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STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
MINE RECLAMATION SECTION
BOX 7921
MADISON, WISCONSIN 53707

MINING PERMIT APPLICATION

(SECTIONS 144.80-144.94, WIS. STATS., AND CHAPTER NR 132, WIS. ADMIN. CODE)
FORM 2700-4 REV. 4-82

Instructions:
Please submit 25 copies of this application and other necessary documents in reproducible form to the above address. Assistance in completing this application and other associated work is available from the Mine Reclamation Section, Department of Natural Resources, Madison, Wisconsin.

SECTION A — GENERAL INFORMATION

1. Name of Applicant: EXXON CORPORATION
   c/o Exxon Minerals Company
2. Street or Route: 655 Washington Street
   City, State, Zip Code: Rhinelander, WI 54501

3. Applicant is (✓ one)
   - ☐ Individual
   - ☐ Sole Proprietorship
   - ☐ Partnership
   - ☒ Corporation
   - ☐ Other (Explain) _____

4. Is Applicant a ☐ Division or ☐ Subsidiary of Another Corporation?
   - ☐ Yes (If Yes, State Name and Address of Parent Corporation.)
   - ☒ No

5. If Applicant is a Corporation, is it Incorporated Under Wisconsin Law?
   - ☐ Yes
   - ☒ No

6. If Applicant is Incorporated Outside Wisconsin, Does it Hold a Valid Certificate of Authority to do Business in Wisconsin Issued by the Secretary of State?
   - ☒ Yes
   - ☐ No

7. Attach a legal description of the mining site and delineate the area on a United States geological survey topographic quadrangle map(s). The map(s) shall be at a scale of 1:24,000 wherever available and at a scale of 1:62,500 elsewhere.
8. Attach a list of names and addresses of each owner of land within the mining site and each person known by the applicant to hold any option or lease on land within the mining site and all prospecting and mining permits in this state held by the applicant.
9. Provide evidence that the applicant has applied for necessary approvals and permits under all applicable zoning ordinances and that the applicant has applied for all necessary approvals, licenses or permits required by the Department.
10. Attach information as to whether the applicant, its parent, its principal shareholders, subsidiaries or affiliates in which it owns more than a 40% interest, has forfeited any mining bonds in other states within the past 20 years, and the dates and locations, if any.
11. Attach information relating to whether unsuitability may exist for surface mining to the extent not fully considered in s. 144.84, Wis. Stats.
12. Attach an itemized statement showing the estimation of the cost to the state of reclamation.
13. Attach descriptions of land contiguous to the proposed mining site which the applicant owns, leases or has an option to purchase or lease.
14. Attach information related to the minimization of disturbance to wetlands in accordance with Section NR 132.06(4), Wis. Admin. Code.
15. Attach a proposed monitoring and quality assurance plan consistent with the requirements of Chapters NR 132 and NR 182, Wis. Admin. Code, and s. 1.11, Wis. Stats.

The Department may require the submission of additional information if it feels that such information is necessary to complete the Mining Permit Application.

SECTION B — FINANCIAL RESPONSIBILITY

1. Attach one copy each of the applicant's and parent company's (where applicable) most recent annual report and most recent Form 10-K as filed with the Securities and Exchange Commission. If these are not available, attach a report of the applicant's current assets and liabilities and other necessary data to establish that the applicant is competent to conduct mining in a manner consistent with the requirements and purpose of ss. 144.80-144.94, Wis. Stats.
2. Attach an explanation and supporting documentation of how the applicant will comply with the financial responsibility provisions of Section NR 132.09, Wis. Admin. Code.

SECTION C — FEE

Enclose a fee of $10,000.00 to cover the estimated costs of evaluating the operator's mining permit application. Upon completion of its evaluation, the Department shall adjust this fee to reflect the actual cost of evaluation less any fees paid for the same services to satisfy other requirements.

