods is related to the number of jobs which would be available. The total number of jobs includes the direct jobs, those at the mine, and indirect jobs, those created by increased regional economic activity and the need for additional services. The analysis assumes that for every 100 direct jobs, an additional 50 indirect jobs would be created. The analyses of population, housing, economics, and local governments, therefore, include predicted increases in regional retail economic activity.

84 The effects of project closure on the socioeconomic systems are presented in a number of tables in the DEIS, including population, employment, housing, public services and facilities, assessed valuation, public school enrollment, and school district impacts. Impacts of a temporary suspension or closure during different project phases were presented on DEIS pages 240 and 241. Additional analyses of closure impacts are presented in qualitative terms in the FEIS.

85 A section analyzing impacts to the tourist industry was prepared for the FEIS. No significant impacts to local or regional tourism are predicted from the project.

86 Comment acknowledged.

87 According to state law, the Department must consider in its environmental impact statement the probable environmental consequences of the proposed action, including the positive and negative effects on the physical, biological and socioeconomic environment. However, the Department's regulatory authority as determined by the legislature does not encompass all of the areas of impact described in the environmental analyses. For example, the Department does not have authority to regulate noise or socioeconomic impacts, and therefore, could not condition the mining and other permits for which it has received applications, with noise or socioeconomic restrictions. This does not mean these impacts would necessarily be not mitigated or that they should be ignored. The

Department has urged the Forest County Potawatomi to work with Exxon in attempting to mitigate some of the negative impacts to the tribe. In addition, the Potawatomi would be the recipient of construction period payments ($100,000 annual indexed grants) starting at the beginning of construction and continuing for up to three years after concentrate production begins. They also would be eligible for first dollar payments during operations. As indicated on DEIS page 183, the total of such payments could be up to $3 million during the project.

88 The positive and negative economic impacts expected from the project as proposed were discussed in the DEIS. The Department has concluded that the overall fiscal and economic impacts of the project are not expected to be substantially adverse. In the FEIS, an expanded discussion of this subject is presented. This discussion provides the current basis of the Department's analysis of that permit question, and additional information presented at the master hearing will contribute to the Department's decision. The decision on economic impacts and all other permits and permit-related issues will be issued within 90 days after closure of the hearing record.

89 The Forest County Potawatomi impact section in the DEIS included many of the suggestions contained in Boggs' letter.

90 A transportation impact analysis is included in the FEIS. The analysis includes potential impacts from rail and highway transportation modes. No hazardous wastes are proposed to be transported from the site, although some toxic chemicals would be delivered to the project site. Shippers would be responsible for complying with all applicable laws.

91 On June 6, 1986, the Sokaogon Chippewa Community filed suit in federal district court against the United States, the State of Wisconsin, and Oneida, Langlade and Forest Counties for an expanded reservation boundary. According to the documents filed (Case No. 86-C-0599) with the court, the boundary of the promised reservation encloses an area within lines drawn between Pelican Lake on the west, Little Rice Lake on the north, Lake Metonga on the east, and Lower Post Lake on the south. This area includes some lands within Exxon's project boundary along Swamp Creek and the proposed access road, but excludes the orebody and the majority of the project site.

92 The effects of a break in the buried water discharge pipeline would be mainly flow related and should have little impact on water quality, regardless of where the break would occur. Water quality in the pipeline must meet WPDES permit requirements, and released water would not affect either groundwater or surface water near the mine. General requirements are addressed in the contingency plan. The major control would be quality control during pipeline construction. Major pipe breaks would be detected through flow monitoring and would be further evidenced by saturated soil conditions and should be observed during regular pipeline corridor patrolling. Adverse conditions would be limited to saturated soil in the area of the break.

93 Fertilizers are defined as substances containing recognized plant nutrients used in promoting plant growth. Labels include specific warnings, directions and recommended amounts for use. Fertilizers contain the primary nutrients nitrogen, phosphorous and potassium expressed as total nitrogen (N), available phosphoric acid (P_2O_5) and soluble potash (K_2O). Additional plant nutrients are expressed on an elemental basis.

Few if any environmental impacts should result from the use of standard fertilizers, especially if handled and stored conscientiously. Exxon proposes to employ soil and tissue analyses to accurately measure fertilizer needs. A correct application of fertilizer places only the recommended necessary amount of fertilizer. This helps prevent nutrient loading of surface waters caused by excessive application rates. Judicious use of fertilizers can

help maintain a vigorous stand of vegetation which in turn protects the waters of the state by preventing runoff and erosion. In addition, any site runoff would be directed into retention basins thereby further decreasing potential impacts.

94 The air quality impact analysis on DEIS pages 154-157 and Fig. 3-13 and 3-14 indicated the pollutant of greatest consequence, total suspended particulates (TSP), would not have a significant impact beyond three miles from the site boundary. The closest portion of the Stockbridge-Munsee Reservation is 35 miles from the project, far beyond the range of measurable air quality impacts from the proposed project.

95 An analysis of rail and highway transportation impacts which would result from the project has been included in the FEIS.

96 The proposed groundwater and surface water monitoring programs have been developed to detect significant changes in water quality and quantity attributable to the project. The plans are designed to detect cumulative impacts as well as helping to distinguish sources of contamination. If unforeseen impacts were detected, the Department has the authority to modify the plan to require such things as more frequent monitoring, increased number of monitoring points and monitoring over a greater area.

The Department did consider the impacts to surface water bodies as a result of seepage from the waste facilities. This evaluation was summarized on DEIS page 142. As indicated by the worst case analysis in the DEIS, the impacts to surface waters from the MWDF would take an extremely long time to develop, and if impacts did occur, the water quality would still be within observed seasonal ranges. Therefore, extensive monitoring to determine this impact is not believed to be warranted. Also, the proposed monitoring would provide early indication of facility performance and any potential groundwater quality contamination which could result in surface water impacts. See responses #296-300.

97 The areal coverage of the terrestrial ecology monitoring program is believed to be adequate to determine reasonably expected impacts. Significant impacts to the terrestrial ecosystem beyond this area are not anticipated. The monitored region would encompass the areas of construction as well as areas in which particulate deposition and groundwater drawdown would occur. The latter two are the main mechanisms which could cause terrestrial impacts.

98 The language cited is from the statutes and is not discretionary. Exxon is liable for damages which it causes. No potential constraints to the exercise of Stockbridge-Munsee treaty rights have been identified.

99 The discharge into Swamp Creek from the proposed wastewater treatment facility would be located downstream from Rice Lake. Consequently there would be no impacts to wild rice in Rice Lake from the discharge. As indicated in the FEIS, sulfate levels in lower Swamp Creek below the discharge may impact the scattered wild rice there.

100 Birds and mammals are not expected to transport environmental contaminants beyond the project boundary in any detectable quantities. See response #321.

101 Vibrations caused by mine construction and operation are not expected to appreciably impact wildlife populations (DEIS page 147).

102 There would be a loss of public land covered by off-reservation treaty rights if the 880 acres of County-owned land were sold to Exxon. An analysis of this impact is included in the FEIS.

103 The preponderance of impacts of the proposed project to the natural resource base would accrue to an area within 2-3 miles of the mine site. These include impacts to groundwater, surface waters and wetlands from the groundwater drawdown, surface water impacts from discharges, wildlife impacts, and land use changes from construction, operations, closure, and reclamation activities. Although these activities would take place within the Wolf River watershed, there would be no measurable water loss from the watershed or thus, from the Wolf River flow. Air quality impacts (discussed on pages 154-157 of the DEIS), are predicted to be well below national standards for all pollutants at the project site boundary. There would be no air quality impacts to the Menominee Reservation. Impacts to the water quality of Swamp Creek and the Wolf River were discussed on pages 140-143 in the DEIS, with additional discussion and clarification provided in the FEIS. The DEIS clearly indicated no significant impacts are predicted for the Wolf River.

Impact analyses of tourism and transportation are included in the FEIS. Predicted impacts to the Menominee Reservation are summarized in a single section in the FEIS.

104 The discussion on subsidence is based on our review of two consultant's reports submitted to the Department by Exxon. These reports detail the methods used to predict subsidence effects of the Crandon mine. Based on our evaluation of these reports and other information regarding mining methods and soil and rock characteristics, the Department believes subsidence would not be a major problem. DEIS pages 110 and 111 presented a description of how the mining method is designed to minimize subsidence. The minimal impact of subsidence, if it occurred, would be limited to the area above the actual underground workings. It is the Department's opinion that it is neither necessary nor desirable to identify all of the source material for each statement in the EIS.

105 The Department predicts subsidence would not have a measurable effect on the groundwater drawdown or upon the surface waters.

106 We agree that subsidence prediction is not an exact science. However, use of the Henderson Mine as an example is not relevant because it was designed and operated using block-caving methods. In other words, the roof of the mine was meant to continually collapse to openings below to provide ore. The Crandon mine is designed specifically to prevent caving and is based on continuously backfilling mined out areas. Reference is made to pages 110-111 of the DEIS.

107 DEIS Table 1-8, as explained in footnote number 9 (footnote number 3 in the FEIS), showed the proposed effluent limits for Swamp Creek calculated for two scenarios. In the first set of numbers, the calculated limits were based on an upstream $Q_{7,10}$ of 13.5 cfs (assuming no flow mitigation for Upper Swamp Creek). In the second set of numbers, the calculated limits were based on an upstream $Q_{7,10}$ of 15 cfs (assuming that there would be flow mitigation to Upper Swamp Creek).

A reduction in upstream flow in Swamp Creek automatically results in more stringent effluent limits. The mass balance equation used to calculate the effluent limits accounts for the capacity of Swamp Creek to dilute the effluent. Under reduced upstream flows, corresponding reductions in chemical concentrations in the effluent would result. Thus the mixing zone concentration in Swamp Creek for each pollutant in the discharge would not change if the stream flows were reduced.

Water quality changes were projected in Swamp Creek in the DEIS using both an average upstream flow (50 cfs) and a $Q_{7,10}$ flow (15 cfs). A reduction in $Q_{7,10}$ flow from 15 cfs to 13.5 would not alter the water quality because the instream mixing zone concentration of the various pollutants would remain constant.

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108 See Response #107.

109 The daily maximum effluent limits for Swamp Creek (DEIS Table 1-8) are designed to protect aquatic life against acutely toxic conditions. These maximum effluent limits were obtained from acute toxicity information in the literature. However, in the calculation of the monthly average limits, which are designed to protect aquatic life against chronic (long-term) toxicity effects, the effluent flow rate is taken into account. Refer to DEIS Table 1-8, which indicated different effluent limits according to the effluent amount.

For the purposes of projecting the resultant water quality conditions in Swamp Creek, it is appropriate to use the average rather than maximum effluent flow rate, because it is more representative of actual long-term discharge conditions.

110 The uncontaminated groundwater is included as part of the average 1,300 gpm discharge flow rate to Swamp Creek. The impacts to receiving waters from this discharge were discussed on pages 140-142 of the DEIS.

111 The section "Impacts to Fish and Aquatic Organisms" on DEIS pages 141 and 142 did not explicitly discuss the potential for fish toxicity because the proposed effluent discharge concentrations (Table 1-8) would be below toxic levels. No measurable impacts to the fishery are expected from the proposed wastewater discharge to Swamp Creek. For the Wolf River, no increases in heavy metals in fish tissue are projected because instream concentrations are not expected to increase above background levels for those metals that bioconcentrate in fish.

112 Refer to response #315 (also #15, #38 and #107) for an explanation of how DNR establishes effluent limitations. Effluent limitations are set based on concentrations lower than those which are toxic to the most sensitive organisms in the receiving waters. In addition, further calculations are included in the FEIS comparing stonefly toxicity with impact conditions in the Wolf River.

113 The DEIS, whenever technically appropriate, provided an analysis of the impact of multiple project features on the same resource. The only example cited in this comment is the combined effects of the effluent discharge, the groundwater drawdown and surface water contamination from MWDF seepage. However, page 142 of the DEIS indicated MWDF seepage would not affect water quality at the point of the wastewater discharge. Furthermore, Table 1-8 provided wastewater effluent limits based on the reduced stream flows which could result from the groundwater drawdown.

114 The DEIS did not conclude that the mitigation plan would adequately protect public rights. Rather, the DEIS assessed the effectiveness of the mitigation plan for the expected impacts and disclosed the lack of available analyses for impacts worse than expected (see page 137).

115 The conclusions drawn in the DEIS were neither optimistic nor pessimistic. Impacts of the proposal were analyzed using scientifically accepted techniques and best professional judgments. Where impacts could not be predicted with high certainty, ranges of potential outcomes were presented. The DEIS did not conclude groundwater standards would not be exceeded. Rather, a range of potential impacts was presented, including scenarios where modeling indicated groundwater standards would be exceeded (see pages 111, 117 and Fig. 3-6).

116 All of the impact descriptions relied on data and/or analyses which Department staff and consultants determined to be accurate and reliable. When Exxon-generated information was utilized, it was verified to the extent deemed necessary by the technical expert. It is impractical to describe all of the analysis which contributed to the professional judgments that the data were valid.

117 The DEIS recognized the uncertainty in impact predictions by using conservative assumptions and/or by presenting a range of potential impacts. For example, a wide range of possible groundwater impacts from the tailings disposal area was presented. Similarly, a range of possible lake level impacts was provided. A detailed description of the effect of uncertainties in socioeconomic analyses was included in the DEIS (pages 157-159).

118 The purpose of an EIS is to describe potential impacts of the various project activities. The relative importance of impacts to different resources would be a value judgment which would vary considerably between individuals and/or government agencies. These types of subjective judgments are not appropriate in an EIS. They may, however, be part of the decision-making required by the statutes on several of the permits required by the company in order to mine.

119 The gross value of the metals in the orebodies can be calculated by using the 1985 metals price ranges (DEIS Table 1-1) and the proposed mill production rates (DEIS Table 1-3). The gross value ranges from $3.10-4.16 billion during the 16-year massive ore phase and $0.72-0.84 billion over the 13-year stringer ore phase. Obviously, the gross value of the metals would not be the return Exxon would receive from the concentrates. Applying historical mine netback rates to the absolute value of the ore yields an estimate of Exxon' a anticipated gross revenues. The return during the massive ore and stringer ore phases would range between $2.02 - $2.6 billion and $0.53 - $0.61 billion, respectively. Additional information on mine profitability and tax revenues is contained in Chapter Three (Public Revenues) of the FEIS. In addition, the above calculations would change as metals prices fluctuate and the estimates of ore reserves are recalculated. Ore is defined as any metal-bearing mineral assemblage that can be mined, processed, and sold at a profit. Thus, ore reserves estimates are dependent on metals prices.

120 The FEIS contains a socioeconomic impact analysis of a mid-project shutdown scenario, but does not speculate on whether it could be caused by metals markets instability, world economic or political conditions, labor strike, short-term change in demand, or other factors. As indicated on DEIS page 157, future expected metals prices would be an important variable in Exxon's decision on whether or not to construct the mine, assuming the necessary permits would be granted. In the discussion of net proceeds taxes (a mine profits tax) on DEIS page 170, it was indicated that metals prices are the most important variable. The price of base metals such as zinc, copper, and lead, is relatively stable over both the short-term and long-term when compared to precious metals, such as silver and gold.

121 The predicted environmental effects if the stringer ore were not mined were discussed on DEIS page 195. The socioeconomic impacts of mid-project closure have been included in the FEIS.

If the mine were closed after the massive ore had been extracted, it could be assumed that it would not have been economically attractive to continue mining the stringer ore. While it would always be physically possible to mine the stringer ore, economic profitability would determine whether in fact it would be mined. This assumes no environmental prohibitions on mining.

The stringer ore consists of approximately 24.5 million tons of the grade described in DEIS Table 2-1. If none of the stringer ore were removed, this would represent about 36% of the ore deposit as presently defined.

122 The section on "Impacts to Swamp Creek and the Wolf River from the Proposed Discharge" has been revised in the FEIS in response to this comment.

123 The DEIS (on page 141) stated the effluent flow rate of 1300 gpm was used to predict water chemistry changes in Swamp Creek and the Wolf River.

124 Revisions were made in the FEIS to discuss the fate of heavy metals in Swamp Creek and the Wolf River.

125 There are no data in the literature to indicate adverse impacts to aquatic life in Swamp Creek would occur as a result of the projected increased concentration levels of heavy metals.

126 Impacts from the wastewater discharge to fish and aquatic life in Swamp Creek and the Wolf River were discussed on DEIS pages 140-142. The discussion includes an analysis of heavy metals accumulation in fish. The conclusion is that metals accumulation in fish tissue is not expected to cause harm to humans who would eat the fish or to fish species in terms of sublethal effects. Although specific information is lacking in the literature relating bioaccumulation levels in fish tissue to sublethal effects, the monthly limits (designed to protect against chronic or sublethal impacts) should afford adequate protection to the fisheries of Swamp Creek and downstream waters.

127 The maximum discharge permitted to Swamp Creek would be 3000 gpm, while the average flow would be approximately 1300 gpm. As indicated on DEIS Table 1-8, effluent limits would be reduced if the amount of effluent would be increased. Effluent limits based on a flow of 3000 gpm have been included in this table in the FEIS.

The proposed wastewater discharge would consist of treated water from two sources: intercepted groundwater and contaminated mine water. Now source performance standards prohibit discharge of mill process water. Depending on the extent of underground mine development, surface water mitigation requirements, actual mine inflow, and water relationships in the processing circuits, the composition of the wastewater stream would vary. No matter which of the sources provide the wastewater for discharge, the effluent limits must be met.

128 Discharge of contaminated mine water during mine development would not be permitted without treatment. Mine shaft water would be pumped to the surface through an oil-water separator and stored until the wastewater treatment facility would be operational in month 19 of construction. The 3 million gallon excess wastewater discharge lagoons are anticipated to be available to receive shaft construction water when shaft sinking in bedrock begins. The 84 million gallon reclaim pond A, projected to be available by construction month 7 at the latest, is estimated to have sufficient capacity to contain all water pumped from the mine for the first 36 months.

129 The reclaim ponds would be operated in series and could provide water surge capacity if needed. The residence times are designed to provide sufficient time for settling of fine particulate matter and for evaporation, oxidation, and biological processes to occur. These processes would control the concentrations of certain constituents in water recycled to the mill to less than one mg/l. Performance estimates by Exxon are based on data from reclaim ponds at other mining operations.

Evaporation and oxidation are projected to reduce the concentrations of organic compounds present in recycle water by 90% or more throughout the year. Biological oxidation of thiosulfate (and other reduced sulfur compounds) to sulfate would reduce concentrations of these compounds by 90% in summer and 10% in winter. Lime would be added to water flowing between the two reclaim ponds to neutralize the sulfuric acid formed from thiosulfate oxidation. Factors causing natural degradation of cyanide in the ponds include photodecomposition by sunlight, volatilization by acidity, oxidation, and biological action.

Reclaim pond B would receive recycle process water, tailings pond decant and underdrain water, and tailings thickener overflow water. The accumulating sediment primarily would be tailings silt and calcium carbonate precipitates. The process water would then flow

into reclaim pond A and sediments of calcium sulfate (gypsum) and metal hydroxide precipitates from pH adjustment between the ponds are projected to accumulate.

130 The reclaim pond design has been modified by Exxon to reinstate the original proposal of a two pond system.

131 The DEIS section on impacts to surface waters from the groundwater drawdown provided an estimate of worst case impacts for groundwater drawdown. The amount of groundwater drawdown assumes no groundwater mounding due to lake seepage, and for this reason is not very probable. The estimate of maximum groundwater drawdown is not the only factor in estimating mine impacts as stated in the DEIS (page 119). Factors such as precipitation, evaporation, runoff, outflow, sediment thickness and permeability, and basin dimensions are important in the water budget model used to predict impacts to lake levels. All these factors have uncertainties which make determining the probability of impacts and the degree of impacts difficult. The maximum case presented in the DEIS was a conservative attempt to address these uncertainties expressed as the maximum groundwater drawdown. Even though this maximum drawdown is unlikely, it was believed that the maximum case would define the upper limit of impacts without mitigation.

An analysis of worst case impacts with and without mitigation is presented in the FEIS. This analysis reflects additional GEOFLOW simulations to better define the range of likely groundwater levels based on aquifer and lake variability. The extended analysis in the FEIS identifies the most probable impacts or range of impacts and worst case impacts.

132 The impact evaluation of surface water mitigation has been revised in the FEIS.

133 Impacts from groundwater drawdown to lakeside wetlands were addressed on DEIS page 121, while impacts to other wetlands were discussed on DEIS pages 130-131. Direct facility impacts to wetlands were discussed on DEIS page 145 and in Table 3-23.

134 DEIS Table 3-14 denoted the expected fishery impacts without mitigation and the guidelines used to quantify impacts, i.e., the percent decline in fish biomass. Although the criterion is specific to brook trout, a comparable rationale applies to the nontrout fishery. Average trout biomass characteristics were provided on DEIS page 131. The magnitude of change (reduction) in biomass (lbs./mile) based on regional averages can be quantified using information in the DEIS.

Benthos availability usually is not the principal factor limiting the number of trout in a population. Research that evaluated the response of a trout population to habitat improvement identified the amount of cover and pools to be of paramount importance, two parameters directly linked to flow circumstances.

135 The comment "stream flows will still be minimal" (with surface water mitigation) was not made in the DEIS. The actual statement on DEIS page 133 was: "physical impacts to streams with surface water mitigation would be minimal even though streams would experience a net reduction in flow."

136 Groundwater relationships with wetlands in the drawdown zone have been determined by both direct and inferential information. Groundwater-influenced wetlands are those where groundwater discharge is evidenced by permanent springs. Groundwater connections also have been determined by comparison of the soil surface elevation of wetlands to the groundwater (piezometric) surface. Where wetlands are groundwater connected, there is close or actual interception of the groundwater surface with the soil surface.

That most wetlands in the groundwater drawdown influence zone are perched has been inferred using several factors. The small size and shallow depth of many of the wetland basins, their clear separation from the water table, the occurrence of many of them in the

upper portions of their watershed (with seasonal inlet/outlet characteristics), the slow percolation rates through the subsurface till layers, and the type of wetland vegetation, have all been contributing factors in determining wetlands to be perched where no groundwater connection could be established directly.

137 The analysis of secondary impacts from the expected level of mitigation pumping was provided in the DEIS (pages 135-138). A revised analysis of secondary impacts is provided in the FEIS.

The impacts of mitigation to streams, including loss of trout spawning habitat in Hoffman Creek, were discussed on DEIS page 133.

138 Some hydrogeological data are available for the area north of Swamp Creek. For the purposes of the analysis, hydrogeological conditions can reasonably be assumed as similar on both sides of Swamp Creek.

139 The DEIS did not conclude the mitigation would protect public rights. Rather, the DEIS provided an analysis of the impacts of surface water mitigation and disclosed where information was lacking or if the impacts were unknown. The last sentence of this comment quotes page 44 of the DEIS. "The previously described measures may not fully mitigate mine dewatering impacts". The Department believes this demonstrates an example of appropriate disclosure of impacts.

140 The placement, timing, and types of erosion control structures and procedures would be contained in the DNR approved reclamation plan. Frequent site inspections by DNR staff would be an integral part of regulatory oversight, especially since any in-field alterations of the plan must be approved by the Department. Mining regulations section NR 132.14(2) and (3), Wisconsin Administrative Code, state no operator may refuse entry or access to Department staff for the purpose of inspection or obstruct or interfere with any such inspection.

141 According to section NR 132.16(2)(a), Wisconsin Administrative Code, the Department may issue a stop order requiring immediate cessation of mining, in whole or in part, any time the Department determines there exists an immediate and substantial threat to public health and safety or to the environment. A condition of the mining permit may be the requirement for restocking, stream improvement, or other mitigation measures if a mishap occurred.

142 As noted in response #140, Exxon must have its reclamation plan approved by the DNR before mine construction could begin. Refer to Chapter Three (Impacts on Soil and Soil Erosion and Other Impacts to Stream Water Quality) for additional discussions on potential soil erosion impacts. Quantification of the soil erosion losses has not been conducted because the sizing of the erosion control facilities, the changing size and location of the discharge points, the phased construction schedule, and the proposed revegetation efforts could significantly alter sediment yield from year to year. DEIS Table 1-10 and Table 1.3-1 of Exxon's EIR provided information on the timing and amount of acreage disturbed. In addition, Table 1.3-1 notes when reclamation activities would begin for the various facilities.

143 Industry standards and governmental regulations governing the design standards and return periods for erosion control structures are based on the consequences if a structure were to fail. Return periods selected for the proposed project are taken from existing state codes: the 10-year, 24-hour storm event design for the solid waste landfills (NR 180.13(10), the 25-year, 24-hour storm event design for the hazardous waste sites (NR 181.44(10), and the 100-year, 24-hour storm event design for mining waste sites (NR 182.11(1). A high risk of having the design capacity exceeded may be acceptable. Failure in this sense does not

necessarily mean that the structure would be destroyed. For example, the failure of a road culvert to pass a peak flow may result in only minor flooding of a roadway or adjacent area and may be acceptable. On the other hand, failure of a stormwater detention basin may result in overtopping of the structure with considerable damage. Thus, the selection of the acceptable risk and design return period depends on the consequences of the design capacity being exceeded.

Designing a structure with enough capacity to protect against extremely rare events is expensive. Therefore, the Department requires a conservative design capacity commensurate with the relative consequences of exceedance.

144 DEIS Figs. 1-7 and 1-16 showed locations for mine/mill site surface water drainage basins and MWDF sedimentation basins, respectively. More specific details on temporary and permanent sedimentation basins and information on locations, life expectancy and maintenance schedules for other erosion control structures can be found in the erosion control plan, reclamation plan, and grading and drainage plan of the mining permit.

145 Comment acknowledged. Quick germinating, rapid growing plants selected for their ability to control erosion would be established on all exposed areas immediately following final grading and the addition of topsoil. Permanent plantings of ground cover, shrubs and trees would be added later. Seed and plant stock would be obtained from local suppliers as well as approved on-site sources. Natural invasion would augment permanent plantings.

146 Seeding, sodding, mulching or other stabilization would be required in areas of exposed soil as soon as practical. Areas of disturbance would be minimized to the extent possible. Runoff collection basins would be installed as a first priority so that in the event of storms, runoff would be contained on-site. Exposed areas not seeded immediately would be physically stabilized using mulch or emulsifiers.

147 Treated water discharged to Skunk Lake would be regulated by the WPDES approval. Contaminant concentrations in Skunk Lake would not be allowed to exceed drinking water standards. During mine operation, water seeping out of Skunk Lake would enter the cone of depression caused by the dewatering of the mine and be drawn into the mine. Thus, any contaminants discharged into Skunk Lake would have little impact on groundwater quality.

148 The inability to calibrate the USGS/DNR and the IT contaminant models due to a lack of actual contaminant releases was anticipated and overcome by using a wide range of potential model inputs to predict a range of potential outcomes. All model simulations showed no significant impact for surface waters.

149 A range of model inputs were used to predict a range of potential outcomes. The results were used to evaluate compliance with state law and provide guidance in the design of monitoring systems. The uncertainties are expressed in the EIS.

150 The post-mining flow of contaminated water out of the orebody was evaluated and found to be insignificant. See response #32.

151 Contaminants from the mine/mill complex would not build up in the groundwater due to the high rates of mine inflow. Potential sources of groundwater contaminants are being designed with containment systems such as liners. During groundwater rebound, the unsaturated zone water would mix with inflowing groundwater and carry any dissolved contaminants downgradient. If the groundwater monitoring system detected significant quantities of contaminants, response measures, as detailed in the groundwater contingency plan, would be actuated.

152 We believe the analysis of impacts to the groundwater from the MWDF as presented in the DEIS adequately stated the potential impacts. DNR staff had extensive input to Exxon's consultant's contaminant modeling effort. A separate contaminant modeling effort conducted by the U.S. Geological Survey with the Department provided independent verification. A number of conservative assumptions, worst case conditions, and various model inputs were utilized to establish a range of possible groundwater impacts approximating real world conditions.

The Department realizes the predictive groundwater modeling is only an evaluation tool. Only actual field experience will verify the accuracy of the modeling efforts. Therefore, the Department would require monitoring to determine the performance of the MWDF by measuring and evaluating leachate quality and quantity, seepage, and groundwater quality and flow patterns. The MWDF design could be modified based on performance of the first cell and laboratory tests.

153 The DEIS recognized the potential for pyrite tailings to produce an acidic leachate under certain conditions. The discussion of leachate formation was expanded in the FEIS.

154 The fact that waste containment sites have not been adequately constructed and maintained historically (i.e., in different states, climates, or under different regulatory control) has little bearing on the likelihood of doing so in Wisconsin. Current engineering design and waste isolation technologies have advanced rapidly in the last 10 years. Waste disposal technologies in several fields are converging on a set of design elements which also have been incorporated into the MWDF and MRDF designs. Combined with a comprehensive and flexible monitoring program and long-term care of the waste site by the operator and state, it is reasonable to predict that groundwater quality standards would not be exceeded at the compliance boundaries.

155 It is indicated in the EIS that contaminants would enter the groundwater from the MWDF. The Department can not allow construction of the MWDF if groundwater standards would be exceeded, though some leachate contaminants would enter the groundwater system.

156 The conclusion that contaminant impacts cannot be predicted is not the Department's conclusion. We believe the contaminant modeling efforts explained in the EIS are valid and useful for the intended purpose.

157 The DEIS contained an impact evaluation (page 213) of the proposed MWDF leachate collection system. An alternative leachate collection (underdrain pipe spacing) and cleanout design (Fig. 4-6) was identified and evaluated.

158 As explained on DEIS page 10, the majority of the coarse fraction of the tailings would be backfilled, not disposed in the MWDF. About 5-10% of the 525,000 tons of waste rock, or 26,000-52,500 tons, brought to the surface could be disposed in the MWDF. In addition, about 400,000 tons of waste rock would be used as rock slope protection in the MWDF and reclaim ponds (DEIS page 12). Together this would amount to about 1.6% of the tailings mass. The MWDF also would receive approximately 320,000 cubic yards of water treatment wastes, which would be about 1.7% by volume of the total MWDF volume. The water treatment wastes would consist of reclaim pond sediment, primarily tailings fines and lime treatment precipitates. Neither the waste rock used as slope protection nor the water treatment wastes would be expected to significantly affect tailings mass permeability.

159 Exxon has considered using the tailings ponds as emergency storage if excess water accumulates in the water circuit. The Department would probably not allow storage for the following reasons. A greater water depth would increase seepage into the underdrain system and increase the water pressure on the liner, thus increasing seepage from the site

in proportion to the pressure on the liner. Another disadvantage of temporarily storing wastewater in the MWDF is the possibility of wave action and erosion of the sideslopes.

160 The tailings ponds are predicted to seep at a rate of 0.6 to 2.4 inches per year during operation. The majority of the seepage would occur in the 2% slope base areas with very little seepage expected through the sideslopes.

161 Oxidation and acid generating reactions in the pyritic tailings would be limited to the unsaturated zone of the tailings mass. This zone would only be several inches thick, and any impacts on MWDF leachate would be minimal. Water aids the decomposition of pyrite but it also can act as a barrier to oxygen transport into the saturated tailings mass. In the decant water pool, the major acidity producing reaction would be thiosalt oxidation, similar to the reclaim ponds, not pyrite oxidation. The tailings surface would have to be exposed for a number of years for significant oxidation to occur. In any case, once a zone was covered by fresh tailings, oxygen in the weathered zone would rapidly be depleted and acidification reactions would be slowed or eliminated.

162 During the operation of each tailings pond, the liner system and underdrain would limit seepage into the groundwater system. Extensive monitoring immediately beneath each pond, in the saturated zone, and of the leachate would be conducted. The purpose would be to detect increased leakage or changes in leachate quality and quantity. The DEIS contained a conceptual outline of potential actions if it appeared significant groundwater contamination could occur. Refer to DEIS page 112 and Fig. 3-1 for MWDF seepage impacts.

163 A considerable amount of information on the constructability of the proposed bentonite soil liner system has become available in the last few years. Similar liner systems have been built in the United States and Canada. Specific construction methods, bentonite handling methods, soil particle size, field testing and similar subjects are plan of operation (permit) details and are beyond the scope of the impact analysis.

164 The question of whether Exxon or its contractor would be responsible for proper liner construction is unrelated to the EIS and was not discussed. Ultimately, Exxon as the applicant would be responsible.

165 This question relates to activities which would be conducted during the regulatory review process. Refer to section NR 182.10, Wisconsin Administrative Code.

166 The reagents identified on DEIS Table 1-5 would be used in the ore flotation and water treatment processes. Refer to the discussion in the FEIS on the ultimate fate of reagents in the mill process.

167 Included in the FEIS are sections which discuss impacts of disposing salt cake in the MWDF and alternative disposal methods.

168 A berm or dike would simply be a low earthen structure placed over the drain layer to segregate the salt cake disposal area from the tailings disposal area. Segregation would be required because additional disposal requirements may be necessary for salt cake disposal. A failure of the earthen berm would not result in any significantly increased threat to groundwater protection.

169 The water treatment plant would continue to operate during reclamation as long as contaminated water and leachate would require treatment. Water from the final tailings pond and leachate would be pumped to the reclaim pond as in the operational phases and to the treatment plant prior to discharge. When volumes of water or leachate would become low enough to impair effective operation of the treatment facility, alternative treatment might need to be provided. Alternatives include a skid-mounted package treatment unit or transportation off-site for treatment at an existing facility. Provisions for treatment of leachate and sludge disposal as long as necessary would be required by the Department.

170 Sediments from the reclaim ponds would not contribute leachate significantly different than anticipated by the mine tailings or wastewater treatment sludges. The physical handling and disposal of large quantities of sediment in the last tailings pond may be of concern. One solution would be periodic cleaning of the reclaim ponds so that the sediment could be incorporated within the tailings over a longer period of time.

171 Sections NR 182.16 and NR 132.09, Wisconsin Administrative Code, require posting of a bond to cover the costs of reclamation including closure of the waste facilities. Costs related to long-term care may be covered by a bond or other methods specified in section NR 182.17, Wisconsin Administrative Code. The bond or other method would be in place before the plan of operation would be approved. The adequacy of the code provisions would be addressed at the master hearing.

172 A discussion of tippage fees that Exxon would pay to the Waste Management Fund, Groundwater Fund, and Environmental Repair Fund for waste disposal during the project was added in the FEIS. In summary, the total predicted amount would be approximately $704,000. The actual amount paid would depend on the amounts of wastes disposed, whether or not salt cake would have commercial value, and other variables.

It is not within the scope of this FEIS to speculate on future waste disposal site clean-up costs and comparison with available remedial funds. It is anticipated the legislature periodically would review tippage fees and adjust them according to projected statewide needs.

Estimated seepage from the MRDF as indicated in the DEIS on page 114 was 500 gallons per day or 0.34 gallons per minute, not 500 gallons per minute as the comment indicated.

173 The analysis of impacts to groundwater quality is based on primary or secondary (state or national) maximum contaminant levels (MCL) being the groundwater quality standards at the compliance boundaries. This was indicated in the DEIS. The Department does not intend to recommend more stringent standards because the MCL's are established to protect public health, safety, and welfare.

It is expected that groundwater underneath and in the immediate vicinity of the MWDF would become contaminated such that secondary drinking water standards would be exceeded. Refer to DEIS figures 3-6, 3-7, 3-10 and 3-11. This is allowable under state law. However, since there are no groundwater users within 1200 feet of the MWDF, the groundwater resource would not be threatened through use of the 1200 foot compliance boundary as specified in section NR 182.075. It is at the compliance boundary that the standards must be met. Water supply regulations would prevent future well construction within the compliance boundary.

Between 50 and 60% of the local groundwater samples were above the secondary standard for iron and manganese. As discussed in the FEIS, the concentration of manganese in the groundwater may be elevated by the project.

174 DEIS page 115 addressed the impacts of soil resaturation after mining. In addition, a discussion of the potential for groundwater pollution from resaturation of soils beneath a reagent, fuel, concentrate or other spill or leak is included in the FEIS.

175 The analysis of potential groundwater contamination impacts referred to by this comment was addressed on DEIS page 111.

176 The DEIS described the nature and impacts of seepage from the landfill. The present design appears to be permittable but it is not described as a no impact facility. Issues such as monitoring and contingency planning and alternatives are described in their respective

EIS sections. The design life of the landfill was explained on DEIS page 19, proposed monitoring on page 40, alternatives on pages 198 and 215 impacts on pages 113-114.

177 Refer to response #92 for an explanation of how wetland-groundwater relationships were determined.

178 Groundwater drawdown impacts to wetlands away from lakes were discussed on DEIS pages 130 and 131.

Groundwater drawdown impacts to lakeside wetlands (without mitigation) were discussed on DEIS page 121. Mitigation for lakeside wetlands is included in the mitigation plan for lakes. One of the important components in the DNR determination of minimum lake levels (DEIS p. 122) was the maintenance of lakeside wetlands.

Most of the groundwater wetlands are located near the drawdown boundary, so that the effect of the small decline in groundwater elevation in these does not warrant mitigation. Installation of mitigation facilities for these wetlands probably would cause more noticeable impacts than to do nothing. As stated on DEIS page 131, subtle shifts in the wetland vegetation may take place, but this is best characterized as a minor conversion of the wetland vegetation, not a wetland to nonwetland conversion. These changes would be subtle and temporary during the operational phase of the mine. When groundwater contours rebound to pre-mining conditions, the "normal" flows would be returned to these wetlands.

179 Analysis of vegetation changes in wetlands was included on DEIS page 131. While groundwater contributions to streams is an important water source, the mitigation wells would provide additional flow to the streams. Impacts to streamside wetlands along the north side of Swamp Creek were discussed on DEIS page 131. These wetlands are above the surface water elevation of Swamp Creek and beyond the groundwater drawdown zone, and thus would not be impacted.

180 Erosion impacts to wetlands are not considered to be significant due to the proposed erosion control program (DEIS page 26-27). If properly implemented, sediment levels reaching wetlands should not be significant. Runoff effluent quality from a series of sedimentation ponds (DEIS Fig. 1-16) and surface drainage basins (DEIS Fig. 1-7) would need to meet water quality discharge standards to wetlands receiving runoff.

181 The effects of mitigation water quality on lakeside wetlands were discussed on DEIS page 126, while stream/spring impacts were discussed on DEIS page 133.

182 Impacts to wetland natural areas are the same as the impacts to the wetlands that constitute these natural areas. Swamp Creek Cedars and the Upper Pickerel Creek Cedars are groundwater influenced wetlands which would be affected as described on DEIS pages 130, 131, and 133. Portions of the Bur Oak Swamp would be impacted by the reclaim pond berm, perimeter access road, and sedimentation pond as described on DEIS page 145.

183 The choice of a particular method for dust control depends on the severity of the problem, cost comparison, convenience of integration with the particular site activities, and Department regulatory review. Assuming dust would be adequately controlled by either method, there are no expected significant impacts from dust control. Dust control measures may be a permit requirement.

184 The possible presence of asbestiform minerals has been evaluated. DEIS page 32 indicated thin-section bedrock samples were analyzed for asbestiform minerals by geologists from the Wisconsin Geological & Natural History Survey. None were found. DEIS page 42 indicated a second test for asbestiform fibers in pilot plant tailings was inconclusive. Therefore, monitoring for asbestiform fibers near the tailings ponds would be required by DNR. The impacts of asbestiform emissions have not been evaluated because none are expected.

185 As explained in the DEIS, tailings dust is the primary source of dust that would contain minute amounts of heavy metals. For the most part, tailings dust would not be present until after operations started and MWDF cell T-1 was in use. The key to preventing significant dust impacts from the MWDF would be to prevent the tailings surface from drying. It is unlikely that the tailings surface would dry due to the fine grain of the tailings. Drying could occur if the MWDF was taken out of service or milling ceased. If that occurred, the Department would require sprinkling or other means to continually wet the tailings mass surface. This level of detail would be covered in the plan of operation.

186 Skunk Lake was omitted from the air impact analysis for the reasons specified on DEIS page 139. The anticipated effects to Skunk Lake from predicted aerial deposition would be similar to the effects on other nearby lakes shown in Table 3-20. Maximum deposition rates would be extremely small, and would be unlikely to change background levels and are, therefore, negligible. The combined impacts of mitigation impacts and aerial deposition would be the same as the mitigation impacts.

187 It is not necessary to take into account "special populations which may be at a higher risk due to the carcinogens in the dust." The unit risk factors used in the air impact analysis to estimate potential cancer risk due to the project dust emissions take into account the differences in sensitivity between people at various stages of their lifetimes.

The reference to the national cancer death rate is given to put the previously predicted project-related risks into perspective. The worst case project risks are negligible compared to normal cancer rates. On an individual basis, the risks are considered small and, from a regulatory perspective, acceptable.

188 No field work to establish baseline metal deposition rates in the project area was conducted because metal deposition due to the project was predicted to be insignificant. The impact analysis for metals emissions on DEIS pages 155 to 157 confirmed this. The predicted metal deposition rates on page 155 (Table 3-30) are far less than the upper Great Lakes area background rates provided on DEIS page 77 (Table 2-20).

No asbestiform background data are provided because no asbestiform emissions are predicted. Please refer to response #184.

189 A noise management plan has been received from Exxon and is included in the FEIS.

190 The noise levels in the area would increase as a result of project implementation. Noise impacts are most detrimental to nesting and foraging wildlife. The predicted noise levels at the closest bald eagle nest (currently on the north side of Rolling Stone Lake) would not interfere with nesting or foraging. Osprey develop tenacious attachment to nest sites and are known to tolerate high noise levels (nesting adjacent to major highways and gravel crushing operations in the region). The pair of ospreys north of the mill site is not expected to abandon the nest or produce fewer young due to noise impacts. Maintenance of adequate no-impact zones around nest sites would help prevent disturbance.

191 The discussion of vibration impacts has been revised. The likelihood of simultaneous firings is extremely remote with modern blasting practices.