SECTION D — MINING AND RECLAMATION PLANS

1. **Attach a mining plan prepared in accordance with s. 144.85(3)(a), Wis. Stats, and Section NR 132.07, Wis. Admin. Code.**

2. **Attach a reclamation plan and timetable prepared in accordance with s. 144.834, Wis. Stats., and Section NR 132.08, Wis. Admin. Code.**

SECTION E — CERTIFICATION

I hereby certify that the information contained in this application is true and correct to the best of my knowledge, and belief. I agree to furnish such further information as may be required by the Department of Natural Resources to complete this application. This document is a revision and update of the Mining Permit Application filed on December 22, 1982, and does not constitute a new submittal.

Dated Rhinelander (City) Wisconsin (State) **, this** 23rd **day of** January **, 19** 86.

DB Achttien

(Signature of Responsible Official)

D. B. Achttien

General Manager, Crandon Project
Exxon Minerals Company and
Attorney in Fact for Exxon Corporation

(Title)

SECTION A - ITEM 7

a) Legal Description of the Mining Site.

The ore deposit is located in Forest County, in the Northern Highlands region of northeastern Wisconsin. Crandon, the county seat of Forest County, is located 5 miles due north of the proposed Project. Other communities in the area include Rhinelander, 28 miles west; Antigo, 45 miles south; and Iron River, Michigan, 44 miles north of Crandon. The Project site is located 2 miles east of State Highway 55 on Sand Lake Road.

The orebody is an east-west striking deposit located in Section 25, Township 35 North, Range 12 East, Nashville Township, and in Section 30, Township 35 North, Range 13 East, Lincoln Township. Physiographically, the deposit lies approximately 0.25 mile north of Little Sand Lake and 1 mile south of Swamp Creek.

The properties owned, under option, or leased by Exxon Minerals Company within the Crandon Project boundary are presented in Table A-7. The actual area to be covered by the Mining Permit is 3971 acres.

b) A delineation of the Mining Site on a United States Geological Survey Topographic Quadrangle Map is attached (Figure A-7).

TABLE A-7

PROPERTIES OWNED, UNDER OPTION, OR LEASED BY EXXON MINERALS COMPANY WITHIN THE CRANDON PROJECT BOUNDARY

Location	Description	Purpose
T35N-R13E:		
Town of Lincoln:		
Section 19:	Portion of NW NW	Access Road Right-of-Way (ROW)
	Portion of SW NW	Access Road ROW
	Westerly 600 feet of SW 1/4	Access Road ROW
Section 20:	Portion of NE NE	Railroad ROW
	Portion of NW NE	Railroad ROW
	Portion of NE NW	Railroad ROW
	Portion of E 1/2 SW NW, SE NW	Railroad ROW
	Portion of E 1/2 W 1/2 SW - 100 feet Easement	Railroad ROW
Section 28:	SW SW	Tailings Facility
Section 29:	Entire Section	Tailings Facility

TABLE A-7 (continued)

Location	Description	Purpose
T35N-R13E:		
Town of Lincoln:		
Section 30:	Entire Section	Mine and Mill Complex
Town of Nashville:		
Section 31:	NE NE, portion of NW NE, portion of NE NW, portion NW NW	Mine and Mill Complex
	SE NE, E 1/2 SE	Tailings Facility
	Portion of SW NE, Portion of W 1/2 SE	Tailings Facility
Town of Lincoln:		
Section 32:	Entire Section	Tailings Facility
Section 33:	NW NW	Tailings Facility
	SW NW, NW SW	Tailings Facility
	S 1/2 SW	Tailings Facility
T35N-R12E:		
Town of Nashville:		
Section 23:	Portion of NE 1/4	Access Road ROW

TABLE A-7 (continued)