192 The annual habitat requirements of Wisconsin endangered, threatened and watch wildlife species in relation to mine impacts have been studied. Only a summary of the studies and major impacts was presented in the DEIS. The design and location of the access road, railroad spur, transmission lines, water pipelines, mitigation wells and facilities, haul road, reclaim ponds and MWDF were chosen, after much discussion and study, to minimize negative impacts to endangered, threatened and watch wildlife species as well as sensitive habitats. Alternate routes and locations for mine facilities would have greater impacts on these species and their habitats.

Specific impacts to wildlife associated with surface water alterations were summarized in DEIS Table 3-16. Impacts due to habitat loss were summarized on DEIS page 147 (including endangered, threatened and watch wildlife species).

193 The risk assessment discussion has been revised in the FEIS. Further, the Department maintains that it is both logical and legally adequate to require remedial action planning for only those identified credible risks.

194 The discussion of spills has been revised to clarify that the risk of a spill resulting in significant environmental degradation is low. We acknowledge that some reagents and fuel would be spilled, but the design and handling features of the project would effectively prevent the release of these materials to the environment. Exxon would be required to maintain records of spills and other incidents and make these records available to the Department. Further, additional reporting/notification requirements would be specified in various permits.

195 Comparing the major facilities of the proposed project to past mining operations which were designed and operated under very different climatic, technological and regulatory conditions would be unproductive. Rather, the assessment of risk of failures for the proposed facilities is based on engineering judgment after completing an extensive evaluation of their design and proposed operation.

196 Failure of the embankment of the reclaim ponds was considered in conjunction with failure of the tailings pond embankment because the construction, modes of failure, resultant impacts, and subsequent remedial actions for the two facilities would be nearly the same. Also, the DEIS did indicate in general terms what steps would be taken in the event of a major or minor embankment failure.

197 Pipeline failures would be detected through regular monitoring and inspections. The EIS has been revised to indicate that if leaks were detected, the damaged section of pipeline would be excavated and replaced.

198 An analysis of long-term seepage from the abandoned mine was provided on DEIS page 111. If, however, post-closure seepage were greater than expected and contamination of the nearby aquifer resulted, groundwater monitoring would detect the changes in groundwater quality. Depending on the severity of the problem, provisions of the contingency plan could be implemented. Implementation of the contingency plan would result in remedial actions to prevent exceedance of groundwater standards at the compliance boundary.

199 The appropriate sections in the FEIS have been revised to address these concerns.

200 The DEIS has been revised to indicate that while erosion control and drainage control features may require frequent maintenance, the risk of significant off-site environmental damage occurring as a result of facility failure is low due to the small volume of water handled by these facilities and their design and maintenance features. The DEIS did indicate what actions would be taken if erosion control or drainage structures failed.

201 Too little detailed information is available on the nature of these orebodies to produce a meaningful assessment of the impact of their being mined. Such an analysis would be excessively speculative. Further, if these deposits were ever proposed to be developed, regardless of the status of the Exxon project, the impacts associated with such activity would be evaluated through a separate environmental analysis and permit review process.

202 It is unlikely that zinc concentrate would be transported to the White Pine, Michigan, smelter because it does not process zinc concentrate. However, if the concentrate were smelted in the Upper Peninsula of Michigan at a modern facility, the resulting air quality impacts on the project site are anticipated to be insignificant. Prevailing winds would

carry smelting emissions away from the project site throughout most of the year. The distance between White Pine and the project is adequate to fully disperse additional smelting emissions.

203 The DEIS indicated that if adverse impacts were detected through monitoring, steps would be taken to evaluate and correct the problem. Further, the administrative codes specify what actions must be taken should monitoring indicate that unforeseen or unacceptable impacts are resulting due to the operation. Permit conditions also would address actions which would be taken in the event of unacceptable impacts.

204 Comment acknowledged. The Department intends to use all credible monitoring data in establishing baseline conditions. The requirement that the monitoring plan be implemented roughly one year prior to construction is meant to ensure that baseline conditions be reaffirmed "immediately" prior to construction disturbance. This is particularly important if the present monitoring programs would be terminated and a significant period of time expires prior to construction. Also, while the details of the private well water quality program have not been developed, samples would likely be obtained on a quarterly basis.

205 The determination of the need for an extension of monitoring after the period of long-term care will be made at that time.

206 The permit applications and approvals, not the EIS, are the appropriate forum for justifying the proposed compliance boundaries. This regulatory function will be examined as part of the master hearing.

The EIS has been revised to include a discussion of the concept of the intervention boundary. The groundwater quality contingency plans and provisions contained in chapter NR 182 specify actions to be taken if monitoring at intermediate points indicates potential groundwater contamination.

207 Piezometers and lysimeters are the standard and most appropriate means of monitoring a waste site.

208 As indicated in DEIS Table 1-15, leachate would be sampled quarterly for the set of indicator parameters and annually for a more extended parameter analysis.

209 Physical sampling of the tailings is not believed to be necessary.

210 Some of the existing wells which are designated as monitoring wells are predicted to go dry due to mine pumping and the resultant drawdown. However, where that is the case, Exxon has been directed to either deepen the well or construct a new monitoring point at that location to an appropriate depth. Wells to be added would be constructed such that they would provide a continuous water level record, even under extreme impact conditions.

211 As discussed on DEIS page 18, the design of the reclaim ponds includes an underdrain which would collect any water which seeps through the overlying synthetic geomembrane liner. Thus, a significant accumulation of water in the underdrain would indicate a failure or inadequate performance of the liner. The current plans for the reclaim pond liners are for two synthetic liners.

212 In addition to requiring spill reporting, the Department intends to require that five wells be constructed on the mill site upon cessation of mine pumping. These wells would be located near facilities with the greatest potential for causing groundwater contamination, such as the preproduction ore pad and the fuel handling facilities. In addition, the Department intends to require the installation of a collection basin lysimeter beneath the preproduction ore pad to be monitored during the operation phase.

213 The discussion and associated table on DEIS page 36 both indicated monitoring of intercepted groundwater would take place prior to the water entering the discharge lagoons.

214 The parameter lists for the different monitoring locations vary because the purpose of the monitoring varies with the location of the monitoring point in the system. For instance, monitoring of the three discharge lagoon inlets is intended to determine the general quality of each of those streams and ultimately the acceptability of the water for discharge or the need for additional treatment. The parameters selected for monitoring would provide a representative indication of the quality of these streams.

215 Monitoring of the lagoon outlet would be for an extensive list of parameters to determine final effluent quality and evaluate permit compliance. Since changes in quality are not expected to occur while the water is in transport in the pipeline, a very limited sampling effort is proposed for the Swamp Creek outfall. However, if significant changes did occur, the parameters selected for analysis would reflect the difference. Temperature would be added to the list of parameters.

216 Section NR 218.04, Wisconsin Administrative Code, defines a 24-hour composite sample. The WPDES permit would specify in detail what constitutes an exceedance.

217 The Department, through the WPDES permit, intends to require monitoring of the sanitary treatment plant. A representative monitoring program was presented on DEIS pages 216 and 217.

218 The DEIS section on aquatic monitoring identified the scope and nature of the proposed plan. For additional details, refer to Exxon's latest revision of the "Monitoring and Quality Assurance Plan" (December, 1985) that explains in detail the aquatic monitoring program.

219 No reference in the surface water monitoring section of the DEIS was made to "indicator parameters."

220 Water and sediment chemistry samples would be split at approximately a 15 percent frequency, and the fishery and benthic sampling would be verified by field studies conducted by the Department on roughly a 15 percent frequency.

221 The Department believes the biological monitoring program is adequate. However, if the monitoring program or other sources of evidence indicate that impacts are or might occur, then additional monitoring would be required of Exxon as part of the monitoring permit.

The aquatic monitoring program would consist of tests measuring acute and chronic toxicity as well as bioaccumulation of metals in aquatic organisms. These tests would ascertain the effects on select laboratory species and in stream organisms at various levels in the food chain. The sampling schedule, locations, and parameters were listed in Table 1-14 of the DEIS. The Department also would collect fish for tissue analyses from the Wolf River at County "T".

222 The analyses to be performed were identified in Table 1-14 of the DEIS.

223 Exxon proposes to monitor benthic macroinvertebrates for heavy metal concentrations at three locations on Swamp Creek during the spring and late summer. The Department intends to require benthos sampling three times a year: prior to snowmelt, during summer low flow, and prior to leaf fall in autumn.

224 Duplicate sediment samples for chemical analyses would be collected approximately one-third of a mile downstream from the outfall site. Additional sediment sampling further downstream may be required in the future as part of the monitoring program,

provided it is demonstrated that contamination of the bottom sediments with heavy metals was occurring and, in turn, would be cause for concern to the aquatic biota.

The DEIS indicated the parameters to be monitored in the sediment in footnote 3, Table 1-14 on page 38.

225 The description of the surface water mitigation plan has been revised in the FEIS.

226 See responses 309 and 310.

227 Actual monitoring requirements will be determined in the permits. Exxon has not proposed monitoring water quality of the mitigation discharges. The Department intends to require monitoring of all discharges which may contain pollutants or which may pose dissolved oxygen or temperature concerns.

228 Reductions in lake levels or stream flows would be evaluated based on technical analysis of monitoring data and comparison with historical information. These data would include groundwater levels, weather data, control point data, records of mine pumping, and results of model simulations. Based on this information, determinations of mine-relatedness would be made.

229 Refer to DEIS Table 1-14 for proposed surface water monitoring and DEIS page 217 for monitoring alternatives. The waterbodies receiving groundwater for augmentation would be monitored. Refer to Table 1-14 of the DEIS for a list of the parameters to be measured and the sampling frequency. Periodic monitoring of the groundwater to be used for augmentation also would be required as part of the monitoring plan.

230 The details of the vegetation/soils/small mammal sampling program have not been finalized. Exxon has proposed to sample a designated transect downwind from the MWDF on an annual basis. The final sampling scheme will be designed so that meaningful results are obtained which can readily be compared to the baseline information.

The use of infrared aerial photography as a means to detect ecological stress is an accepted and common practice, and thus it is not necessary to further explain its use in the EIS.

Rice Lake, and its associated wild rice beds, would be included in the aerial photography program. This program would detect stress in the rice crop. Further, contingent upon receiving tribal approval, the surface water monitoring program would include regular water quality sampling of Rice Lake.

231 Based on results of air quality modeling, the Department believes that the proposed air sampling stations would provide adequate spacial coverage and would thus generate representative data on air quality around the facility. Further, the vegetation/soil/small mammal sampling would provide an indication of impacts resulting from deposition of particulates. The monitoring frequency and timing for asbestiform fiber monitoring should also provide representative values and are believed to be suitable.

232 The Department has no regulatory authority over noise, which typically is regulated by local ordinances. Usually, monitoring is required by the regulating authority. The use of explosives is regulated by the Department of Industry, Labor and Human Relations, and recordkeeping requirements are specified in section ILHR 7.37, Wisconsin Administrative Code.

233 Except for the DNR's mine permit authority involving the "no net substantial adverse economic impact" test, DNR has no direct regulatory authority for socioeconomic impacts. Therefore, DNR does not propose to require monitoring of socioeconomic impacts as part of the conditions of the mining permit. However, some socioeconomic monitoring activities were identified on DEIS pages 239-241.

The Mining Investment and Local Impact Fund Board (MIB) was created by the Legislature explicitly to distribute funds to municipalities for mitigation of mining impacts as discussed on DEIS page 86. State law would allow funding from the MIB for a municipality to conduct monitoring studies to determine mine-related impacts.

234 This comment is an introductory conclusion, and is more specifically addressed in the responses which follow. Additional information has been provided in the FEIS regarding the economic effects of the mine. This regulatory question would be addressed further at the master hearing.

235 The Department believes it is outside the scope of the impact statement to attempt to determine the priorities of particular impacts. It is, however, the document's function to provide the decisionmaker and the public with the information necessary to perform the prioritization described in the comment. It is DNR's position that the FEIS does provide the necessary information.

Uncertainties relating to the socioeconomic impact analysis were described on DEIS pages 157-159.

236 The DEIS (pages 157-159) referred to the uncertainties surrounding Exxon's decision-making processes, including the possibility of an unscheduled closure of the mine. A temporary suspension or premature closure was briefly discussed on DEIS pages 195 and 240. However, the specific effects which would result from closure would vary widely, depending on the timing of the closure. It is beyond the scope of the EIS to describe the effects of each possible closure scenario. However, the discussion in the FEIS has been expanded to include the predicted impacts of closure after the zinc-rich ore had been mined.

237 The percentage figure for locally hired construction workers was derived from the job-by-job analysis of contractor employment shown in DEIS Table 3-34. This figure was determined by considerations of job requirements and existing job skills among study area residents. Local job skills were determined by conversations with labor unions, government officials, and employers in the study area. The analysis assumed Exxon would give hiring preference to local residents as discussed on DEIS page 161.

238 Refer to response #237.

239 The DEIS (pages 157-159) referred to uncertainties in analyzing socioeconomic impacts. Among these uncertainties were the potential number of local hires, local unemployment rates at the time of construction, and other critical issues which would affect the inmigrant labor force needed to staff the project. It is beyond the scope of this document to describe the specific effects of each such scenario. The historical experience of other large projects in the United States confirms the scope and diversity of such scenarios, ranging from extensive local hiring when a mature industrial base precedes the project, to extensive inmigration where the industrial sector is poorly developed and little or no effort is made to hire locally.

If no preferential hiring policy or on-the-job training were pursued (assuming the same local availability of qualified work force as was incorporated in the DEIS analysis), the Department's socioeconomic consultant estimates 10 to 15 percent of the construction work force and 30 to 40 percent of the operations work force could be hired locally. In the absence of a preferential hiring policy, positions filled by local residents would tend toward clerical, office, and unskilled labor employment and less toward skilled and professional employment than under a policy-influenced project staffing.

If a union contractor were selected, it is probable the proportion of existing area residents filling construction trade jobs would be lower. As in the case of an absence of a local hiring policy, the local employment potential would tend more toward less skilled jobs. In

both cases, the resulting socioeconomic projections would be correspondingly affected by the proportionately greater need for immigrant labor.

240 The nonwhite (Native American) communities in the vicinity of the proposed mine have historically had extremely high unemployment rates and thus very small participation in the regional labor force compared to the white community. Partly because of high unemployment, a higher percent of Native Americans live beneath the poverty level, live in substandard and crowded housing, and may not be able to afford adequate health care. For these and other reasons explained in the EIS, it is appropriate to identify alternative actions which could be taken relative to Native American employment.

241 The assumption of local hiring practices could indeed have been studied as well as a number of other variables which were discussed. However, in order to perform the analysis in a workable manner, it was necessary to conclude that certain variables must be assumed at a fixed value. In the case of Exxon's hiring practices, it was assumed that Exxon's statements on the subject were made in good faith, and the analysis incorporated both these statements and a critical analysis of their workability in practice.

There are considerable skills mismatches between the available labor supply and that required to construct and operate the mine. There also are too few workers of certain skills (e.g., pipefitters, electricians, millwrights, ironworkers, rock drillers, engineers, etc. from DEIS Table 3-34) in the area, so there would be substantial inmigration to fill those job needs. For the most part, training would not fill these needs. Moreover, training would not be geared to mine-specific jobs, but more generic jobs.

Nicolet College and Technical Institute in Rhinelander already has added a program for diesel and heavy equipment maintenance. In addition, it is evaluating the feasibility of a heavy equipment operator course, while other potential course areas being discussed are safety training, supervisory training, and electronics repair. Except for company sponsored on-the-job training, no other training at Nicolet College would be specific to mining, although there would be applicability from such courses as secretarial, accounting, and others.

242 The population projections contained in the DEIS are not based on Exxon's projections per se (although the projection methodology incorporates many similar assumptions), but were calculated on the basis of the method briefly described on DEIS page 159 and described in detail in DRI's Final Socioeconomic Impact Analysis.

243 We agree there would be significant impacts from the inmigrating population during the construction period. Because the methodology employed in the DEIS does not use generic cost or service factors to project public expenditures but relies on local conditions and preferences, it requires that all populations be assigned to localities before expenditures can be projected. As indicated on DEIS Tables 3-41, 3-42, 3-47 and 3-48, increased costs to municipalities and school districts were shown for the construction period. The projections were based on estimated inmigrant population multiplied by the prevailing community costs on a per person basis.

244 The public costs associated with both the construction and operations phases of the project were calculated for each year of the project period as discussed on DEIS page 167. Total costs for all jurisdictions for all the relevant years were added to produce the respective $90 million and $7 million projections. Although the expenditures projected for the construction period approximate a pro rata share of a 36-year total, the types of costs incurred during the construction period and during the operation periods would be quite different. For example, during the construction period, although total employment was greater, the proportional school costs would be considerably lower than during the operations period due to the differences in projected family composition. The DRI projection methodology was described in detail in the Final Socioeconomic Impact Assessment.

Response No.	Response

245 Refer to response #243. We anticipate the information in the EIS would be of value to the Mining Impact Board in developing socioeconomic mitigation strategies.

246 The projection methodology used in the EIS is based on standards which currently prevail in the study area, not statewide standards which this comment recommends. This method provides some cost standards which are higher than a statewide average and some which are lower than average, and many that differ widely among communities within the study area. It is used for two principal reasons in this EIS: (1) it more closely approximates the actual circumstances in the area (rather than a hypothetical and artificial "ideal"), and (2) it avoids the unreasonable implication that an industrial developer would be held to one standard while the impacted communities would operate on another.

247 The term "minimum impact" as used in the DEIS was somewhat misleading in that it represents the impacts based on current standards, even where these standards are assumed not to be consistent with standards developed outside the communities. The "minimum impact" terminology has been deleted.

Comparison of the prevailing community standards (DEIS Table 2-29) with other communities or state averages would show others would be higher and others lower than those in the project area, and would be an irrelevant comparison. Adopting some other standard to use in predicting impacts to local municipalities would be speculative.

248 How the net proceeds tax is computed and what deductions are available to a mining company are outlined in section 70.375, Wisconsin Statutes. It is not appropriate to repeat the net proceeds tax law in the EIS. In calculating Exxon's net proceeds tax liability, it was assumed Exxon would make full use of all allowable deductions.

249 The net proceeds tax calculations conducted by the Department of Revenue (DOR) were based on a number of assumptions and data sources as explained on DEIS pages 170 and 171. The most significant of these assumptions was the price of metals. Conducting a net proceeds tax analysis on current metals prices is inappropriate, because those are not the prices Exxon would receive for its concentrates. The best way to conduct the tax estimates is to use the predicted prices of metals at a future date which would coincide with concentrate production. That is what DOR did.

250 We agree the history of mining shows cyclical patterns, but to predict the cycles is impossible. If an early project termination were to occur, a possible time would be at the conclusion of the zinc-mining phase, year 2007 on DEIS Table 3-44. Net proceeds taxes fall sharply, indicating a significantly different profitability situation while mining the copper-rich ore. The impacts of closure after the first phase of mining were discussed on DEIS page 195 and have been expanded in the FEIS.

251 While we generally agree with these statements, there are two additional points to note. First, net proceeds tax estimates were made at the expected price, and at $\pm$10%, and $\pm$20% of expected metals prices. This range provides estimates of the potential variability in metal prices. The 80% calculations are closer to what current metals prices are for zinc and gold.

The second point is that the Mining Impact Fund is not the only source of mitigation funds. The mining damage fund (s. 107.30-.35, Wisconsin Statutes) is available to compensate individuals. There also are other possibilities to consider: the Badger Fund (for which there is no current intended distribution of the principal) could be used to mitigate negative impacts if the legislature so decided. Or, the legislature could loan money to the MIB as it has in the past. However, these last two cannot be depended upon now as future finance sources.

252 The lag between when property tax collections are needed and when they actually would be collected was identified on DEIS page 169.

A worst case property tax analysis was cited on DEIS page 170 for the Township of Lincoln. The analysis excluded the $100,000 annual construction period payment the Township would receive from the Mining Impact Fund, but if it were included, it is unlikely there would be an increase in the Township taxes. For Nashville Township, the projected gross increase in public service and facility costs (DEIS Table 3-41) is $51,000 during the third year of construction, and is $28,000 or lower during each operations period year. These are "gross" increases, and actually would be lessened by project-related private and industrial developments which would increase the township's total assessed valuation. The gross increases would be less than the annual $100,000 construction period payments, which could continue for three years after concentrate production begins.

As indicated on DEIS Table 3-43, substantial increases in the assessed valuation in Forest County and the Crandon School District are predicted. Home building and industrial development would add to that increase. Substantial reductions in school district and county tax levies could accrue to those residents. Any such predictions would have to be based on how county and local officials would choose to distribute the tax windfall, either by reducing the tax levy, or maintaining the levy and greatly increasing local expenditures, for example, for long-deferred maintenance.

253 The discussion of corporate income tax liability has been revised in the FEIS to indicate that its payment is dependent upon corporate organization. The projection of corporate income taxes was conducted by the Department of Revenue based upon data utilized in the net proceeds tax calculations.

254 A transportation impact analysis is included in the FEIS.

255 As explained on DEIS page 87, transportation costs are included in the public service costs per capita, and thus are included in the projected increased costs to municipalities from the project.

The roadways which would receive the bulk of the increased traffic resulting from the project are state trunk highways or county trunk highways as illustrated on DEIS Fig. 2-13.

256 The safety problem along STH 55 at Mole Lake was identified on DEIS page 93; additional impacts are projected on DEIS page 176; mitigation alternatives are discussed on DEIS page 239. As identified on DEIS page 93, long-range planning for improvements to STH 55 have begun. The costs of rebuilding STH 55 would be borne by the state.

257 The list of six factors is a recapitulation of the discussion which preceded it, and each of the preceding sections includes quantified and narrative analyses which contributed to the statement that the positive economic effects studied would outweigh the negative ones if the project would proceed as proposed. The discussion is only a summary of the DEIS information which pertains to the economic permitting question in section 144.855(5)(a)1.e. While additional discussion on the overall economic effects is included in the FEIS, a decision on the permit question would follow the master hearing.

258 The positive effects referred to include the rapid increases in assessed valuation, taxes which would be paid by Exxon, availability of new jobs, wage receipts, expenditures by Exxon in the study area, and increased economic activity, all of which would peak late in the construction phase and early in operations.

While there would be a lag in property and net proceed tax collections, the majority of these taxes would be collected in the first half of the project. In addition, five

municipalities would receive construction period grants from the Mining Impact Fund which could total more than $3.3 million as illustrated in DEIS Table 3-46.

259 The DEIS did contain a brief impact analysis of the project impacts on the tourist industry and recreation within several miles of the mine (page 181). The Department does not believe there would be significant tourism impacts from the project. A section in the FEIS on tourism impacts provides the analysis.

Economic diversification in the area was addressed in the DEIS section on jobs, page 162. For each 100 direct jobs (at the project) created, there would be 50 indirect jobs created through stimulation of economic activity in the region. Approximately 310 jobs would be indirectly created, thus leading to economic expansion and diversification.

260 The Department believes the discussion of alternative tailings processing presented on DEIS pages 224-226 adequately explored the range of reasonable alternatives and their impacts. The general costs of the proposed method of disposal were presented on DEIS page 45, while general costs for alternative facilities were presented on page 225.

261 Alternative amounts of effluent discharge to Swamp Creek in relation to surface water mitigation needs are addressed in the FEIS (Table 1-8).

262 The DEIS addressed the alternatives of closer collection pipe spacing in the MWDF underdrain (Fig. 4-6 and page 213), MWDF liner thickness and composition (page 214), and cleanout devices for the MWDF underdrain piping (Fig. 4-6 and page 214).

263 Responses to these and additional summary comments are provided in the detailed responses which follow.

264 The purpose of the geotextile would be to prevent significant migration of fine materials into the drain layer and thus prevent clogging. The geotextile would need to perform this function during the operation period and after reclamation until the tailings dewatered to field capacity. There is a growing body of literature on the useful applications of synthetic fabrics. The structural integrity of the MWDF is due mainly to soil materials, not synthetic fabrics.

The existing technical literature indicates degradation processes affecting geomembranes in a stable buried condition operate extremely slowly, if at all. There are no known naturally occurring organisms which attack the basic polymers which make up geomembranes.

265 Microbiological growth and associated chemical precipitation mechanisms in the drain system are subject to testing and examination both in the laboratory and when the MWDF is in operation. The Department's consultant (see P. Helmke report), however, believes it is unlikely that precipitation mechanisms would clog the collection pipes. Precipitation is more likely to occur in the filter layer or drain layer above the collection pipes. Operating experience from landfills with leachate of similar constituents or greater strength indicates sand drainage blankets may support biological growth but almost never clog completely.

The DEIS alternatives section discussed an MWDF design with closer underdrain pipe spacing and provisions for clean out (Fig. 4-6).

If clogging occurred and reduced leachate collection resulted, this would be evidenced by substantially increased seepage from the MWDF. The purpose of monitoring wells and collection lysimeters would be to detect increased seepage. Under these circumstances, Exxon would be required to correct the increased seepage problem.

266 The well construction information for existing monitoring wells has been reviewed, and in cases where wells would not be functional, Exxon has been directed to construct new wells

screened at the appropriate depth. Wells which are not yet constructed would be done so to ensure continuous collection of meaningful data through the operations phase.

267 The statutes require an operator to be responsible for the long-term care, including monitoring, of a waste facility for a maximum of 30 years after approved closure. After that period if additional monitoring were necessary, it would be the responsibility of the state to continue the monitoring.

268 DEIS page 40 stated that a company may apply to the Department for termination of its long-term care responsibility for the reclaimed MWDF after 10 years. By that time, cell T1 of the MWDF would have been closed, reclaimed, and monitored for about 35 years. The Department would review site conditions and monitoring results and hold a hearing on the termination request. The Department probably would not have any incentive to terminate the owner's responsibilities until the end of the 30 year long-term care period. The provision in the law for early termination was an option developed for small mine waste disposal areas which would not require long-term care and which would not pose a threat to groundwater resources.

After the long-term care period prescribed by law, the state assumes responsibility for maintenance and monitoring. These activities would be funded through the waste management fund which was created specifically for that purpose. Money accumulates in the waste management fund from waste disposal fees. Under certain conditions, the Mining Impact fund or the environmental repair fund could be used by the state for long-term care. In addition, the Badger Fund, which receives 40% of the net proceeds tax payments, could possibly be used if the Legislature made such a determination.

After the 30 year long-term care responsibility, Exxon still could be liable if, for example, substantial groundwater contamination would occur. Liability would not end after the 30 year long-term care period.

269 The Department does not believe that clogging in the lysimeters would be a problem due to the design features of the MWDF and the expected nature of the leachate. Studies indicate chemical precipitation should not occur, but if it did, the precipitation would take place in the overlying liner before leachate would reach the lysimeter. Further, if clogging of the lysimeter should somehow take place, it would only happen after the accumulation of significant volumes of liquid, thus indicating the failure of the liner. Detection of this condition would occur much before total clogging of the lysimeter. This check on the liner performance is the main function of the lysimeters, and it is believed that they would serve this purpose for the life of the project.

The Department's experience with lysimeters is they are useful and reliable instruments. The main cause of failure has been due to improper construction which can be corrected with close quality control.

270 Geohydrological conditions at the mine workings in southwestern Wisconsin are very different from those at Crandon. Groundwater flow within the ore host rocks in the southwest is very rapid, and the host rock serves as an aquifer for domestic water supplies. The flow through the Crandon orebody is expected to be insignificant compared to the flow in the overlying glacial materials, so any contaminants emanating from the mine are not likely to be detectable in the glacial aquifer. The Department would probably maintain the glacial aquifer monitoring wells even after Exxon's period of long-term care if there were concerns about glacial aquifer contamination.

271 Monitoring control sites is now part of the proposed mitigation plan.

272 As indicated in the DEIS, Little Sand, Duck, Deep Hole, and Skunk lakes are seepage lakes which are in continuity with the water table. However, the lakes are nearly hydraulically isolated from the groundwater system because of the low permeability of the fine grained sediments underlying the lake bottoms. The lakes' influence on the water table is

minimal. Piezometers placed through the lake sediments documented very little mounding of the underlying aquifer beneath the lakes. For example, groundwater potentials under Little Sand Lake appear to have been only about one meter higher than the surrounding groundwater potentials. The other lakes show even less influence on the underlying groundwater potentials. The EIS graphics have been redrawn to represent the actual field conditions.

273 The lakes are a minor source of recharge compared to all other recharge areas. Little Sand Lake is the only lake which contributes a significant amount of recharge. Using an 8.5 inch annual recharge rate and maximum possible lake sediment conductivity, the total seepage for all four lakes is about 450 gpm. Total project area recharge is 6260 gpm, making the lake component about 7% of the total.

274 This is not true. All DNR hydrologic analyses treated the four lakes as being seepage lakes, not perched lakes.

275 The groundwater modeling has undergone close scrutiny by many different hydrological professionals, including Department staff, Dr. Mary Anderson (DNR consultant), the U.S. Geological Survey, the Wisconsin Geological and Natural History Survey, and consultants representing local government. Alternate models have been constructed and hydrogeological parameters used as model input have been tested within their range of uncertainty in order to provide a range of potential outcomes. The range of outcomes produced was used to describe and encompass potential impacts of project activities.

276 The lake impact projections in the DEIS were DNR's predictions of the expected and the worst case impacts which reasonably could be predicted to occur. Increasing the worst-case impacts by 60% is not justified. A range of lake sediment conductivities was used as input to the GEOFLOW model. The highest possible aquifer transmissivity and recharge were used to allow calibration of the highest potential sediment conductivity. This exercise indicated lake conductivities higher than those labeled as WDNR 3 are not reasonable, and no further increase in lake conductivity should be made in determining lake seepage under impact conditions. Field lake water budget studies also confirmed the range of lake sediment conductivities. As noted on pages 122, and 137 of the DEIS, the analysis of the mitigation plan's ability to deal with worst case impacts was not completed. The FEIS provides this analysis.

277 A range of dispersivities which provided a wide range of potential outcomes was chosen. Values chosen included those utilized in areas having similar hydrogeological conditions. This provided a realistic range of potential impacts.

278 See responses #149, 275, 277, and 296-300. Some contaminants would reach Hemlock Creek much sooner than 9000 years, but dispersive processes would keep contaminant concentrations at very low levels. A simple flow analysis does not account for dispersion of contaminants.

279 This statement is not true. The models have been tested on actual field problems and through comparison to analytical solutions.

280 The models were verified for accuracy by simulating actual field problems and through comparison to analytical solutions.

281 Refer to responses #264 and 302. There are no known processes which could degrade the cap membrane if installed and maintained as proposed. The preservation of similar earthen structures for several thousands of years is well documented in archaeological and civil engineering literature.

282 The approval of the MWDF design would be conditioned to insure the drain system functions as intended. Some evapotranspiration loss might occur but this should not significantly affect contaminant transport or groundwater quality.

283 The groundwater models do not assume the liner drains need to be functional for 9,000 years after site closure, although natural sand deposits have lasted for much longer periods and maintained natural permeabilities. The drainage layer in the final cover will only contact soil water, and once a natural soil filter has set up, should function as long as it is not significantly disturbed. Some long-term maintenance of the MWDF by the state is expected to be required but should be confined to surface features. With proper functioning of the overdrain in the final cover, the drain beneath the tailings mass should cease to be of importance once leachate pumping ceases and seepage rates at the base of the waste mass fall below a few inches per year.

284 Many conservative assumptions were incorporated into the contaminant modeling. Some of these were as follows:

1. The D'Appolonia/IT cross-section traversed the longest possible portion of the MWDF, therefore allowing the highest possible contaminant concentrations to be produced.

2. For the IT model, the till thickness underlying the MWDF was reduced from the 43 feet found in most areas to the minimum value of 26 feet which was found in only a limited area.

3. The MWDF cap membrane was assumed to fail such that 10% of its area was completely destroyed.

4. The DNR/USGS model ignored unsaturated flow and introduced MWDF seepage directly into the saturated zone.

5. The DNR/USGS model introduced seepage from the entire base and sideslope area of the MWDF. This introduced over twice as much leachate as expected during operational periods because the sideslopes are not anticipated to contribute significant leachate quantities.

6. The DNR/USGS MWDF operational seepage was given a range of 0.6 to 2.4 inches per year which included a conservative high value.

7. A 30 year duration for operational seepage was used as model input though seepage is expected to be significantly reduced within 15 years after the initiation of the operation of a given tailings pond.

8. A conservative (high) value of 2000 mg/l was chosen to represent the sulfate concentration of the tailings leachate.

9. A wide range of dispersivities was examined. While a longitudinal dispersivity of 17 feet coupled with a longitudinal to transverse dispersivity ratio of 1000/1 may produce slightly greater sulfate concentrations in the bedrock and lower till unit, it is important to note these areas are not likely to ever be used for water supplies.

285 We believe that rates of contaminant delivery have been correctly chosen and the distribution properly represented.

286 See response #284.

287 The Department believes proper professional judgment has been used for technical evaluation of project impacts. Computer modeling is an accepted and technically reasonable approach to estimate potential impacts.

288 The USGS/DNR and IT model simulations were independent evaluation efforts. In many instances, different model inputs and assumptions were used. It is not surprising that in some areas similar input values were chosen which simply confirms the reasonableness of

such values. The similarity of independent evaluation activities is a strong affirmation of the accuracy of the impact analyses.

289 Both the oxygen concentration of the water and the water flow rate are important components of the oxygen flux controlling pyrite oxidation and subsequent sulfate production. However, both the amount of water moving through the final reclamation cap and oxygen content in the water are expected to be low.

290 Liner hydraulic conductivity tests were conducted over an 18 week period. Increased hydraulic gradients were used which allowed about 50 years of actual field seepage to be simulated. The test leachates varied from a pH of 3 to 9. The initial conductivity of 1.0×10^{-8} cm/sec increased to 1.5×10^{-8} cm/sec. This increase of 50% is not significant considering the large range of hydraulic conductivity values possible.

291 The permeability of the liner would be 5 to 10 times lower than that used by the Department to evaluate potential seepage impacts. The bentonite amended soil liner must only function until the tailings have dewatered close to field capacity, which would be less than 50 years after the beginning of the operation of a given tailings pond. After that time, the MWDF cap would limit seepage to a low steady state amount.

292 The groundwater drawdown would approach its maximum after project year 6 or 7, after significant underground development had occurred and when increased pumping would be required to prevent mine flooding. During this period, the extent and nature of the groundwater drawdown would be measured in monitoring wells surrounding the project site. If necessary, interim computer modeling, when the cone of depression was partly developed, would aid in predicting the final cone of depression should mine inflow be higher than anticipated.

Groundwater quality data, a well water sampling program, and groundwater level information would be required as part of the preconstruction monitoring program. These data would help define the natural system against which mine-induced changes would be compared. It is DNR's responsibility to determine whether impacts to a water well are mine-induced or not, as stated in section 144.855, Wisconsin Statutes.

293 Additional interpretation of the impacts of mitigation water to Little Sand and Deep Hole Lakes is provided in the FEIS.

294 It is unlikely that the mine effluent would comprise the sole source of mitigation water for Skunk Lake. Since the projected effluent quality would not meet the criteria for chromium, selenium, sulfate, iron and total dissolved solids for a discharge to Skunk Lake, two options exist. Either additional treatment of the effluent would be required prior to discharge or a large percentage of the mitigation water would have to be uncontaminated groundwater in order for the water quality standards to be met. Under no circumstances would a discharge of wastewater to Skunk Lake be permitted, unless the water quality criteria specified in DEIS Table 3-9 were met.

Although sulfate levels in the effluent would be significantly higher than background levels in Skunk Lake, it is not expected to pose any problem, since sulfate is not considered a toxic pollutant. The acceptable stock watering limit for sulfates is 500 mg/l (California Water Quality Criteria, 1971). The limits established for Skunk Lake would be below 500 mg/l for sulfates, and thus should provide adequate protection to animals that would drink the water.

295 The FEIS addresses mitigation of both expected and maximum case impacts.

296 - 300 A simple mass balance calculation can put the MWDF surface water impacts in perspective. The worst case steady state seepage of the MWDF is about 0.067 inches/year with sulfate concentrations being 2000 mg/l. A conservative case where all the sulfate

seeping from the MWDF is assumed to flow directly into Hemlock Creek is calculated by allowing 400 acres of lined area to release sulfate for one year. (The MWDF design as modified by Exxon consists of a 270 acre lined area.)

a) Total mass of sulfate released per year =

$$\frac{\text{mg } SO_4}{\text{year}} = (400 \text{ acres}) \quad \frac{43{,}560 \text{ ft}^2}{\text{acre}} \quad \frac{0.67 \text{ inches}}{\text{year}} \quad \frac{1 \text{ ft}}{12 \text{ in.}} \quad \frac{7.48 \text{ gal}}{1 \text{ ft}^3} \quad \frac{3.8 \text{ liters}}{1 \text{ gal.}}$$

$$\frac{2000 \text{ mg } SO_4}{\text{liter}} = 5.53 \times 10^9 \text{ mg } SO_4/\text{year}$$

b) The $Q_{7,2}$ flow for Hemlock Creek at SG-6 is about 2.0 cfs, therefore the yearly flow =

$$\frac{\text{liters}}{\text{year}} = \frac{2.00 \text{ ft}^3}{\text{sec}} \quad \frac{7.48 \text{ gal}}{\text{ft}^3} \quad \frac{3.8 \text{ liters}}{\text{gal}} \quad \frac{3600 \text{ sec}}{1 \text{ hr}} \quad \frac{24 \text{ hr}}{\text{day}} \quad \frac{365 \text{ days}}{\text{year}}$$

$= 1.8 \times 10^9$ liters/year

c) Therefore, the maximum increase in sulfate concentration in Hemlock Creek at SG-6 would be:

$$\frac{\text{mg } SO_4}{\text{liter}} = \frac{5.53 \times 10^9 \text{ mg } SO_4}{1.8 \times 10^9 \text{ liters/year}} = 3.1 \text{ mg/liter}$$

Downstream on Swamp Creek at SG-3 where the $Q_{7,2}$ is 6.7 cfs, the increased sulfate concentration would be 0.9 mg/liter.

Even without the effects of dispersion which would retard the arrival of the sulfate at Hemlock Creek for several thousands of years, the steady state worst case calculation as made above shows insignificant environmental surface water impacts can be expected from MWDF seepage at the projected, conservative rate.

301 Exxon may not cause an unreasonable detriment to public rights in surface waters. After closure, it must continue to mitigate mine-induced surface water impacts as long as necessary.

302 The longevity of geomembranes is addressed in response #264. In addition, the long-term success of the waste containment facility depends on geomorphic and geological stability more than on membrane permeability. It is unlikely that the small amount of water which would leak through the final reclamation cap would contain sufficient amounts of oxygen to cause significant pyrite oxidation.

303 Exxon's proposal did not include a provision for clean out of underdrain pipes. Refer to response #265 on underdrain clogging and response #283 on geomembrane longevity. Also refer to the discussion on DEIS page 214 and Fig. 4-6 on underdrain clean out alternatives.

304 Stability of the geomembrane liners is addressed in response #265. Wetting and drying of the bentonite-modified soil liner is not expected to occur. The bentonite-modified soil liner would be covered by the geomembrane, a drain layer, and five feet of till and topsoil. The topsoil would support a plant community. The bentonite-modified soil layer should remain at a relatively constant moisture content following installation.

Construction of the final reclamation cap, as explained on DEIS page 28, would begin after the tailings had consolidated. The grading layer would have to be compacted to provide a suitable base for the liners and limit air and water movement into the tailings.

305 It is very likely that the state would continue groundwater monitoring following termination of Exxon's long-term care responsibility. However, the decision would be based on a review of technical data at that time.

306 The FEIS provides the Department's expected and worst case impact analysis along with an analysis of the ability of Exxon's proposal to adequately mitigate surface water impacts.

307 Responses to comments #8, 10, 148, 149, 155, 173, 275, 277, 278, 279, 280, 281, 284, 285, 287, and 288 address the Department's groundwater evaluation activities. If the MWDF were recommended for approval by the Department and the Department's conditions for approval were incorporated by the decision maker, significant groundwater impacts would be unlikely. The contingency plan discussed on DEIS pages 236-7 for the project provide for progressive monitoring, evaluation, and response. The plan would allow for a flexible response to potential groundwater impacts. Since, as the commentor has pointed out, groundwater contamination problems would be most likely to occur after many years, a conservative waste containment design is required.

308 Refer to response #140 and 141. The discussions on impacts to soils and soil erosion impacts to water quality are revised in the FEIS.

309 A discussion on the thermal effects of mitigation water to lakes and streams is included in the FEIS.

310 Under worst case conditions of lowest lake level and coldest background lake temperature, there would be areas of noticeable temperature increases of one to four acres in Little Sand Lake and less than one acre in Deep Hole Lake. Some fish species or those not acclimated to the micro-habitat created by the mitigation water might avoid the area of thermal contrast. Conversely, a positive response could result as well, with fish moving into areas of warmer or cooler water depending on the season. The impact is either one of avoidance or attraction, neither of which should adversely affect the fishery.

For streams, where flow reduction occurs, the loss would be from groundwater. Therefore, the use of comparable groundwater to augment flow should not cause measurable changes in the fishery except that noted for brook trout reproduction. If significant thermal contrasts would be encountered and sustained in a substantial portion of a stream, then fish growth could be affected. The optimum temperature for brook trout growth is around 66°F. Cooler than optimum, or normal, stream temperatures in summer may retard growth. This could decrease overwinter fingerling survival as there is a positive correlation with their average size in the fall and stock density in the spring. Warmer than normal, but not to exceed 50°F., stream temperatures in the winter would create favorable conditions for brook trout by alleviating certain rigors of winter stress. In general, fish are attracted to cooler water in the summer and warmer water in the winter.