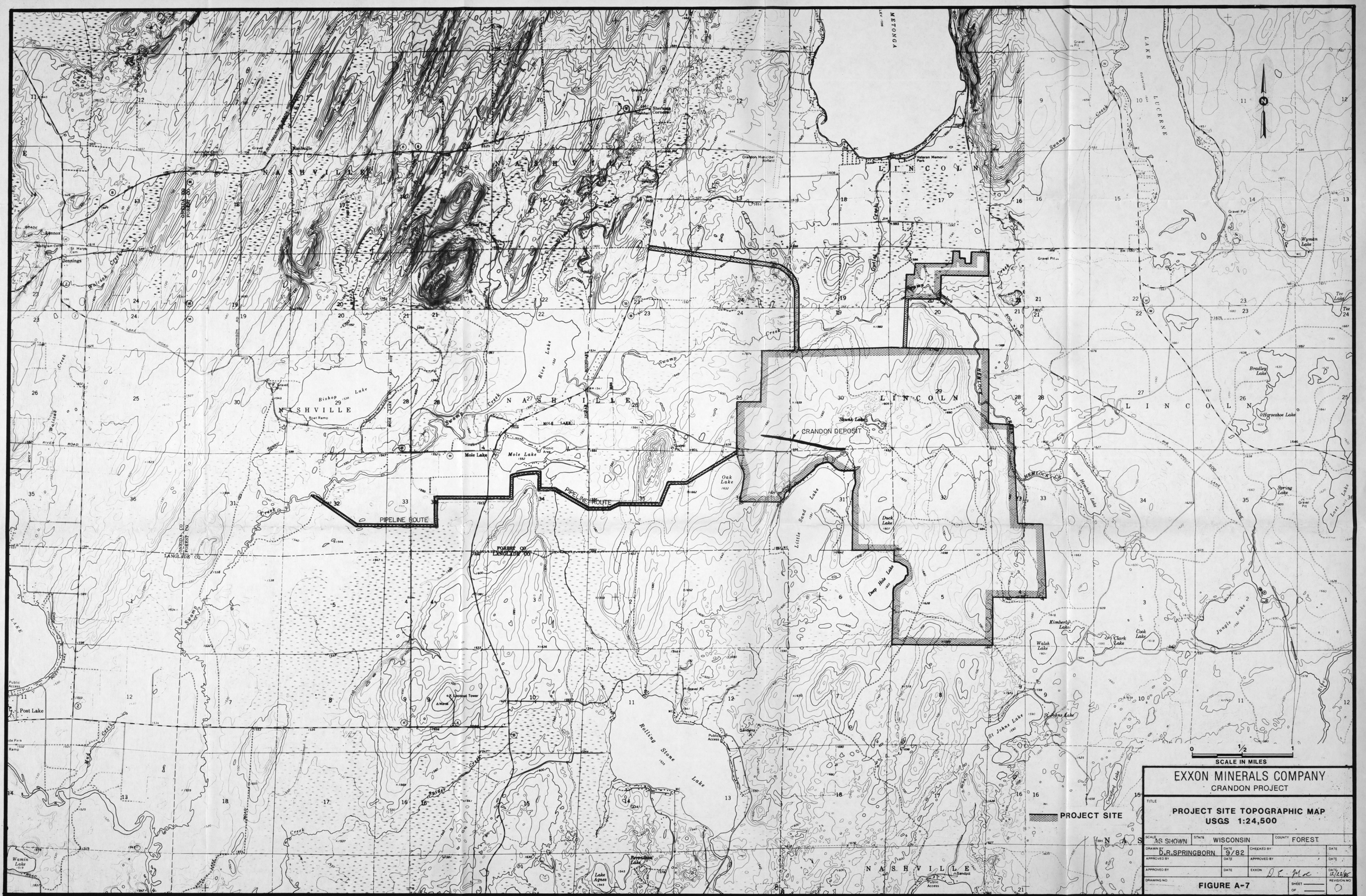
Location	Description	Purpose
T35N-R12E:		
Town of Nashville:		
Section 24:	Portion of N 1/2 N 1/2, Portion of SE NE	Access Road ROW
Section 25:	E 1/2 NE, SE	Mine and Mill Complex
Section 36:	NE NE, Portion of NW NE, Portion of S 1/2 NE 1/4, and lakelot properties	Mine and Mill Complex
T34N-R13E:		
Town of Nashville:		
Section 4:	NW 1/4	Tailings Facility
Section 5:	Entire Section except portion of W 1/2 NW	Tailings Facility
Additionally	All Town Roads in the Town of Nashville in the following sections are covered by a Mining Lease: T35N-R13E: Section 31 T35N-R12E: Sections 23, 25, 26 and 31 T34N-R13E: Sections 4 and 5	