The onset of trout spawning also may be linked to photoperiod (exposure to daylight), not just temperature. Observed summer maximum water temperatures in Class I brook trout streams in northern Wisconsin are variable and range from 60° - 80°F., yet spawning activity in these waters begins in late October or early November.

311 Impacts to water quality from the proposed surface water mitigation plan were discussed on DEIS pages 122-126 (lakes) and 133 (streams). A thermal impact analysis is included in the FEIS.

The concentration of iron in the groundwater is similar to the average ambient levels for those streams that would requiring augmentation. Based on the similarity of the water chemistry in the groundwater and streams, and due to the low concentrations of iron in the groundwater, the formation of iron deposits would not be expected.

The mean iron concentrations in the groundwater are close to the seasonal ranges found in Deep Hole and Little Sand Lakes. A problem is not expected in terms of formation of iron deposits, but, as a precautionary measure, monitoring for iron would be required on a periodic basis as a part of the monitoring plan.

312 The environmental impacts of mitigating increased seepage from Little Sand and Deep Hole Lakes were discussed on DEIS pages 122-126. The discussion included impacts to water quality and aquatic resources for the expected case conditions. In the FEIS, the discussion of impacts is expanded to encompass worst case conditions.

Subtle shifts toward less acid-tolerant organisms would be expected to occur as the result of groundwater augmentation to Little Sand and Deep Hole Lakes. In addition, an increase in species diversity might occur due to increases in alkalinity, conductivity and total dissolved solids, parameters which are linked to productivity in an aquatic ecosystem. The biological impacts under worse case mitigation conditions would be similar to the expected case conditions. However, a greater shift towards less acid-tolerant organisms and more species diversity might occur under worst case mitigation conditions.

Expected increases in the various parameters favor increased fish production and diversity. Elevating the pH from 5.4 to 6.6 would create a more favorable environment for minnows. Their absence in Little Sand Lake is attributed to the low pH. An increase in prey species (minnows) could enhance predator growth and/or abundance. The higher pH would create a favorable environment for smallmouth bass and/or walleye if introduction of these species were deemed an appropriate management strategy.

Increased alkalinity would buffer these lakes, particularly Little Sand Lake, from the adverse impacts of acid rain. This singular aspect is a significant positive fishery impact which would result from mitigation water.

313 Phosphorus would not increase in Little Sand Lake as the result of groundwater augmentation. The range of concentrations of phosphorus in the groundwater is lower than in the lake. Although nitrate levels in the groundwater are higher than in the lake, algal productivity should not change because phosphorus is the limiting nutrient in Little Sand Lake based on the nitrogen/phosphorus ratio.

Heavy metal concentrations in both the groundwater and in Little Sand Lake are below the detection level, with the exception of copper (DEIS Table 3-8). Consequently, detectable changes in heavy metals are not expected for Little Sand or Deep Hole Lakes.

314 Exxon would be required to mitigate reduced stream flows and lowered lake levels to the extent that woody vegetation could not encroach upon lake or stream margins. Therefore, there has been no need to plan for restoration of such areas at project closure as the comment indicates.

315 For the discharge to Swamp Creek, site-specific water quality criteria have been established to provide for the protection and propagation of fish and aquatic life and recreational uses in that stream. These criteria are designed to protect the reproduction, growth, and well-being of the organisms that live in Swamp Creek. Specifically, the standards developed for Swamp Creek were established to protect the most sensitive aquatic species for which data are available (usually these are small zooplankton species called Daphnids).

An extensive data base exists in the literature on the effect of toxic substances on fish and fish food organisms. All these sources of information were examined to develop appropriate criteria. The acute criterion protects aquatic organisms against the short-term toxicity of a pollutant (the data are expressed as 96-hour LC-50 values); the chronic criterion protects aquatic life against long-term exposure from a pollutant.

Criteria and effluent limitations have been developed for the pollutants projected to be in the discharge. The effluent limitations are based upon a given set of known conditions regarding stream and effluent flow and the ambient water chemistry. As the data base expands or effluent flow rate changes, appropriate modifications to the criteria and limitations would be made.

Short of performing an in-depth bioassay study after the discharge is occurring, there is no way to accurately determine the extent of bioaccumulation of heavy metals in aquatic organisms or in the bottom sediment of Swamp Creek. Consequently, the impacts to aquatic biota, as a result of bioaccumulation of heavy metals, were not discussed in detail in the DEIS. There are no data available in the literature relating sublethal effects in fish and aquatic life to bioconcentration or bioaccumulation levels of heavy metals; nor are there any data in the literature, except for mercury, relating levels of bioaccumulation to potential impacts to human health.

As part of the monitoring plan, the Department intends to require that Exxon conduct acute bioassay studies of their effluent on a quarterly basis. In addition, they would be required to conduct chronic bioassay studies prior to the time of each WPDES permit reissuance.

If additional information on bioaccumulation becomes available, and the bioassay monitoring results on Swamp Creek provide evidence that toxicity levels are being exceeded, then more restrictive limits would be imposed to protect aquatic life.

Due to the lack of literature data on sublethal effects of bioaccumulation on aquatic organisms or carcinogenic impacts to humans, it is impossible to develop a scientifically defensible standard, on that basis, for regulatory action. It also should be recognized that the toxics data base is constantly expanding as new information becomes available. Standards are set based on the best available scientific data.

316 See response #307. The Department would recommend that the MWDF plan approval include provisions for Exxon's continued collection, treatment and disposed of leachate after mine/mill closure.

317 See response to comment #395.

318 Refer to the "Monitoring and Quality Assurance Plan" submitted by Exxon in December 1985 for some of the sampling procedures to be followed for biological monitoring. More specific submittals - QA/QC documents and protocols for individual monitoring efforts - will be required of Exxon. These documents/protocols would need DNR approval prior to initiating any monitoring program.

Before water would be discharged from the lagoons to Swamp Creek, several monitoring features would ensure compliance with the effluent limitations. First, sampling of water entering the lagoon would occur. The lagoons would have sufficient capacity to hold wastewater until testing results were available. If the water met the effluent limitations, it would be pumped to Swamp Creek or would be used in conjunction with Exxon's mitigation plan. If it did not meet the effluent limitations, the water would be pumped back through the treatment system or to the reclaim ponds.

Other safety features currently planned include equipping the control room with a computer console for monitoring the performance of the system. The plant would have an extensive instrumentation and control system to monitor the performance of each process.

Effluent from each of the systems and the lagoons also would be analyzed continuously for pH, specific conductance, and turbidity to alert operators of any short-term fluctuations in effluent quality. If upset conditions would occur, alarms would alert operators that system adjustment is required.

319 Refer to response #224.

Exxon has proposed a twice annual sampling frequency (early spring and late summer) for benthic organisms in its "Monitoring and Quality Assurance Plan". In order to determine the effects of the discharge on the life stages of macroinvertebrates in Swamp Creek, the Department believes sampling in early spring, during the summer low flow, and in the fall would be necessary. The Department intends to require such a benthic organism sampling schedule.

Benthic organisms would be collected from artificial substrate samplers for population studies (i.e., species composition, total numbers, density). In addition, benthic organisms would be collected from natural substrate samplers for tissue analysis for heavy metals. The macroinvertebrates collected from the artificial substrate samplers would be stored for later analysis. This would serve as a future check to verify data already analyzed.

Water used for mitigation would come from groundwater sources and would replenish the loss of existing groundwater. Chemically, as far as the heavy metals are concerned, the mitigation water should have the same or very similar concentrations to the water it would replace. Consequently, to require monitoring of the aquatic biota for heavy metals at the mitigation sites is not justifiable.

Heavy metals are not expected to leak from the MWDF to adjacent surface waterbodies, and thus no aquatic monitoring of the biota for heavy metals is proposed (refer to DEIS pages 142 and 143).

320 Given the amount of data that already has been generated by Exxon's consultants on the project area lakes and streams, one year's worth of additional data collection, prior to construction, would provide sufficient baseline information.

Monitoring of control areas is proposed in the surface water mitigation plan.

Corrective actions have been defined for short-term impacts. However, for long-term problems, remedial actions were not specified at this time. The best approach, from an environmental standpoint, would be to evaluate the problem once the information is in hand, and then to specify an appropriate solution.

321 The FEIS indicates that while migrating waterfowl and shorebirds would be attracted to the MWDF and reclaim ponds, their use would be of short duration. Birds would use the areas only temporarily because the shoreline habitat would be beach sand, there would be no invertebrates for food, and there would be no shoreline or aquatic vegetation for food or cover. Due to the expected short use, no acute or chronic impacts are expected and no significant movement of contaminants from the ponds is expected.

322 While dust suppressants and herbicides probably would be used during the project, the amounts and types that would be used are unknown. Water may be used as a dust suppressant on roadways and on the tailings mass. This level of detail would be included in the plan of operation, which would be prepared after the master hearing and approved by the Department. It is expected that the use of approved herbicides and chemicals in accordance with specified application instructions would have negligible to minimal, localized impacts.

323 Additional impact analysis associated with project closure and interruption is included in the FEIS. Also see response #236.

324 The DEIS (pages 79, 80) incorporated other factors in addition to the areas supplying workers in determining the study area delineation. Some workers would travel long distances for relatively short periods of employment. This fact was incorporated in the analysis during the construction phase, in which 10 percent of the construction work force is expected to commute on a weekly basis from outside the study area.

325 The potential for public services costs following inmigration resulting in later excess capacity is recognized throughout the report, and particularly in public education. Grade shifting and other short-term solutions are assumed necessary to meet temporary peak impact needs.

326 Comment acknowledged. The impacts of a mid-project closure scenario are included in the FEIS.

327 See responses #307 and 316.

328 Contingency procedures which would be followed if there were unanticipated impacts from the MWDF on groundwater quality were outlined on pages 236 and 237 of the DEIS. In addition, contingency procedures were developed for potential groundwater pollution resulting from the mine, reclaim ponds, mine-mill surface facilities, and landfill (MRDF). A comprehensive monitoring plan has been designed to detect groundwater quality changes related to these facilities.

329 A section on potential acid formation in the tailings is included in the FEIS.

The MWDF design does not depend on continued deliberate neutralization of pH. The slurry transport liquid would be neutral to alkaline due to pH adjustments required in the flotation process. Liquid in the decant pool undoubtedly would be reduced to pH of approximately 7 by thiosalt oxidation, which also should consume oxygen in the ponded liquid. If the tailings surface were kept saturated, which is Exxon's stated intention and can be reinforced by approval conditions, the pH within the tailings mass should not decline to 4 or less. The existence of carbonate sludges and sediments added to the tailings mass might be slightly advantageous. It may be more accurate to state the MWDF is a convenient location for disposal of sludge than to imply sludge additions are necessary for leachate quality control. Mineralogy studies indicate other noncarbonate minerals in the waste mass also would provide some acidity neutralization.

Experience at other tailings sites indicates only a few percent by weight of lime or limestone in a tailings mass effectively neutralizes leachate from a coarse, exposed tailings surface. A highly oxidized surface layer due to pyrite oxidation took several years to develop, and was dependent upon continuous exposure of the tailings surface to the atmosphere.

The process water stream would be monitored and maintained at alkaline conditions. In addition, the reclaim pond waters would be maintained at a pH of above 7 as it moved between ponds. The project would require tremendous quantities of lime to be transported to the mill, and lime addition, should it be necessary, could easily be accomplished. Long-term control of pyrite oxidation is dependent on tailings surface saturation or placement of a soil cover.

330 A section on pyrite oxidation and acid formation is included in the FEIS. Thiobacillus and other bacteria would be present in the tailings mass, due simply to invasion from soil minerals. Under anaerobic conditions, these bacteria should not develop the populations needed to cause acid drainage problems. Due to the saturated conditions and consequent absence of oxygen, the pyrite oxidation reactions would not be self-sustaining. Furthermore, research indicates the waste mass would have sufficient neutralizing capacity to buffer any acidity formed at the tailings mass surface.

A leachate with high acidity, sulfate, and dissolved solids content might cause precipitation reactions within the underdrain and liner. Precipitation of secondary minerals may compensate for adverse effects to the soil liner permeability caused by acidic leachate. Even if acidic reactions occurred, they would probably be short-term. Long-term control of seepage would be provided by the final cover structure, not the bottom liner.

Leachate monitoring was addressed in the DEIS. The leachate collection system should provide rapid, readily obtainable samples of leachate quality. Other monitoring instrumentation could be added to plan of operation or during project operation if needed. However, it is uncommon to have sampling points directly within the waste mass itself, regardless of the waste type. Laboratory tests of scale physical models could be set up using actual project process water, tailings, and environmental conditions.

331 Piping can be controlled by soil gradation requirements both for the liner and for the underlying subbase soil. In addition, piping would be minimized if the water pressure on the liner were controlled by pumping the leachate collection system. In a well graded soil with a moderate fines content, the resulting soil pore spaces should be sufficiently small to retain even unhydrated (not swollen by water) bentonite particles. Piping is rare or unusual with properly constructed lined landfills. The problem has been observed with water retention dams and conventional tailings dams where high hydraulic heads and more permeable materials are commonly employed.

332 As noted in response #329, the neutralizing capacity of the tailings is not totally dependent on the addition of carbonate sludges.

333 Refer to response #329. Monitoring of the pore water within the tailings mass could be performed during operations, but sampling would be difficult. There would be little advantage in this type of sampling because there is access to the leachate via the leachate collection system. The depth of neutralization would be unimportant assuming sufficient acidity was produced to even require neutralization.

334 Refer to response #329.

335 The DEIS section on MWDF liner-leachate compatibility (page 113) indicated high concentrations of acidic chemicals could degrade the liner. However, acid leachate with a wide range of dissolved salts should not affect amended soil permeability significantly. Only strongly acidic conditions for extended time periods can cause such damage. If such conditions existed, they would be detectable in the leachate. With the physical conditions of the site, such acidic conditions are not expected.

The tailings would not be classified as hazardous because it does not meet the conditions imposed by the EPA toxicity test. Wastes such as flyash, coal spoils material, and several other inorganic waste types also have the potential to form acid leachate but are not hazardous wastes.

336 DEIS page 13 explained how runoff water would move laterally in the drain layer to the recharge enhancement zones thus minimizing seepage into the tailings mass. DEIS Fig. 1-17 provided details of the MWDF showing the perimeter vertical drains. The use of the perimeter vertical drains would allow water to seep into the subsoils without causing saturation or erosion of the dike sideslopes. These drainage features were included in the cap redesign in the second feasibility study for the MWDF. This has advantages for both the groundwater modeling of contaminant transport and for reducing potential surface water and saturation effects on the sideslope cover soils.

337 The effect of water in the sideslopes would only cause problems if the entire dike cross-section would become saturated. The dikes would be quite stable otherwise. A deepened vertical drain and horizontal drain segments at the dike base would eliminate the possibility for slope stability problems.

338 The geomembrane is one of several features that would be barriers to infiltration. Other features include the cover vegetation, cover soil, drain layer, and amended soil liner.

The effective duration of the geomembrane in a buried environment is unknown, especially where it is kept anaerobic and in contact with soil water, rather than leachate. It is

expected to be very long, as there are no soil organisms known to affect it. The technical literature expresses more concern with geomembranes seaming and covering operations than in longevity.

339 The Department has not made the assumption that all of the geomembranes used in the final reclamation caps would need to be replaced. Therefore, the cost calculations of total replacement are not warranted. It would be speculative to predict the magnitude, timing or cost of repair for such a failure. Refer to the FEIS section which identifies the various state funds and money sources available for future funding of problematic waste disposal sites.

Also refer to response #264, which addresses geomembrane longevity. There are few plastic materials which are known to be directly attacked by bacteria or other degradation micro-organisms. By comparison, wood (cellulose) is known to be decomposed by bacteria. However, wood and other cellulosic materials buried in anaerobic environments for 10,000 years or longer have suffered little decomposition.

340 EPA conducts a wide range of research through various contractors investigating both laboratory and field permeability questions. Field permeability tests are desirable, but none has been developed that the Department feels is suitable for field construction quality control.

The recommendation for a test area is a good idea, and we feel the preproduction ore pad and MRDF cell 1 would be good places for additional instrumentation and lysimeter use. Of all the field instrumentation for permeability calculations of which we are aware, only basin lysimeters exhibit the simplicity and reliability which field conditions require.

The desired soil liner permeability is 1×10^{-7} cm/sec (1.6×10^{-9} feet/sec) or lower. Exxon would have to conduct additional laboratory and field tests necessary to demonstrate that these permeabilities can be achieved.

341 The leaching and oxidation potential of rock used as riprap in the tailings ponds and relcaim ponds is not expected to be a problem. The potential for acidic leachate generation from waste rock would be reduced because the surface area of the rocks would be relatively small and the pyrite content of the rock would be much lower than the massive ore. Nonpyritic waste rock or rock scavanged from site construction also could be used in place of waste rock extracted directly from the mine. Oxidation would be primarily limited to rocks that were not submerged by tailings or water. The volume of leachate from the waste rock would be extremely small compared to the volume of water in the decant pool or reclaim ponds. Exxon could utilize pyritic waste rock as mine backfill in any case.

342 Exxon would only use waste rock in confined disposal facilities. All of the facilities would be lined and the water would be treated in the water treatment system.

343 The bentonite-amended soil liner of the preproduction ore storage pad would have a protective soil cover. Any precipitation or leachate would be collected in drainage basin #3. This water would be treated as indicated in the DEIS. Pyrite oxidation of the stockpiled ore would produce acidic runoff, but the liner permeability should be protected by the soil cover as well as the removal of leachate.

344 Impacts of the backfilled orebody on the overlying aquifer water quality were evaluated on DEIS page 111. The coarse tailings to be used for backfilling have been evaluated by leach tests in a manner similar to waste rock and fine tailings. As the mine filled with water after closure, a stratified system should develop. Dissolved contaminants would be most common in the deepest portions of the mine. In contrast, the upper levels should have much lower concentrations since the greatest flows should occur in the upper levels of the mine.

Significant quantities of mine water should not seep into the overlying glacial aquifer following closure. The modeled exchange of groundwater between the abandoned mine and

the glacial aquifer should approximate pre-mining levels, which is very small (page 111 DEIS). See comment #32.

345 Refer to responses #363-365, which address the concerns raised by the Department of Health and Social Services.

346 Exxon would be responsible for mitigating mine-induced surface water impacts for as long as these impacts persist after mine closure. A discussion of closure period mitigation is included in the FEIS.

347 Section NR 140.03, Wis. Adm. Code, specifies that all facilities on a mine site are covered by Chapters NR 132 and NR 182. Also, see page 39 of the DEIS.

348 Applicable groundwater standards will be determined at the regulatory portion of the master hearing. If the groundwater standards established are the maximum contaminant limits, then state law provides that groundwater quality must meet those standards at the compliance boundary. State law does not provide for zero change in groundwater quality, only protection to a standard. Standards are set, however, to protect public health, safety, and welfare.

349 Available data indicates the inorganic form of arsenic is carcinogenic. Inorganic arsenic would be the predominant form in the wastewater and Swamp Creek. Arsenic in fish is primarily the organic form which has not been shown to be of toxicological concern for humans. Since Swamp Creek is not used as a public water supply, it is not appropriate to set effluent limits based on long-term human consumption of the water. Consequently, the limits that would apply to the Swamp Creek discharge are based on fish and aquatic life criteria (refer to DEIS Table 1-8).

350 See Response #347 and page 39 of the DEIS.

351 Section NR 132.09, Wis. Adm. Code, refers to permit issuance, reclamation bonding, and liability insurance. Closure and long-term care responsibilities are contained in sections NR 182 and 144.41, Stats.

352 The air curtain destructor is not part of the MRDF operation, but would contribute ash to it. The air curtain destructor would be required to have a separate solid waste license.

353 Exxon intends to build reclaim pond A early in the construction phase. The pond is needed for wastewater storage from initial site construction and also would have the capacity to store any water treatment sludges. The sludges could be removed at any time during project life if such actions were necessary.

354 The MRDF leachate is expected to be relatively weak compared to most industrial site leachates. We expect minimal effects on the amended soil liner.

355 This is a permit-related question and, therefore, was not addressed in the DEIS. Section 144.44(2)(nr), Wisconsin Statutes, exempts mining project landfills from the issues of need and site life requirements.

356 Refer to response #355. The MRDF is not subject to the negotiation/arbitration process due to its being part of a mining project.

357 None of the proposed solid waste disposal areas would impact a designated critical habitat. Therefore, no exemptions would be required.

358 No borings were performed specifically for the MRDF, as hydrogeologic and geologic control had already been established in the MWDF and groundwater modeling investigations. Backhoe pits to resolve remaining questions were considered acceptable.

359 The issue of test pit seepage will be addressed during the regulatory review and in greater detail in the plan of operation. This concern can be remedied with drainage controls and is not insurmountable. We expect this problem to be vastly reduced once the confining dikes around the waste disposal facilities have been constructed, as these would limit infiltration adjacent to the waste disposal areas.

360 Recycling of non-tailings wastes was discussed on DEIS pages 33 and 224. With the low population and minimal industrial facilities in Forest County, opportunities for recycling are very limited compared to the southern part of the state.