TABLE A-7 (continued)

Location	Description	Purpose
Pipeline Easements:		
T35N-R12E:		
Town of Nashville:		
Section 25:	Portion of E 1/2 SE, SW SE, (also included in Project boundary description)	Water Pipeline Easement, 50 foot
Section 36:	Portion of N 1/2 NE (also included in Project boundary description)	Water Pipeline Easement, 50 foot
	Portion of N 1/2 NW (also included in Project boundary description)	Water Pipeline Easement, 50 foot
	Portion of SW NW	Water Pipeline Easement, 50 foot
Section 35:	Portion of NE NE, SE NE, SE NW, and SW NE	Water Pipeline Easement, 50 foot
	Portion of NE SW	Water Pipeline Easement, 50 foot
	Portion of NW SW	Water Pipeline Easement, 75 foot
Section 34:	Portion of NE SE	Water Pipeline Easement, 75 foot
	Portions of S 1/2 NE, NW NE,	Water Pipeline Easement, 75 foot
	Portions of Government Lot 4,	Water Pipeline Easement, 10-50 foot
	Portion of SW NW	Water Pipeline Easement, 25 foot

TABLE A-7 (continued)

Location	Description	Purpose
Pipeline Easements:		
T35N-R12E:		
Town of Nashville:		
Section 33:	Portion of S 1/2 NE	Water Pipeline Easement, 25 foot
	Portion of SE NW	Water Pipeline Easement, 50 foot
	Portion of N 1/2 SW	Water Pipeline Easement, 50 foot
Section 32:	Portion of N 1/2 SE	Water Pipeline Easement, 50 foot
	Portions of NE SW, Portions of E 1/2 NW	Water Pipeline Easement, 50 foot



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
PROJECT SITE TOPOGRAPHIC MAP
USGS 1:24,500

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY D.R.SPRINGBORN	DATE 9/82	CHECKED BY	DATE		
APPROVED BY	DATE	APPROVED BY	DATE		
APPROVED BY	DATE	EXXON	DATE 12/23/86		
DRAWING NO. FIGURE A-7		SHEET OF	REVISION NO		

SECTION A - ITEM 8

Names and addresses of land ownership within the mining site and each person known by the applicant to hold any option or lease on land within the mining site and prospecting and mining permits in this state held by applicant are provided in Table A-8. A land ownership map for the Project site is provided in Section D - Mine Plan, Figure 2-3.

TABLE A-8

LOCATION, DESCRIPTION AND OWNERSHIP OF PROPERTIES
WITHIN THE CRANDON PROJECT BOUNDARY

Location	Description	Owner
T35N-R13E:		
Town of Lincoln:		
Section 19:	Portion of NW NW - Optioned for 200 feet Roadway ROW	S. N. Moe, et ux 1129 Primrose Court Neenah, WI 54956
	Portion of SW NW - Optioned for 200 feet Roadway ROW	Adah S. Paul Lake Shore Drive Crandon, WI 54520
	Westerly 600 feet of SW 1/4 - Optioned for 200 feet Roadway ROW	John B. Hess RFD 1, Box 157 Laona, WI 54541
Section 20:	Portion of NE NE - Optioned for Railroad ROW	Leo Zelechowski, et ux R. R. 2, Box 384 Crandon, WI 54520
	Portion of NW NE - Optioned for Railroad ROW	Delmar Pennington, et ux R. R. 3, Box 309 Elkhorn, WI 53121
	Portion of NE NW - Optioned for Railroad ROW	Everette Rudloff, et ux R. R. 1 Crandon, WI 54520
	Portion of E 1/2 SW NW, SE NW - Optioned for Railroad ROW	Wallace C. Bradley, et al 204 W. Grant St. Crandon, WI 54520
	Portion of E 1/2 W 1/2 SW - 100 foot Easement - Location to be selected	American Can Co P.O. Box 790 Green Bay, WI 54305
Section 28:	SW SW - Option for Purchase	Forest County c/o Forest County Clerk, Court House Crandon, WI 54520

TABLE A-8 (continued)

Location	Description	Owner
T35N-R13E:		
Town of Lincoln:		
Section 29:	Entire Section	Forest County Crandon, WI 54520
Section 30:	NE, NE NW	Forest County Crandon, WI 54520
	NW NW, S 1/2 NW, S 1/2	Exxon Corporation 1251 Avenue of the Americas New York, N.Y. 10020
Town of Nashville:		
Section 31:	NE NE, Portion of NW NE, Portion of NE NW, Portion of NW NW	Exxon Corporation New York, N.Y. 10020
	SE NE, E 1/2 SE	Exxon Corporation New York, N.Y. 10020
Town of Lincoln:		
Section 32:	Entire Section	Exxon Corporation New York, N.Y. 10020
Section 33:	NW NW - Option to Purchase	Virgil Richter 450 Lincoln Drive Apt. 120 Twin Lakes, WI 53181
	SW NW, NW SW - Mining Lease	Gerald K. Solpers 1427 Porlier Street Green Bay, WI 54301
	SW SW - Option to Purchase	J. Smits 818 Virginia Dr. DePere, WI 54115
	SE SW - Option to Purchase	Eugene Baeten R. 2 Green Bay, WI 54301

TABLE A-8 (continued)

Location	Description	Owner
T35N-R12E:		
Town of Nashville:		
Section 23:	Portion of NE 1/4 - Optioned for 200 feet Road ROW	Thomas A. Mihalko, et ux R. 1 Crandon, WI 54520
Section 24:	Portion of N 1/2 of N 1/2 Optioned for 200 feet Road ROW	Mihalko Land and Logging Co., Inc. R. 1 Crandon, WI 54520
	Portion of SE NE - Optioned for 200 feet Road ROW	S. N. Moe, et ux 1129 Primrose Court Neenah, WI 54956
Section 25:	E 1/2 NE, SE	Exxon Corporation New York, N.Y. 10020
Section 36:	NE NE, Portion of NW NE, Portion of S 1/2 NE, and lakelot properties	Exxon Corporation New York, N.Y. 10020
T34N-R13E:		
Town of Nashville:		
Section 4:	NW 1/4 - Mining Lease	CFI Mineral Associates I c/o Connor Securities Co. P.O. Box 2320 Minneapolis, MN 55402 CFI Mineral Associates II 3229 North 8th Street Wausau, WI 54401 CFI Mineral Associates III (Wisconsin) 550 South Avenue Glenco, IL 60022 CFI Mineral Associates IV 17 Bramble Lane Riverside, CT 06878
Section 5:	Entire Section except portion of W 1/2 NW - Land Exchange Option	Owens-Illinois, Inc. P.O. Box 1035 Toledo, OH 43666

TABLE A-8 (continued)