361 The MRDF and MWDF effects on groundwater would be distinguished by leachate quality and pumping records, lysimeters, groundwater monitoring wells, site construction documentation records and other monitoring techniques.

362 The MRDF (landfill) will be included in the reclamation plan required by section NR 132.08, Wisconsin Administrative Code.

363 Refer to response #375. In addition, Exxon is required to prepare a contingency plan to prevent or minimize human health or environmental damages in the event of an accidental emergency discharge. The detailed contingency plan is part of the plan of operation, which must be approved before construction of the proposed facility could begin. One part of the contingency plan is a spill prevention, control and counter-measure plan.

The FEIS contains a revised risk assessment of possible accidental health and environmental hazards potentially associated with mine operation. Contingency measures for each risk are identified.

Potentially contaminated water collected in sedimentation basins #2 (mine/mill) and #3 (preproduction ore storage pad) would be directed to the wastewater treatment plant prior to discharge.

364 The FEIS contains an expanded transportation impact analysis.

365 A fully equipped emergency medical vehicle would be stationed at the site. It would be staffed by project personnel and would be capable of transporting the injured to outside medical facilities. The DEIS contained information on existing health facilities and a projection of project impacts.

366 The description of the traffic forecasts has been clarified as to worst case.

367 The sentence on truck traffic has been omitted.

368 Comment acknowledged. The term congestion refers to the traffic situation which may occur at shift changes during summer months, when the local population is increased with summer residents and tourists. Congestion implies temporarily slowed or stopped traffic at intersections, stop lights or in urban areas because of factors such as over-capacity, filled parking areas, or numerous pedestrians.

369 During the operations period, the worst case projection of traffic impacts indicates at or above-capacity conditions for Highway 55 between the mine access road and Crandon and CTH S. These are projected to occur during shift changes during the summer, and would be temporary.

370 In the FEIS the discussion of vehicle accidents and accident rates has more specific projections.

371 Refer to response #370.

372 The Forest County Highway Department has deferred a significant amount of county highway maintenance and equipment replacement. Population influx to the county and new

service demands probably would require the county to upgrade its capabilities during the construction period. The cost estimates in the DEIS were for equipment maintenance/replacement and personnel.

373 Comments acknowledged. Changes made as indicated.

374 Refer to response #369, which addresses traffic impacts during operation.

375 Sections on the toxicology of the reagents used and transportation impacts have been included in the FEIS. Waste rock, tailings slurry, and concentrates are not "hazardous" according to U.S. EPA definitions, and therefore do not require special procedures. The impacts of heavy metals and suspected carcinogens in air emissions were evaluated on DEIS pages 155-157. Projected heavy metal deposition in soils surrounding the facility is extremely low, thus long-term monitoring of soils would not be warranted.

The administration of occupational health and safety laws is the responsibility of the Department of Industry, Labor, and Human Relations. Its substantial regulatory authority includes such health-related areas as mine ventilation; use of respirators for dust, fumes, vapors and gases; use of diesel-powered equipment underground; record of exposure to radioactive elements; industrial exhaust systems; and occupational noise exposure.

376 There was a description of the human services provided in the three county area on pages 88-92 of the DEIS. Pages 167, 168 and 174 provided analyses of increased costs to municipalities.

377 A copy of this letter also was submitted with comments from the Public Intervenor. Refer to responses #363-365.

378 Organization of the DEIS was determined, in part, by publication time and cost. Graphics require more time in the printing process than text, thus they were submitted prior to the text completion and could not be paginated with the text. Grouping color figures is more economical than placing them where they are first mentioned in the text.

379 The Department does not believe that each factual statement in the DEIS should be footnoted or otherwise attributed to its source. We have, however, added a list of key documents used in the FEIS. We are not trying to produce an EIS similar in style or content to the technical literature in scientific and professional journals because it is not aimed at a technical audience.

380 The risk assessment discussion has been revised to clarify that the "risk" being evaluated is the risk of significant environmental impacts due to the various occurrences. For example, while the probability of a minor reagent or fuel spill/leak taking place over the life of the project is high, the risk posed to the environment is low due to the design and handling features of the project.

The focus of the risk assessment is on events which could result in environmental impacts. Therefore, events such as worker injuries or other safety related occurrences are not considered even though considerable data exist regarding frequency of such accidents. Information from federal sources was used for evaluating the frequency of events such as project-initiated fires and accidental explosions since these occurrences pose a potential threat to the environment.

381 Monitoring data interpretation and levels at which some intervention or additional monitoring must take place would be specified in various permits.

382 There appears to be sufficient soil material to warrant recovery and stockpiling of topsoil for reclamation use. This conclusion was based on site transects, backhole borings, consultant reports, Exxon's computations, and SCS field staff reports. The soil science chief at the Rhinelander Land Conservation Office who helped map the project site

estimated that there is sufficient quality and quantity of material to warrant salvage of topsoil, and that rocks should not pose serious problems. Exxon's consultants (Foth and Van Dyke), obtained soils data from auger samples and projected a mean topsoil depth of 9.8 inches. Exxon states in their reclamation plan that the upper soils would be better for use in reclamation than the lower soils and therefore would be stripped and salvaged.

The presence of stones would not pose insurmountable problems for topsoil salvage and stockpiling. Larger fragments, rocks, and boulders could be used as rip-rap, slope stabilization or crushed for gravel. While certain areas may contain localized concentrations of rocks, few problems are anticipated regarding topsoil salvage and stockpiling. Soils with coarse fragments may have productivity equal to or greater than premining soils. Numerous studies have demonstrated the beneficial effects of stones in mine soils, especially regarding reforestation.

383 Under the worst case scenario and certain model assumption inputs, the sulfate concentration at the compliance boundary in some aquifer units could exceed the groundwater quality standard as explained on DEIS pages 111, 112 and 116-117. Most simulations, however, indicate the groundwater quality standard for sulfate would not exceed 250 ppm at the compliance boundary, and would be substantially less than that.

384 Comment acknowledged.

385 Comment acknowledged.

386 An explanation of areas potentially requiring special erosion control (DEIS Fig. 1-18) has been added to the text. These are areas on the reclaimed MWDF where rock rip-rap or engineered water control structures would be needed.

387 There will be no requirement for monitoring alkalinity in the wastewater discharge. However, alkalinity would be monitored in Swamp Creek as part of the surface water quality monitoring program as shown on DEIS Table 1-14. Total hardness is proposed to be monitored in both the discharge and in Swamp Creek.

388 There would be an approximately one year (or more) lapse between the granting of permits and start of construction, due to the need for Exxon to develop and receive approval of its plan of operation, develop construction contracts, etc. We anticipate no problems in the timely scheduling of mandatory, preconstruction environmental monitoring elements. It would be Exxon's responsibility to comply with preconstruction monitoring requirements in order to receive subsequent approvals.

389 Refer to response #388.

390 The word, "uniformly", has been deleted from the text. The point of the discussion is that the wells are located spatially to provide coverage in all directions from the MWDF and are finished in the hydrostratigraphic units of most concern.

391 It is believed that the proposed monitoring well configuration is reasonable in its extent of spatial and hydrogeologic orientation and coverage. The monitoring locations were selected to provide a network capable of detecting migration of contaminants away from the waste facilities. The wells have been located within the hydrostratigraphic units which would most readily transmit the contamination, and they are situated spatially so that the major flow directions during all phases of the project would be adequately intercepted.

392 Anomalies detected on the air photos would be followed with field investigations to determine cause as explained on DEIS page 41. Systematic direct observation (either by air or ground reconnaisance) to detect vegetation stresses does not seem warranted as an explicit monitoring element. A high level of direct, daily observations would be made by Exxon operations staff, as well as through Department staff oversight of operations.

It would be interesting to sample permanent vegetation plots to test predictions of subtle species changes in groundwater-influenced wetlands. However, since these changes are predicted to be hard to detect and of a temporary nature (for the duration of depressed groundwater levels), and because there is no standard or corrective action that can be taken by Exxon or the Department in applying the results of such sampling, long-term vegetation plot sampling would not be incorporated into the monitoring program. However, water level changes are scheduled to be monitored (DEIS Fig. 1-21).

393 Refer to response #388.

394 The air monitoring sites on DEIS Fig. 1-25 have been identified.

395 The details regarding sample collection and analytical procedures would be specified as part of the quality assurance/quality control document submitted to the Department for review and approval prior to implementation of the monitoring plan. In addition, many of the administrative codes specify the sampling and analytical procedures to be followed. Therefore, they are not described in the DEIS.

396 The discussion and impact analysis of the proposed surface water mitigation plan has been expanded in the FEIS to include the worst case scenario.

397 Mine stope production, crushing, and ore hoisting activities would be conducted at a rate of 7800 tons per day, while the concentrator would be sized at 7400 tons per day. Therefore, the concentrator would operate for more days per year compared to the other activities.

398 The correct figure is 165 million standard cubic feet (scf) of natural gas per year.

399 The reference to the Rhinelander-Ladysmith Greenstone belt has been deleted.

400 For the purposes of the EIS, it is believed that the use of the term "middle Precambrian" is preferable, as it is likely to be more widely recognized by those people only casually familiar with geology.

401 The correct time period for the Penokean orogeny has been incorporated into the discussion on the bottom of page 50.

402 The following reference, specific to the geology of the Crandon deposit, has been included in a bibliography in the EIS. May, Edward R., Schmidt, Paul G., 1982, The Discovery, Geology and Minerology of the Crandon Precambrian Massive Sulphide Deposit, Wisconsin: In R. W. Hutchinson (Ed.) Precambrian Sulfide Deposits, Special Paper 25, Geological Association of Canada.

403 The discussion in the DEIS is believed to be adequate. If readers desire a more detailed discussion of the orebody, the above mentioned reference provides extensive information.

404 The term "spike" is not a technical geologic term. It is simply a descriptor relating to the relatively narrow, deeply weathered zone of the orebody as depicted in DEIS Fig. 2-2.

The brief discussion of argillization has been revised. The statements regarding low permeability of the bedrock are based on results of bedrock permeability tests and examination of core samples.

405 The explanation of work performed by the Geological and Natural History Survey on asbestiform mineralization has been revised in the FEIS. Also see response #123.

406 Comment acknowledged. The discussion of radiological studies has been amended.

407 The level of discussion of the glacial sediment hydrogeology presented in the EIS is thought to be appropriate for general readership. Technical reports supporting Exxon's applications are available for the more technical reader.

408 The evidence for boundaries of the groundwater study area includes (1) measurement of groundwater potentials in vertical cross-sections across streams or adjacent to lakes and (2) mass balance relationships between expected groundwater discharge and measured stream flows. Professional judgment for a boundary such as Rolling Stone Lake indicated underflow was unlikely. Some small areas of boundary underflow occur in the region of St. John, Walsh, and Mole Lakes. Underflow at these lakes is thought to be insignificant in extent or far removed from sources of hydrological stress such as mine dewatering.

409 This section has been redrafted to more clearly express the correct hydrogeological conditions.

410 DEIS Table 2-2 indicated the range of concentration for selenium is less than 0.001-0.001 and is correct as stated.

411 The table indicated in a general way that water containing large amounts of dissolved salts tends to be found in the deeper portions of the bedrock. It is thought this water may represent, in part, water derived from paleozoic sediments which once had overlain the present bedrock.

412 Correction made.

413 The referenced figure has been revised.

414 The intent was not to indicate all the factors which contribute to lake elevation fluctuations, but rather to identify beaver activity at the outlets of the three lakes. Beaver dams have had a marked impact on these lake levels.

415 Table 2-4 has been changed by adding the period of record for lake level fluctuations and the dates of high and low levels.

416 Comment acknowledged. Definitions of lake types have been added in the glossary.

417 There is a potential for impact on the small, scattered stands of wild rice in Swamp Creek below the mine discharge point (especially in the 200-300 foot mixing zone) due to the sulfate levels that are predicted (DEIS Table 3-21). A discussion of this impact is included in the FEIS.

418 We believe the historical, economic and sociocultural information on Native Americans in Chapter 2 is appropriate. It gives the reader an overall perspective of the Native Americans' present situation. The reader needs this information to understand the project impacts to Native Americans described in Chapter 3.

419 Refer to response #379.

420 The range of dispersivity values utilized in the modeling included those appropriate for the scale and type of aquifer materials found at the MWDF site. An extreme set of values using a very low longitudinal dispersivity coupled with a very high longitudinal to transverse dispersivity ratio was not included in the modeling because model stability problems would have resulted. The high permeability of the glacial materials and the large flow distances modeled make such a set of values unlikely.

There is no reason for the dispersivity ratios to be the same for figures 3-6, 3-7, 3-10, and 3-11.

421 Comment acknowledged. Reduction in normal root zone oxygen-deficits would likely contribute to increased growth rates among many wetland tree species, assuming lower water table levels do not cause drought stress.

422 For higher level trophic organisms other than humans or fish (i.e., eagles or osprey), scientific data on the bioconcentration of heavy metals do not exist.

423 Comment acknowledged. The location of the proposed natural gas pipeline adjacent to an existing road and the need to maintain the right-of-way in an open condition prescribe management limitations.

424 The list of natural phenomena has been expanded to include extreme wind conditions such as downbursts.

425 Under section 144.83(2), Wisconsin Statutes, and Administrative Codes sections NR 182.11 and 132.07, the minimum standards for metallic mineral mines include backfilling.

426 DNR has not been granted authority by the legislature to regulate noise sources. Local governments typically regulate noise through nuisance ordinances. Noise impacts were analyzed in the DEIS as required by the Wisconsin Environmental Policy Act (s. 1.11, Wisconsin Statutes).

427 DEIS Table 3-25 showed that noise from construction and operations of the mine generally would not be audible at Lake Metonga or Lake Lucerne. However, certain atmospheric conditions could prevail that would at times allow mine noise to be audible at those locations.

428 A noise abatement plan recently received from Exxon is included in the FEIS.

429 Dust during construction activities would come mainly from earth moving and grading the mine/mill site, reclaim ponds, tailings pond T1, excavation, blasting, and vehicle traffic on unpaved roads. Diesel engines would be a source of exhaust particulates, but no emissions of heavy metals in dust would be expected until ore crushing, handling, and tailings disposal would begin in project year three. During operations, predicted levels of heavy metals in dust particles are well below health-related standards.

430 Proposed and alternative methods for controlling dust emissions from the MWDF were discussed on DEIS pages 27, 30 and 230. The proposed methods of dust control are specified in a separate report supplemental to the MWDF Feasibility Report. The air permit, mining permit, and feasibility report approval would specify the approved dust control measures as well as guidelines as to when the measures must be implemented. The proposed air monitoring program would provide the necessary spatial coverage to assess the generation and deposition of dust from the MWDF.

Based on noise projections, the Department does not believe that noise monitoring is warranted. The Department has no authority to regulate noise pollution. The company has indicated in its noise abatement plan that it would employ certain practices to minimize noise impacts.

DEIS pages 39-41 explained the monitoring proposed for the five facilities (MWDF, MRDF, reclaim ponds, mine, and mine/mill surface facilities) for compliance with groundwater standards. Conceptualized responses which could be taken if monitoring detected significant changes in groundwater quality around the MWDF were explained on DEIS pages 236 and 237.

431 Comment noted.

432 The net proceeds occupational tax on persons extracting metalliferous minerals was developed to assure that money would be available to municipalities for costs associated with social, educational, environmental and economic impacts of metalliferous mineral mining (s. 70.37(1) Wisconsin Statutes). One way to mitigate increased Township expenditures caused by mining-related activities would be for the Township to submit documented expenditures to the Mining Investment and Local Impact Fund Board. Reimbursement would depend on mining-relatedness, fund availability, and other criteria established by the Board.

The impact analysis of the tax implications to the Township of Lincoln has been revised for the FEIS. The tax study cited for the Township did not include the $100,000 (indexed) annual construction period payment from the Mining Impact Fund.

433 Correction made.

434 "Uncertainties in local zoning and land use regulations" refers to the inability to predict whether or not communities would adopt zoning ordinances, how zoning ordinances would restrict certain types of development, such as subdivision or mobile home parks, and the strength of local zoning ordinances when faced with variance requests. Uncertainties also reflect the inability to predict what decisions would be made by future town boards whose composition has not yet been determined.

435 Because the City of Antigo is the most highly developed retail and commercial center in the study area with available land for commercial development, it is expected that more business (and therefore more secondary workers) would locate there. Conversely, because the project site is more accessible to developed residential areas in Oneida and Forest Counties, it is expected that more project workers would locate there.

436 The DEIS and the Final Socioeconomic Impact Analysis incorporated an analysis of housing need which used as a basis Research and Planning Consultants' (RPC) Forecast of Future Conditions report and accompanying technical reports. It was concluded that the overall demand for housing projected in the report was excessive, and the total demand was correspondingly reduced. The lower projection of housing demand has been confirmed by numerous comments during the DEIS review process. However, the DEIS did not include a replacement housing analysis of the scope and detail of that performed by RPC, and therefore, no specific mix of housing types was generated for the DEIS projection.

437 The distinction between these two capital facilities is that the existing Forest County jail facilities could suffice under the baseline scenario, while the Elcho sewage facilities could not.

438 The results of a worst case traffic analysis by DOT indicate Highway 55 between the mine site and Crandon could be over-capacity during the third year of construction and during operation. The over-capacity would occur at peak traffic periods (shift changes) during the summer months, when tourist traffic increases.

439 If CTH S were to be rebuilt, the cost would be borne by Forest County. It is unlikely that CTH S would be incorporated into the state highway system, because the county would then have maintenance responsibilities for what is now STH 55 from CTH S into Crandon.

440 Traffic projections indicate the highest traffic levels would occur during shift changes. At these times there may be temporary lines of traffic at intersections in the vicinity of the mine. The traffic projections were from a worst case analysis. The traffic problems would be primarily a temporary inconvenience, thus no mitigation may be required. If mitigation would be desirable, it would be most appropriately done by local officials, who would be most qualified to evaluate this problem, if it develops, in relation to other local mitigation needs.

441 The Forest County needs include about $1 million in additional equipment and $300,000 for additional personnel during the construction period. The needs for Oneida and Langlade Counties have not been ignored. DEIS Tables 3-41 and 3-42 included projected costs for roads.

442 See the response to #440.

443 Alternative means of sludge disposal were discussed on DEIS pages 221-222. It appears there would be no overriding problems with sludge disposal, and that contractual arrangements with a licensed hauler could be made.

444 When and if Exxon decides to begin construction, it would have to decide what to do with the refuse generated before the on-site refuse facility is ready. The landfill would be one of the first facilities built, and the first cell would be ready within a few months after the start of construction. Prior to that, Exxon would have to contract with a licensed hauler to dispose of its refuse in a landfill which would accept their type and volume of refuse. Some landfills only accept waste from their residents; however, that would be open to negotiation. If that would be foreseen as a problem, Exxon could choose to construct the landfill earlier, before substantial refuse generation by construction activities. Another option, although seldom used, would be for Exxon to store wastes (with Department approval) on-site until the landfill facility was available.

445 Native American populations on the reservation are treated separately based on their unique legal and institutional status. No predictions were made of the potential number of job seekers who would come to the Crandon area, be unable to receive jobs, but remain in the area and require public support. This would depend on local and national unemployment rates, other simultaneous hiring projects, and Exxon's contractor hiring policies. It is believed this would be a relatively isolated occurrence. It is more likely that unsuccessful job seekers would remain in the vicinity only a short time before leaving.

446 Native Americans historically have collected and used many native plants for food, fiber, medicinal, or religious purposes. Whether they now use bur oak parts, and with what frequency, has not been confirmed by any of the DEIS comment letters. The Sokaogon Chippewa may be able to gain access to the area by requesting permission. Exxon has permitted some hunting use, for example, on their property, and we are not aware that Exxon has refused reasonable requests. There also are reports of alternative collection sites for bur oak on the southwest shore of Little Sand Lake.

447 The FEIS presents an impact analysis of project closure after the zinc-rich ore has been mined. In addition to the proposed, the worst case, and early closure scenarios, there exists a range of alternative futures with an accompanying range of associated economic effects. To conduct further analyses from among this vast array of alternatives is beyond the scope of our impact analysis. Likewise, to substitute the judgment of DNR for that of Exxon in determining the most probable circumstances surrounding project development is not justifiable. Clearly, it is not reasonable to conclude that Exxon would proceed with project development without a strong belief in profitability. However, there are circumstances which are beyond the control of either Exxon, the State of Wisconsin, or local study area communities which may compel closure or suspension of the project at some point after construction commences.

448 No attempt was made to quantify the effects of the project on local property values because specific influences on value depend on the unique mix of factors that would exist at the time of mine development. Included among these factors are: the number and proximity of housing vacancies; desirability of converting seasonal dwellings to permanent ones; local zoning ordinances or absence of them, which would affect subdivision or mobile home

park locations; location in relation to major thoroughfares; proximity to the project; expectations and judgments of residents as to the desirability of living near the project; potential for retail development, and others. It is anticipated that in the short term, land values would probably increase during the initial stages of the project and would decline during the final stages of the project, all things being equal. However, to be more specific on temporary land value fluctuations would be speculative.