Location	Description	Owner
T34N-R13E:		
Town of Nashville:		
Section 6:	Part of Government Lot 5, described by metes and bounds	Paul Renkus, et ux Box 197 Wabeno, WI 54566
Additionally	All Town Roads in the Town of Nashville in the following sections are covered by a Mining Lease: T35N-R13E: Section 31 T35N-R12E: Sections 23, 25, 26 and 31 T34N-R13E: Sections 4 and 5	
Pipeline Easements:		
T35N-R12E:		
Town of Nashville:		
Section 25:	Portion of E 1/2 SE, SW SE, owned for 50 foot Pipeline ROW (also included in Project boundary description)	Exxon Corporation 1251 Avenue of the Americas New York, N.Y. 10020
Section 36:	Portion of N 1/2 NE owned for 50 foot Pipeline ROW (also included in Project boundary description)	Exxon Corporation New York, N.Y. 10020
	Portion of SW NW, owned for 50 foot Pipeline ROW (also included in Project boundary description)	Exxon Corporation New York, N.Y. 10020
	Portion of N 1/2 NW, owned for 50 foot Pipeline ROW (also included in Project boundary description)	Exxon Corporation New York, N.Y. 10020
Section 35:	Portion of NE NE, owned for 50 foot Pipelne ROW	Exxon Corporation New York, N.Y. 10020
	Portions of SE NE, SE NW, and SW NE, 50 foot Water Pipeline Easement	Mihalko Land and Logging Co. R.F.D. 1 Crandon, WI 54520
	Portion of NE SW, 50 foot Water Pipeline Easement	Tom and Arlene Tambellini R.F.D. 6 Rhinelander, WI 54501
	Portion of NW SW, 75 foot Water Pipeline Easement	Patrick and Susie Phalen, Jr. 3059 Hwy. CC Slinger, WI 53086

TABLE A-8 (continued)

Location	Description	Owner
Pipeline Easements:		
T35N-R12E:		
Town of Nashville:		
Section 34:	Portion of NE SE, 75 foot Water Pipeline Easement	Patrick and Susie Phalen, Jr. Slinger, WI 53086
	Portions of S 1/2 NE, NW NE, 75 foot Water Pipeline Easement	Patrick and Lillian Phalen R.F.D. 1 Crandon, WI 54520
	Portions of Government Lot 4, 10-50 foot Water Pipeline Easement	Hobert R. and Faye M. LeMaster 1711 54 Street Court Moline, IL 61265
	Portion of SW NW, 50 foot Water Pipeline Easement	Robert and Helen Jacobsen R.F.D. 1 Crandon, WI 54520
Section 33:	Portion of S 1/2 NE, 50 foot Water Pipeline Easement Portion of SE NW, 50 foot Water Pipeline Easement	Robert and Helen Jacobsen R.F.D. 1 Crandon, WI 54520
	Portion of N 1/2 SW, 50 foot Water Pipeline Easement	David J. and Edward F. Bula R. 1, Box 698 Crandon, WI 54520
Section 32:	Portion of NE SE, 50 foot Water Pipeline Easement	David J. and Edward F. Bula R. 1, Box 698 Crandon, WI 54520
	Portions of NW SE, NE SW, SE NW, Water Pipeline Easement. Portions of E 1/2 NW	John Schallock Flossie Schallock Neil Schallock Alpha Schallock Crandon, WI 54520

TABLE A-8 (continued)

Location	Description	Owner
Lake Bed Ownership Within Project Area:		
T35N-R13E:		
Town of Lincoln:		
Section 30:	Portion of E 1/2 SE; that portion underlying Skunk Lake	State of Wisconsin
Section 32:	Portion of W 1/2 SW: that portion underlying Duck Lake	State of Wisconsin
Town of Nashville:		
Section 31:	Portion of E 1/2 SE; that portion underlying Duck Lake	State of Wisconsin

Note: Exxon Minerals Company does not hold any prospecting and/or mining permits in the State of Wisconsin as of this submittal date.

SECTION A - ITEM 9

Attachment A9-1 contains the letter of transmittal for the Town of Lincoln zoning application and Attachment A9-2 is a copy of the receipt provided by the Zoning Administrator. EMC plans to file a zoning application with the Town of Nashville in January 1986 and copies of the transmittal letter and receipt will be provided to DNR when the filing occurs.