449 Disposal of sanitary wastes from recreational vehicles used during project construction is unlikely to be a problem. Most such vehicles would probably locate near the project area, and arrangements would have to be made between private haulers and the City of Crandon municipal waste treatment plant or other regional facility. Elcho's ability to accommodate additional sanitary wastes is limited, although Crandon's facility is substantially under capacity (DEIS Table 2-39).

450 Although project related population and traffic increases might attract additional recreational and tourism-based activity in the study area, the additional congestion and altered economic and environmental character of the area could discourage some recreational and tourist activity. Although we believe there would be no significant overall impact to tourism in the area, additional rationale is presented in the FEIS.

451 The discussion of public services and facilities costs is revised in the FEIS.

452 According to the Forest County Sheriff, the current jail (which was built in 1909) is only marginally adequate to serve the county's needs for the next few years, assuming no significant population increase in the county. Forest County has cooperative agreements with its two neighboring counties: Oneida County accepts Forest County's juvenile offenders (at a cost of $50 per day each), and Florence County, which has no jail, refers its adult offenders to Forest County. The effect of housing Florence County inmates is not considered directly under either scenario, since it is assumed the fees paid by Florence County exactly offset the cost of providing the service.

Under the without-project scenario, the costs of referring juvenile offenders to Oneida County are included in the current cost standards. Under the with-project scenario, a new jail (including both adult and juvenile facilities) would be required, together with associated staffing and other costs. These needs are in addition to the public facilities and service cost projections cited for Forest County.

453 The turnover of labor pool and wage inflation (discussed on DEIS page 181) are effects common to areas which experience sudden diversification and growth of the type anticipated if the project were implemented. While the effects of job changes can be disruptive to the affected employers and employees, it is not considered a significant impact.

Similarly, the effects of wage inflation due to the project are expected to be minimal, given the small relative employment share represented by the project in the local study area. Also, wage inflation is a relatively short-term phenomenon, and has offsetting positive effects, i.e., a higher income to employees. Together, these two effects are not projected to be significant impacts of the project.

454 Comment acknowledged.

455 The capacity figure for the Elcho School District was determined prior to the elimination of three elementary school classrooms. Current capacity is 525.

456 Comment noted.

457 Correction made.

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458 Correction made.

459 DEIS Table 2-18, Emissions of Existing Point Sources of Air Pollution, has been updated to include the most recent data. Data on Rhinelander Paper and Daniels Packaging have been included.

460 The study area was selected through a process described on DEIS pages 79 and 80. As noted there, it is quite possible that other areas would experience impacts, but the most significant impacts are projected to occur in those jurisdictions identified. We believe the Townships of Rolling, Polar, and Norwood are too remote from the project given their present amenities, to sustain significant project-related population impacts.

461 These data were obtained from Exxon's consultant's Report on Current Conditions, which cites as its sources the U.S. Department of Commerce, Bureau of the Census, 1977 Census of Retail Trade-Wisconsin.

462 Comment acknowledged.

463 The typographical error was corrected.

464 Correction made.

465 Correction made.

466 Correction made.

467 Comment noted.

468 The assumption was made that the City of Antigo would have continuous accessibility to a landfill; if not the existing one, an expanded or new facility.

469 Correction made.

470 At this time, the Soo Line segment which would serve the proposed mine is not proposed for abandonment. If abandonment was being considered, the Soo Line would have to follow procedures established by the Interstate Commerce Commission. The procedures applicable to this segment would last at least six months and would require public input to determine the effects of abandonment on local users.

Concentrate transportation alternatives were discussed on DEIS pages 231 and 232. Although the ultimate destinations for the concentrates would not be known until contracts have been signed some time after construction begins, rail transportation would be most economical for the shipper and have fewest overall impacts. Formulation of alternative transportation routes depends on which Soo Line segments might be abandoned. A major rail line to the west is the Chicago, Milwaukee, St. Paul and Pacific which intersects the Soo Line north of Tomahawk. A short line, operated by Exxon or another party, could connect the mine site with the main rail lines. The Soo Line may keep the route open in anticipation of the mine/mill being built.

471 Correction made.

472 Correction made.

473 The primary concerns raised on these pages are the impacts of the groundwater drawdown combined with the worst case mitigation impacts and impacts to water wells from MWDF leakage. At the time of DEIS release in May 1986, the Department had not received the final surface water mitigation plan, and therefore, could not complete a worst case impact analysis. For the FEIS, the impact analysis has been revised and expanded. The Department does not predict significant impacts to water wells from MWDF leakage.

474 The Department does not predict measurable impacts to nearby water wells from the proposed mitigation pumping at Martin Springs, Upper Pickerel Creek, or Creek 12-9.

475 DEIS Figures 1-20 and 1-21 indicated the proposed surface water and groundwater monitoring sites that would be required by the permitting process. Several of the sites are within Ainsworth Township.

476 DEIS Fig. 1-26 showed a mitigation pipeline to Martin Springs from a proposed well. DEIS Table 3-23 indicated about 3 acres of forested wetlands would be disturbed by mitigation corridors for pipelines and powerlines, and the discussion on DEIS page 145 indicated a total of 17 acres for mitigation corridors would be disturbed. The Martin Springs powerlines and pipeline corridors would have no appreciable impact on deer wintering in the area.

477 Construction of the well and installation of the buried power line, and discharge pipeline to Martin Springs could cause disturbance to the nearby eagles during nesting activity. Therefore, construction would not be scheduled during the nesting season. Subsequent operation of the facility is not believed to be a disturbance to future eagle nesting activity.

478 The standards that apply to the Swamp Creek discharge were established to protect all aquatic life in that stream. In some cases, zooplankton species are not the most sensitive organisms in terms of impacts from toxic pollutants. In situations where fish or macroinvertebrates are more sensitive than zooplankton species, the standards would be set to protect those organisms. In still other cases (e.g., mercury), more stringent limits were applied to protect human health.

479 See responses #349 and 496.

Certain background levels for heavy metals already exist in Swamp Creek and the Wolf River (DEIS Table 3-21). The quality of the existing stream water cannot be considered pure (i.e., like distilled water or uncontaminated rain water). Furthermore, the Department has conducted a stream classification of Swamp Creek based on its habitat characteristics. As a result of the stream classification, Swamp Creek has been confirmed to support a variety of aquatic organisms, as well as recreational uses. Water quality criteria were established to protect recreational uses and aquatic organisms, which includes the entire food chain.

Since all contaminants in the effluent would not be removed from the wastewater, zero discharge of pollutants would not occur. Some measurable increases in heavy metals would occur in Swamp Creek below the discharge as a result of the addition of Exxon's effluent. Adverse impacts to the aquatic biota in Swamp Creek are not expected to result because of the extremely small increases in heavy metals concentrations. Very little or no measurable changes in concentrations would be expected to occur to the Wolf River (refer to table 3-21).

480 An analysis of impacts to tourism has been included in the FEIS.

481 DEIS Table 2-36 has been changed to reflect the different Elcho K-12 school capacity of 525 students. Annual projections of with-project and without-project enrollment by school district were presented on DEIS Table 3-47. During the final year of project construction, enrollment in the Elcho district is projected to increased by 52 students, and during the operations period, by about 38 students. While the projections are subject to uncertainty, they do indicate that the Elcho School, with its reduced capacity, would remain slightly under capacity if the project were implemented.

482 Comment acknowledged. The FEIS contains an expanded analysis of transportation impacts.

483 Subsequent responses address more specific concerns regarding impacts to Ground Hemlock Lake.

484 The Department does not have the authority to condition permits to compensate local property owners for mining-related damages. However, there is a mining-related damage fund (section 107.30-50, Wisconsin Statutes) administered by the Department of Industry, Labor and Human Relations as explained on DEIS page 239.

485 Developed areas shown on DEIS Fig. 2-9, were interpreted from aerial photographs of the study area. Apparently the south shore of Ground Hemlock Lake has a relatively intact tree cover. This area is indicated as developed in the FEIS.

486 The lakes addressed in greater detail in the DEIS are the lakes which are projected to be most impacted by the proposed project. Ground Hemlock Lake is not projected to be impacted significantly by the predicted groundwater drawdown, as indicated on DEIS Table 3-10. Compare the impacts to seepage lakes, shown in DEIS Table 3-6 with the projected impacts to Ground Hemlock Lake (DEIS Table 3-10).

The state law which would prevent the Department from issuing the required permit, if there would be an unreasonable detriment to public rights in those waters, is based on severity of impacts, not whether the lakeshore is developed or inhabited.

487 The two Native American tribes are treated in greater detail for three reasons: 1) They are independent and with sovereign status; 2) Exxon's socioeconomic consultant was not granted permission to work with the tribes, and gathered only secondary data. The tribes both cooperated with DNR's consultant, allowing more useful data to be gathered; and 3) The tribes have an economic and social fragility compared with the dominant white culture, predisposing them to be more vulnerable to project impacts.

488 DEIS Figures 3-13 and 3-14 indicated areas of equal air quality impact extend to the east due to the more frequent westerly winds. Refer to the air quality impact analysis, which predicts air impacts to be minimal.

489 Comment acknowledged.

490 The Department does not predict any groundwater quality changes in the wells around Ground Hemlock Lake or in the lake's water quality. Groundwater flows radially from the MWDF area, although primarily northeastward, and some flows southwestward. Seepage from the MWDF eventually would enter the groundwater and follow the same pattern. To the northeast, it would enter Hemlock Creek and be further diluted. There is no known underflow beneath Hemlock Creek, thus contaminants from MWDF seepage are not predicted to reach Ground Hemlock Lake.

491 No mitigation for Ground Hemlock Lake is proposed because there are no measurable impacts to Ground Hemlock Lake predicted.

492 Exxon's proposal to the Department indicates no use of the lands east and south of Ground Hemlock Lake for mining-related purposes. Therefore, there is no discussion of impacts to those lands.

493 The impacts predicted to occur to drainage lakes (DEIS Table 3-10) would not result in measurable changes to lake water levels or water quality. Therefore, further discussion of impacts is not warranted.

If impacts to Ground Hemlock Lake, or any other surface water body, from mining activities would be greater than expected and harm public rights of those waters, the Department would require the operator to mitigate these negative impacts. It is the state's responsibility to protect public waters. Also refer to the mine-related damage fund explained on DEIS page 239.

494 Alternative MWDF sites and impact analyses were presented on DEIS pages 196-198. Dust impacts are not projected to be significant, and all air impacts are projected to be below state and national air quality standards. Noise impacts are not regulated by the Department because the legislature has not given it that authority.

495 This comment is based on assumptions of environmental damage to Ground Hemlock Lake. The analyses in the DEIS indicate no predicted impacts to lake levels, no impacts to the lake water quality, minimal air quality impacts, and some noise impacts. While the Department has been granted authority by the legislature to regulate the first three areas of impact, the Department has no authority to regulate noise pollution.

496 Comment acknowledged. We did not include DEIS Table 3-24, Generalized Community Responses to Noise Increases, to try to minimize predicted noise impacts. Its purpose was to put the various levels of noise increases (measured in decibels) which would be experienced by local residents in a recognizable frame of reference based on the experiences of other communities.

497 The noise level impacts from the MWDF were taken into account during the construction of the first MWDF cell. Due to the nature of the noise data, it was not possible to determine the noise levels of subsequent construction activities during operations. However, the operation phase does take into account the noise level impacts from MWDF operation.

498 A noise abatement plan proposed by Exxon has been included in the FEIS.

499 DEIS Tables 3-5 and 3-11 referred to predicted surface water impacts in the absence of a mitigation plan. Increased lake seepage, similar to what is predicted to occur to Little Sand, Duck, Skunk, and Deep Hole Lakes, would not impact Rolling Stone Lake. The total reduction in groundwater flow to Rolling Stone Lake, exclusive of the tributaries, is estimated to be about 26 gallons per minute. In contrast, during a year of average precipitation, the amount of water falling directly onto an area the size of Rolling Stone Lake would average more than 1,000 gallons per minute. In terms of that lake's water budget, 26 gallons per minute is an insignificant amount, and resultant impacts would be negligible.

The impact analysis of the proposed mitigation plan has been expanded in the FEIS to include the worst case conditions.

500 The impacts of Exxon's revised surface water mitigation plan are included in the FEIS.

The Department does not have the authority or capability to guarantee that Rolling Stone Lake would not be impaired in any way as this comment requests. However, the Department does have the responsibility and authority to protect unreasonable detriment to public rights in surface waters.

501 Exxon has proposed to aerate groundwater which would be used to mitigate surface waters. An aeration device at the discharge structure would allow mixing with air, and monitoring dissolved oxygen levels would be required.

502 One of the advantages of constructing the MWDF in four separate cells is that performance of the first cell could be monitored and evaluated. If necessary, subsequent cells could incorporate design changes. Another way that would be used to evaluate liner performance would be monitoring the nature and amount of leachate collected by the underdrain system. This would be carefully evaluated. In addition to groundwater quality monitoring wells near each tailings pond, collection basin lysimeters would be placed beneath each pond to monitor seepage moving downwards toward the groundwater.

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503 Recourse for private well service affected by mining is explained in section 144.855(4), Wisconsin Statutes. The burden of conducting an investigation and deciding who is responsible is placed on the Department of Natural Resources, not the landowner.

504 Comment acknowledged. Some of the increased costs to the Elcho School District would be paid by any new residential and industrial development within the district, although there would be a lag between when the money would be needed and when it would be available. The remaining increased costs would be borne by school district residents. The statutes identify school district costs resulting from a mining project as reimbursable from the Mining Impact Fund. It is possible that increased school district costs would be offset by state aids. However, that depends on the equalized valuation in the district (Elcho formerly was a zero-aid district) and the number of students.

505 Comment acknowledged. Refer to DEIS Table 3-25, which contained predictions of construction and operations noise. Location #8 is located on the north end of Rolling Stone Lake.

The source of seismic vibrations referred to on DEIS page 74 is from earthquakes.

506 Comment acknowledged.

507 The correct surface water area of Rolling Stone Lake is 672 acres.

508 Average water budgets for the modeled lakes were developed using average rainfall figures and a groundwater recharge rate of 8.5 inches annually. Average figures, which encompass both dry and wet ranges for rainfall and high and low annual recharge, are the most appropriate figures to use to create mathematical models. The models are then used to simulate the impacts of very low precipitation.

509 Comment acknowledged.

510 Forecasting impacts to surface waters resulting from a predicted change in groundwater levels (which in turn is dependent on mine inflow rates) relies upon a number of assumptions. The assumptions are made from field and laboratory tests from a limited number of samples which become the basis for understanding the hydrologic regime in the area in question. Predictions of hydrologic conditions also are based on past weather records. Analyzing the assumptions with mathematical models is one of the best means for predicting hydrologic impacts. The results of these models, however, are not completely certain. By examining a range of expected case and worst case scenarios, the amount of uncertainty inherent in such predictions can be reduced.

511 All costs of preparing and publishing the environmental impact statement are paid by Exxon to the state general fund according to state law. In addition, costs incurred in processing the mining permit are reimbursed to the Department.

512 The Department has no authority to require Exxon to post a performance bond or insurance guarantee for the four purposes stated. Exxon would, however, be required to post financial instruments adequate to insure proper closure, reclamation and long-term care.

513 The legislature defined mining-related purposes [s. 70.375(1)(bm), Wisconsin Statutes] in 1985. Municipalities outside of the socioeconomic study area may have mining-related costs. None of these costs are predicted to be significant, however.

Whether the Mining Investment and Local Impact Fund Board (MIB) would reimburse local municipalities for mining-related costs would depend on MIB policy, availability of funds,

whether the legislature lends additional funds to the MIB, and other factors. What can be said is that the MIB is explicitly delegated the authority to mitigate mining-related costs to municipalities and presumably would do that to the best of its ability.

514 Additional information on the nature of the chemicals shipped to the mine/mill, stored, and used there is provided in the FEIS. Emergency response procedures in the event of a release also are identified.

515 Because some of the schools in the Rhinelander School District are well below capacity while others are near capacity, it is projected that certain shifting of enrollment would occur, both within individual schools and between schools. DEIS Table 3-47 contained projections of public school increases for each district.

516 Comment acknowledged.

517 It would be Forest County's financial responsibility for maintenance and upgrading county trunk highways in the region of the mine. To the extent the changes would be mine-related, the county could be reimbursed by the MIB.

518 See response #522.

519 An impact analysis of the proposed project on the tourism industry is included in the FEIS.

520 See response #444.

521 The impacts of a temporary mine shutdown were briefly discussed on DEIS page 240. The discussion is expanded in the FEIS in general terms. Shutdown impacts are dependent on the number of employees laid off, shutdown duration, other economic factors, mitigation funding available to the Mining Impact Board, and Exxon initiatives aimed at impact reduction.

522 The Township of Schoepke, which includes the Pelican Lake area, was not included in the socioeconomic study area (DEIS Fig. 2-13) as explained on DEIS pages 79 and 80. While relatively close to the proposed project, the township is not expected to receive significant impacts. Certainly there could be some impacts, such as limited residential development, temporary increases in traffic following shift changes, increased home sales and filling of vacancies, economic changes resulting from Elcho School District costs, and possible conversion of cottages for permanent occupancy. These types of impacts however, cannot be accurately forecast. But the township does not have major shopping areas, major highways which would be used by project traffic, taxing authority over the project or amenities like the Crandon, Antigo, and Rhinelander areas possess. Thus, overall socioeconomic impacts to the Township of Schoepke are anticipated to be small. In addition, the Township could choose to enact a zoning ordinance to either encourage or discourage inmigration and settlement patterns.

523 Corrections have been made.

524 The DEIS included an analysis of impacts to the Elcho School District. While the Township of Elcho is the only township from that district within the local study area, the impacts are applicable to all municipalities within the Elcho school district.

525 The air quality impact analysis on DEIS pages 154-157 predicted very minor changes to ambient conditions. The analysis showed that dust impacts would become insignificant beyond two or three miles from the site boundary. Dust from the mine/mill operations would not be toxic. Tailings dust from operations would contain extremely small amounts

of several heavy metals. The predicted amount of annual heavy metal deposition from tailings dust is substantially less than the amount which naturally occurs from all sources in the area.

No toxic wastes would be moved by construction vehicles.

526 There are no impacts predicted for water wells around Ground Hemlock Lake because the groundwater drawdown would not extend to the area. As indicated on DEIS Fig. 1-19, Ground Hemlock Lake lies within zones 2 and 3, in which there would be representative water wells sampled for baseline quality.

527 Compliance boundaries are lines drawn around the MWDF, landfill, mine, reclaim ponds, and mine/mill surface facilities. Groundwater quality at the compliance boundaries must meet the established groundwater quality standards. Between each facility listed above and the compliance boundary, groundwater monitoring would be conducted to detect any changes in groundwater quality. If groundwater changes would occur, and it would appear that standards could be violated at a compliance boundary, then intervention would be required to correct the problem. The measures available for intervention have been established in the contingency plans for such occurrences.

During operations and following closure and reclamation of the MWDF, some seepage from the MWDF into the groundwater would occur. Groundwater levels are predicted to return nearly to pre-mining conditions within several years. Over the long-term (hundred to thousands of years), contaminants (chiefly sulfate) are predicted to disperse away from the MWDF and beyond the compliance boundary. Most computer modeling simulations indicate the concentration of sulfate and other contaminants would be below standards, which are established to protect public health, safety, and welfare. Refer to response #173.

528 In accordance with the statutes and codes, the plan of operation would be prepared by Exxon and submitted to DNR for approval following the master hearing. Development of the plan of operation must take into consideration the specific conditions related to the feasibility report approval issued subsequent to the master hearing. The plan of operation must be approved by DNR before Exxon could begin construction.

529 The groundwater drawdown is predicted to extend eastward nearly to Hemlock Creek (DEIS Fig. 3-3), about 0.5 mile west of Ground Hemlock Lake. Therefore, no significant impacts would occur to the lake, and no mitigation planning is required. Also see the responses to comments 536, 539 and 540.

530 The FEIS contains an expanded discussion of impacts to tourism. No significant impacts to the tourist industry are expected to occur if the project were implemented.

COORDINATION, SCOPING AND PUBLIC INVOLVEMENT

Following Exxon's July 1978 submittal of a Notice of Intent to collect data, the DNR took steps to bring other agencies, local governments, and the public into the environmental review process. Early efforts included establishing an Interagency Technical Work Group consisting of numerous state agency representatives in the spring of 1978. Additionally, two public informational meetings were held in November, 1978. The meetings were held in Crandon and Rhinelander to receive public comment on the perceived environmental concerns associated with the project, information needed by the DNR to evaluate the anticipted environmental impacts, and information on verification procedures. Since then, more than fifty meetings have been held by the Department in the area to discuss the project proposal and its impacts.

The DNR's most important interagency coordination, public participation and scoping initiatives to date include:

1. Distributing Exxon's Environmental Impact Report, permit applications, and supporting documents to state and federal agencies for review.