In addition to these zoning applications, the following Land Use Permit Applications have been filed and approved by Forest County:

Town of Lincoln

1) To erect Road Bridge at Reference Station 2810.05 (#124-84)

2) To erect Railroad Spur Line in vicinity of Skunk Lake (#119-84)

3) To erect Drainage Culvert at Railroad Station 511.80 (#121-84)

4) To erect Railroad Bridge at Reference Station 516.70 (#120-84)

Town of Nashville

1) To erect Water Discharge Structure on Swamp Creek (#123-84)

2) To erect Water Discharge Pipeline in vicinity of Oak Lake (#122-84)

3) To erect Water Discharge Pipeline in vicinity of Mole Lake (#118-84)

The Forest County Land Use Permits for locations in the Towns of Lincoln and Nashville were approved on October 17 and 30, 1985, respectively.

The following permit applications have been filed with the Department of Natural Resources:

1) Air Quality Management Application;

2) WPDES Application;

3) Mine Waste Disposal Feasibility Report;

4) Mine Refuse Disposal Feasibility Report;

5) Mining Permit Application;

6) High Capacity Well Approval Applications; and

7) A series of Chapter 30/31 Permit Applications.

The permit applications required to begin the Crandon Project construction are summarized in Table A-9. It is the intent of EMC to submit applications for all DNR permits required to begin construction prior to FEIS issuance.

ATTACHMENT A9-1

EXXON MINERALS COMPANY

P. O. BOX 813, RHINELANDER, WISCONSIN 54501-0813, (715) 369-2800

CRANDON PROJECT

December 17, 1985

Mr. John Wilson
Town of Lincoln Zoning Administrator
R.R. #1
Crandon, Wisconsin 54520

Dear Mr. Wilson:

Enclosed is the Amended Planned Development Application for Exxon Minerals Company's Crandon Project. A check in the amount of $200.00 to cover the filing fee was submitted on March 8, 1984.

Nine additional copies of the application are being transmitted to you under separate cover for distribution.

We intend to work very closely with you and the Town of Lincoln Zoning Committee during the next several months in order to rapidly respond to all concerns of the Zoning Committee. It is our hope that the application can be processed during early 1986.

Please feel free to contact me any time at 478-3393 if you have any questions.

Sincerely,

Frank J. Sonderman

Frank J. Sonderman
Local Affairs Coordinator

FJS/sq

enclosure

ATTACHMENT A9-2

RECEIPT

Received this 17 day of December '85, from Exxon Minerals Company, ten (10) copies of a Metallic Minerals Mining Planned Development Application consisting of the following materials:

- An application fee of $200.00 as required by Section 15.03.1(a) of the Zoning Ordinance (Per. 20.03). (Submitted March 8, 1984).
- A signed and notarized statement containing information required under 15.03.1(b).
- A map of the proposed district according to Section 15.03.1(c).
- A description of the proposed project containing the information required under 15.031(d).

One copy of the application has been initialed, dated and placed on file with the Clerk, Town of Lincoln.

By: John A Wilson

Title: Zoning Administrator

/sjq

PERMITS REQUIRED TO BEGIN CONSTRUCTION OF THE CRANDON PROJECT

Statutory Obligation	Administering Agency	Activity	Action
FEDERAL			
33 U.S.C. 1344	U.S. Army Corps of Engineers	Dredge or fill permits for activities in or impacting navigable streams or wetlands	Permit issuance
30 U.S.C. 801 et seq	Dept. of Labor-Mine Safety & Health Administration	File legal identity report	No action
33 U.S.C. 1321	EPA	Spill prevention control and counter measure plan	Have plan on file before operations begin
16 U.S.C. 470F	Advisory Counsel on Historic Preservation	Monitors actions of federal government which may involve sites having buildings, structures, or objects eligible for inclusion in the National Register	Coordinate with U.S. Army Corps of Engineers
18 U.S.C. 843	Bureau of Alcohol, Tobacco and Firearms	Explosives user permit	Permit issuance

Many federal programs that would otherwise be applicable are administered by the state. It is assumed that the state will remain or become authorized to administer the following federal programs: National Pollution Discharge Elimination System; Resource Conservation and Recovery Act Solid Waste Disposal programs; Clean Air Act -- non-PSD aspects; and Safe Drinking Water Act.