2. Asking state and federal agencies to determine their Wisconsin Environmental Policy Act (WEPA) and National Environmental Protection Act (NEPA) responsibilities relating to the proposed project and to work with the DNR to avoid duplication of effort. As a result, the DNR and PSC are joint lead agencies and DATCP, DOT, and DILHR are contributing to this EIS as cooperating agencies.

3. Providing status reports on the DNR's review of the project to the involved agencies.

4. Seeking public review of the EIR and establishing a respository system of 14 libraries across the state where the EIR, permit applications, related reports and significant correspondence are available. Using public and agency comments in DNR's review letters for Exxon's response.

5. Compiling a project mailing list of several hundred interested and affected citizens. Individuals on the list periodically received project status report, or were notified of important project developments.

6. Conducting numerous open houses and small group meetings in the project area with government officials, mining impact committees, Native Americans, interest groups, and the media.

7. Distributing the EIS to state, federal, and local units of government agencies and public for review. During the review period, a meeting was held on June 20 and 21, 1986, to receive comments on the DEIS. A public meeting will be held after release of the FEIS.

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Warzyn Engineering, Inc., Madison, vibrations;
Wisconsin Geological & Natural History Survey, Madison, groundwater modeling;
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Graphics and cover design by Robert Lehrman.

EIS DISTRIBUTION

1. Federal Agencies

Environmental Protection Agency - Region V
Army Corps of Engineers
Department of Agriculture
- Soil Conservation Service
- Forest Service
Department of Interior
- Fish and Wildlife Service
- Geological Survey
Council on Environmental Quality
Advisory Council on Historic Preservation
Bureau of Mines
Bureau of Indian Affairs
U.S. Federal Energy Regulatory Commission

2. State Agencies

Department of Administration
Department of Agriculture, Trade and Consumer Protection
Department of Development
Department of Health and Social Services
Department of Industry, Labor and Human Relations
Department of Justice - Attorney General
Department of Justice - Public Intervenor
Department of Public Instruction
Department of Revenue
Department of Transportation
Geological and Natural History Survey
State Historical Society
U.W. Facilities Planning

3. Local and Regional Agencies and Units of Government

East Central Regional Planning Commission
North Central Regional Planning Commission
City of Antigo
City of Crandon
City of Rhinelander
Forest County and the towns of Crandon, Lincoln and Nashville
Oneida County and the towns of Crescent, Pine Lake, Pelican and Newbold
Langlade County and the towns of Elcho and Ainsworth
County and Town Mining Impact Committees
North Central Mining Impact Planning Committee

4. Native American Communities

Forest County Potawatomi
Sokaogon Chippewa
Menominee Tribe
Stockbridge-Munsee Tribe

5. Libraries

Antigo Public Library
Vaughn Public Library (Ashland)
Crandon Public Library
Brown County Public Library (Green Bay)
City and County Library (Ladysmith)
Madison Public Library
Milwaukee Public Library
Platteville Public Library
Rhinelander Public Library
Charles M. White Public Library (Stevens Point)
Nicolet College Learning Resources Center (Rhinelander)
Marathon Public Library (Wausau)
L.E. Phillips Memorial Public Library (Eau Claire)

Other Libraries:
U.W. Engineering Library
U.W. Steenbock Library
Legal Reference Library (State Capitol)
U.W. Law Library
Reference & Loan Library (Madison)

6. Elected Officials

Governor Anthony Earl
Senator William Proxmire
Senator Robert Kasten
Representative David Obey
Representative Toby Roth
State Senator Lloyd Kincaid
State Representative James Holperin
State Representative Thomas Ourada
State Representative John Volk

ENVIRONMENTAL IMPACT STATEMENT
GLOSSARY

Aerobic - Chemical reactions that require either the presence of oxygen or the organisms that only can exist in the presence of oxygen. Particularly important for the oxidation or weathering of pyrite in the waste rock and tailings.

Alkaline - A measure of the buffering capacity of water, i.e., the capacity to neutralize an acid.

Anaerobic - The absence of oxygen in a water body or physical system. The lack of oxygen inhibits the metabolism of aerobic organisms or may reduce rates for chemical reactions.

Aquifer - An underground layer of porous rocks or sediments that is saturated with water and yields significant quantities of groundwater to wells and/or springs.

Attenuation - A decrease in the concentration of a pollutant in a fluid resulting from physical, chemical, and/or biological processes with the soil.

Backfill - Tailings, waste rock or glacial sand used to fill stopes created during the operation of the mine.

Background Conditions - Concentration of a parameter or pollutant naturally occurring in the environment. Also called ambient conditions.

Basalt - A dark gray to black, dense to fine-grained, igneous rock.

Berm - An elongated man-made earthen mound, usually built to break a long slope or channel runoff water to minimize erosion.

Bioassay - A test used to determine the toxicity of pollutants in wastewater on an aquatic organism.

Biochemical Oxygen Demand (BOD) - The amount of dissolved oxygen required to decompose organic matter in water or effluent. BOD_5 refers to oxygen needs in a 5 day period, the short-term period of decomposition for some wastes.

Breccia - A coarse grained rock composed of angular broken rock fragments held together by a mineral cement and originating by igneous processes.

Caving - A high capacity, low cost mining production in which the bottom of a block of ore is removed. As the ore above collapses into the opening it is removed.

Chlorite - A group of greenish, platey minerals. Chlorite is common in low grade metamorphic rocks.

Cone of Depression - A conically shaped area of dewatered sediments caused by groundwater drawdown.

Critical Flow Condition - ($Q_{7,10}$) The mean seven-day low flow occurring in a stream during a 10-year period. This is often abbreviated as $Q_{7,10}$ where 7=days and 10=years.

Dewatering (mine pumping) - The decline of the water table due to the pumping of water from the underground mine.

Dip - Angle of inclination of a rock surface from the horizontal.

Dispersion - A process which causes the spreading of a contaminant throughout a system.

Dissolved Oxygen (DO) - The amount of oxygen dissolved in water. Adequate dissolved oxygen is necessary to support a diverse aquatic community. Low dissolved oxygen concentrations generally are due to excessive organic residues; e.g., decaying vegetation in lakes or organic wastes in wastewater.

Drainage Lake - A lake with its level generally lower than the groundwater table and which has an outlet as the primary means of water loss. Stream flow provides the major water source to most drainage lakes. Rice and Rolling Stone Lakes are examples of drainage lakes in the environmental study area.

Drift (Mining) - A horizontal, underground tunnel or passage used to gain access to the orebody.

Drumlin - An elongated hill of glacial drift with the long axis of the hill parallel to the movement of the glacier.

Influent - A term for wastewater flowing into a treatment plant.

Effluent - A term for wastewater flowing from a treatment plant.

Effluent Limitation - Any restriction established by the state or the EPA on the quantities, rates, and concentrations of chemical, physical, biological, and other constituents discharged by a point source into surface waters.

Epilimnion - The upper generally well oxygenated circulating layer of water in a stratified lake.

Evapotranspiration - The combined loss of water from a given area by evaporation from land and water surfaces and transpiration from plants. Transpiration is the process by which water vapor is released by foliage during respiration and photosynthesis.

Fauna - A collective term referring to all the animals of a particular area or time.

Field Capacity - The amount of water held in tailings or soils after water in the larger pores is drained by gravity.

Footwall - The wall or rock on the underside of an inclined orebody.

Formation - The basic geologic unit in the description or organization of rock sequences in a given area. A formation is a body of rock thick enough to be mapped and contains features which distinguish it from adjacent rock units.

Gangue - That part of an ore that is not economically desirable.

Geomembrane - A manufactured or synthetic material with very low permeability.

Geotextile - A manufactured or synthetic material with a relatively loose weave. The material allows the passage of water but retards the movement of soil or tailings particles.

Glacial Drift - A general term applied to all soil and rock material (clay, silt, sand, gravel and boulders) transported by a glacier. In this report, drift is used to refer to sorted stratified layers such as outwash deposited by glacial meltwaters.

Ground Cover - Fast growing herbaceous plants grown to keep soil from eroding in areas disturbed by construction or other activities.

Groundwater - Water contained in saturated, porous rocks or sediments.

Groundwater Model - A series of mathematical equations used in a computer to analyze the physical and chemical processes influencing groundwater quality, quantity and/or flow patterns.

Groundwater Table - The fluctuating, upper surface of the zone where all the pore space within the rock layers or sediments are water filled.

Hanging Wall - The wall or rock on the upper side of an inclined orebody.

Hardness - The characteristic of water which is defined by measurements of salts of calcium, magnesium and iron such as bicarbonates, carbonates, sulfates, chlorides, and nitrates.

Hydrograph - A graph showing the variation in stream flow over a period of time.

Hydroxides - A compound of an element, such as a metal, with hydrogen and oxygen.

Hypolimnion - The lower, cold, noncirculating, generally oxygen depleted water layer in a stratified lake.

Infiltration - The movement of water into the pores of the soil or tailings from an outside source; e.g. precipitation.

Lacustrine Deposit - Fine grained mineral and organic sediments at the bottom of lakes, of both glacial and recent origin.

Leachate - A liquid, usually water, which has percolated through waste material and has become contaminated with dissolved and/or suspended substances.

Leaching - The selective removal of soluble constituents from ore or rock by slowly percolating water.

Liners - A layer or layers of low permeability materials such as native clay, bentonite-amended soil or a manufactured geomembrane (hypalon, PVC, or polyethylene) used to contain contaminated liquids.

Lysimeter - A device used to measure the quantity and/or quality of leachate seeping from a waste containment facility.

Massive Ore - An orebody containing greater than 50% sulfide minerals by volume. Massive ore in the Crandon deposit is the zinc-rich ore.

Milligrams Per Liter (mg/l) - A unit of concentration of a substance in water. For most parameters, this is equivalent to the unit of parts per million.

Mineral - A solid, naturally formed, inorganic element or compound with a definite chemical composition and an internal crystalline structure.

Mineral Soils - Soils comprised predominantly of minerals, and typically with less than 20% organic matter.

Mixing Zone - A region in a lake or stream in which a discharge of different characteristics than the receiving water is in transit and is progressively diluted from the source to the receiving system.

Monitoring Well - A well used to obtain water samples for water quality analysis and/or measurement of groundwater levels.

Moraine - A land form produced by an accumulation of unsorted, unstratified glacial till. The landforms may be relatively flat to irregular (ground moraine) or ridge-like (end moraine).

Morphometry - The physical shape and form of a water body.

Ore - A naturally occurring mineral deposit containing a valuable constituent which can be profitably mined or extracted.

Outwash - Glacial deposits consisting of stratified sands and gravels. These materials are deposited by meltwater streams at or beyond the margin of a glacier. These deposits have moderate to high permeability and often constitute the major aquifer if saturated.

Oxidation - The process whereby a substance combines with oxygen. Often associated with the weathering of rocks or the decomposition of organic matter.

Parameter - A parameter is a substance or element in water, air or soil which can be easily measured and serves as an indicator of environmental quality.

Parts Per Million (ppm) - A volume unit of measurement; the number of parts of a given pollutant or parameter in a million parts of air, soil or water.

Perched - A term descriptive of lakes or wetlands isolated (above) from the groundwater system which do not significantly contribute to or receive from the groundwater. Oak Lake in the environmental study area is a perched lake.

Percolation - Downward flow or filtering of water through pores or spaces in rock or soil.

Permeability - The capacity of a material to conduct or transmit liquids or gases. Materials with larger, interconnected pores (e.g., sands and gravels) can transmit large quantities of water (high permeability) while materials with small, poorly connected pores (e.g., silts and clays) transmit low quantities of water (low permeability).

pH - A measure of the acidity or alkalinity of a substance. pH is represented on a logarithmic scale of 0 to 14 with 7 being a neutral, 0 most acidic and 14 most alkaline.

Piezometer - A groundwater observation well used to measure groundwater levels or determine direction of flow.

Pleistocene - An interval of time often referred to as the Ice Age. Generally considered to be the last one million years.

Precambrian - The oldest, major era in the geologic time scale, equivalent to about 90% of geologic time. Rocks in this era were formed between the earth's formation and 450,000,000 years ago.

Precipitate - A solid that separates from a liquid because a chemical/physical change occurs in a solution such that dissolved substances form insoluble compounds.

Reagent - A substance used to produce a desired chemical reaction; reagents are used to enhance the flotation and separation of the valuable minerals.

Recharge - Process by which water percolates through the soil and into the aquifer.

Rib Pillar - A pillar of ore left between stopes to maintain mine stability.

Runoff - The portion of precipitation that flows across the ground surface to a wetland, stream or lake. Runoff can pick up pollutants from the air or the land and carry them to receiving waters.

Seepage - The passage of fluids through a permeable material.

Seepage Lake - A lake type which has no permanent flowing outlet, but which looses water mainly by seepage into the groundwater through its basin walls. Water sources are mainly rainfall and runoff. Examples of seepage lakes in the environmental study area are Little Sand, Duck, Deep Hole and Skunk Lakes.

Spring Lake - A type of drainage lake (with an outlet) in which the major source of water is from discrete springs.

Stopes - Large, vertical underground excavations from which ore is removed.

Stringer Ore - Mineral veinlets or filaments occurring in a discontinuous pattern in the host rock. Stringer Ore in the Crandon deposit is the copper-rich ore.

Subsoil - The layer of earth beneath the topsoil which is usually lacking in appreciable quantities of organic matter.

Sump - A depression or tank-like area to catch contaminated liquid for drainage or disposal.

Tailings - Finely ground nonmetallic waste rock separated during the ore processing.

Till - An unsorted, unstratified heterogeneous mixture of clay, silt, sand, gravel and boulders deposited directly by and underneath glacial ice without subsequent reworking by meltwater.

Tuffs - Rocks formed from compacted, fine grained volcanic ash.

Turbidity - A measure of the amount of suspended solids in water.

Vertical Crater Retreat - A bulk mining method in which sequential horizontal sections of ore are blasted and removed prior to backfilling.

Waste Rock - Rock removed during mining operations whose mineral composition is not of economic value.

Water Table - See groundwater table.

Watershed - The land area contributing runoff to a stream, lake or wetland.

Wetlands - Areas where water is near, at, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation.

EIS INFORMATION SOURCES

Readers seeking additional information about the project should refer to the documents listed below. Due to the complex nature of this project, the number of project revisions and amendments, and the number of information sources used, only the major and most current documents are listed. If the following documents are insufficent, please review their associated bibliographies.

Personal communication with the DNR staff having review/permitting responsibilities also is welcome, especially for questions regarding Chapters Three and Four. Narrative found in the Impacts and Alternatives chapters is a result of DNR staff analysis of the latest Exxon submittals as well as DNR's consultant reports.

MAJOR EXXON PERMIT APPLICATIONS AND REPORTS

Air Quality Permit Application - Crandon Project (3 Vols.) (Exxon Minerals Company, December 1985)

Environmental Impact Report - Crandon Project (10 Vols.) (Exxon Minerals Company, November, 1985)

High Capacity Well Approval Application - Potable, Construction, and Contingency Supplement - Water Wells and Transmission Systems - Crandon Project (2 Vols.) (Exxon Minerals Company, December 1985)

High Capacity Well Approval Application - Underground Mine Ground Water Inflow Control and Drainage Systems - Crandon Project (2 Vols.) (Exxon Minerals Company, December 1985) Note: The Hydrologic Impact Contingency Plan (Vol. 2) was revised September, 1986.

Mine Refuse Disposal Facility Feasibility Report - Crandon Project (STS Consultants, Ltd., November 1985)

Mine Waste Disposal Facility Feasibility Report - Crandon Project (Exxon Minerals Company, December 1985)

Mining Permit Application - Crandon Project (2 Vols.) (Exxon Minerals Company, December 1985)

Water Treatment Facility Final Plans and Specifications (CH2M Hill, Inc., October, 1986)

Wisconsin Pollutant Discharge Elimination System (WPDES) - Wastewater Discharge Permit Application - Crandon Project (Exxon Minerals Company, December 1985)

OTHER EXXON TECHNICAL REPORTS

Mine/Mill

The Discovery, Geology, and Minerology of the Crandon Precambrian Massive Sulphide Deposit, Wisconsin (May, Edwarde and Paul Schmidt. In: R. W. Hutchinson, Ed., Precambrian Sulfide Deposits, Special Paper 25, Geological Association of Canada, 1982)

Transportation of Reagent Materials - Off-Site Risk Related Issues - Crandon Project (Zordan Associates, Inc., November 1984)

Mine Waste Disposal Facility

Bentonite-Amended Soil Liner Usage in Solid Waste Disposal Facilities (Black & Veatch, June 1984)

Geohydrologic Comparison of Site Areas 30, 31, 40 and 41 - Exxon Crandon Project (Golder Associates, February 1982)

Radiological Testing Program - Crandon Project (Hazelton Environmental Sciences, August 1981)

Revised Reclamation Cap Design and Water Balance Analysis - Crandon Project (Ayres Associates, November 1985)

Siting Report - Review of Potential Alternative Mine Waste Disposal Areas (Exxon Minerals Company, June 1982)

Soil Attenuation Study - Crandon Project: Final Report (2 Volumes) (D'Appolonia, November 1982)

Study on Characterization of Crandon Mill Tailings (Colorado School of Mines Research Institute, October 1982)

Waste Disposal Facility Reclamation Cap - Crandon Project Water Balance Analysis (Owen Ayres & Associates, Inc., November 1982)

Water Treatment

Aquatic Biology of Swamp Creek for the Crandon Project - Final Report (Ecological Analysts, Inc., August 1983)

Aquatic Biology of Swamp Creek for the Crandon Project - January - December 1983 (Ecological Analysts, Inc., April 1984)

Chemistry and Hydrology in Swamp Creek, 1983 (Ecological Analysts, Inc., April 1984)

Chemistry and Hydrology in Swamp Creek, 1984 (EA Science and Technology, May 1985)

NR 110.09 Facilities Plan for the Exxon Minerals Company Mine/Mill Complex Sanitary Wastewater - Crandon, Wisconsin (CH2M Hill, Inc., November 1985)

Water and Sediment Chemistry and Hydrology in Swamp Creek - Final Report (Ecological Analysts, Inc., July 1983)

Water Treatment Facility Engineering Report (CH2M Hill, Inc., September 1984)

Socioeconomics

Forecast of Future Conditions Socioeconomic Assessment - Crandon Project (Research and Planning Consultants, Inc., October 1983)

Wetlands

Crandon Project Wetlands Assessment Report (4 Volumes) (Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc., August 1982)

Hydrological Balance for Selected Wetlands - Crandon Project (Interdisciplinary Environmental Planning, Inc., December 1982)

Supplemental Wetlands Assessment Report - Crandon Project (Interdisciplinary Environmental Planning, Inc., August 1983)

Revised Water Balance Analyses for Wetlands in the Mine Waste Disposal Facility Area - Crandon Project (Ayres Associates, November 1985)

Groundwater

Bedrock Permeability - Crandon Deposit (Roger G. Rowe, May 1984)

Final Draft (Revised): EIR Appendix 4.1A - Attachment A.10 - Lake Impact Analysis and Related Hydrological Assessments (Exxon Minerals Company, September 1985)

Groundwater Inflow Model for the Proposed Crandon Mine (T. A. Prickett & Associates, December 1982)

Hydraulic Relations Between Little Sand, Oak, Duck, Skunk, and Deep Hole Lakes and the Main Ground Water Aquifer - Crandon Project (Dames & Moore, April 1985)

Hydrogeologic Study Update for the Crandon Project (2 Volumes) (STS Consultants, Ltd., June 1984)

Predictive Groundwater Inflow Modeling and Sensitivity Analysis (T. A. Prickett & Associates, October 1984)

Supergene Weathering at the Crandon Deposit (Roger G. Rowe, April 1982)

DNR CONSULTANT REPORTS

Analysis of the Noise and Seismic Vibration Impacts from the proposed Exxon Crandon Mine Project (Howard, Needles, Tammen and Bergendoff, April 1985)

Analysis of Wisconsin Tax Impacts Related to Development of Exxon's Crandon Ore Body (Memorandum from Jon Skavlem, Wisconsin Department of Revenue to William Tans, Wisconsin Department of Natural Resources, January 1986)

Comments on D'Appolonia's Flow Model of the Crandon Site as Documented in Appendix 4.1A of the EIR (Mary P. Anderson, August 1983)

Comments on Prickett, Golder and D'Appolonia Models (3 Reports by Mary P. Anderson, January 1984)

Final Socioeconomic Impact Analysis of Exxon's Proposed Crandon Project (Denver Research Institute - University of Denver, April 1986)

Groundwater Flow and Mine Waste Disposal Facility Contaminant Movement Along A Cross-Section Through Exxon's Proposed Mine Project Area, Crandon, WI (United States Geological Survey and Wisconsin Department of Natural Resources, June 1985)

Literature Review for Disposal of Sulfide Mine Tailings (Philip A. Helmke, July 1986)

Review of the Crandon Project Reports Submitted by Exxon Minerals Company Assessing Possible Uses for Pyrite Tailings (Andres A. Trevino, December 1984)

Review of the Mining and Milling Waste Materials and Interaction of the Tailings Leachate with the Mine Waste Disposal Facility Liner and Subsoils for the Crandon Project (Philip A. Helmke, December 1984)

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