Statutory Obligation	Administering Agency	Activity	Action
STATE			
Wis. Stat. 23.11	DNR	EIR submittal	Determine adequacy
Wis. Stat. 30.12	DNR	Placement of structures	Permit issuance
Wis. Stat. 30.12	DNR	Placement of riprap	Permit issuance
Wis. Stat. 30.19(1)(c)	DNR	Grading of banks	Permit issuance
Wis. Stat. 30.20 (1)	DNR	Dredging	Permit issuance
Wis. Stat. 31.23	DNR	Bridges	Permit issuance
Wis. Stat. 86.07	Dept. of Transportation	Permit to connect mine access road to State Highway 55 and to run water discharge pipeline underneath Highway 55	Permit issuance
Wis. Stat. 28.11(11)	DNR - Forest County	Withdrawal of land within project site boundary from County forest status	Approval of Forest County withdrawal application filed on December 2, 1980 with DNR
Wis. Stat. 101.15	DILHR	Mine shaft sinking, hoisting and ventilation of underground workings	Review mining activities and issue all applicable permits (see letters dated May 3, 1983 and August 30, 1983 between DILHR and Exxon for a more specific listing of required approvals

Statutory Obligation	Administering Agency	Activity	Action
Wis. Stat. 101.12	DILHR	Surface building plans, blasting procedures	Review and approve applicable construction procedures and building plans and issue applicable permits
Wis. Stat. 145.02	DILHR	Plumbing and fire protection	Review and approve plans and issue applicable permits
Wis. Stat. 144.025	DNR	Water quality certification	Approve water quality certification application
Wis. Stat. 144.025(2)(e)	DNR	High capacity and mine dewatering wells	Application approval
Wis. Stat. 144.04	DNR	Waste water treatment system including reclaim pond, potable water supply, and sewage package treatment plant*	Plan approval
Wis. Stat. 144.392, 144.391	DNR	Air emissions	Permit issuance
Wis. Stat. 144.44	DNR	Mine Waste and Refuse Feasibility Reports, Plans of Operation	Report and plan approval and issue license
Wis. Stat. 144.85	DNR	Mining	Permit issuance
Wis. Stat. 144.86	DNR	Bonding	Authorize Commencement of mining

Statutory Obligation	Administering Agency	Activity	Action
Wis. Stat. 59.971	Forest County, DNR	Placement of mining structures in shoreland, flood plain and wetland zoning districts	Approve the placement of such structures in the zoning districts
Wis. Stat. Chap. 147	DNR	Water discharge	Permit issuance
Wis. Stat. Chap. 162	DNR	Potable water supply	Review and approve final plans
LOCAL			
The Towns of Lincoln and Nashville, City of Crandon and Forest County have zoning ordinances.			
Chapter 5 Forest County Zoning Ordinance	Forest County	Land use permits for mining activities located in shore-lands	Issue land use permits
Chapter 15, 16 Town of Lincoln Zoning Ordinance	Town of Lincoln	Approval of siting of facilities in Town	Approve mining planned development application and related land use permits
Chapter 15, 16 Town of Nashville Zoning Ordinance	Town of Nashville	Approval of siting of facilities in Town	Approve mining planned development application and related land use permits
Crandon Municipal Airport Zoning Ordinance	City of Crandon	Approval of surface facilities in airport approach and turning zones	Issue permit for surface facilities in airport approach and turning zones

SECTION A - ITEM 10

Neither the applicant, its principal shareholders, subsidiaries or affiliates in which it owns more than 40 percent interest, have ever forfeited any mining bonds in other states within the past 20 years.

SECTION A - ITEM 11

Information relating to whether unsuitability exists for surface mining to the extent not fully considered in s.144.84, Wis. Stats., is not applicable to this application.

SECTION A - ITEM 12

Reclamation Costs

Reclamation costs for the Crandon Project have been developed individually for each of the primary facilities or groups of facilities in the Project according to the following groupings: (1) access road; (2) railroad spur; (3) haul road and tailings transport system corridor; (4) mine/mill site area; (5) mine waste disposal facility; (6) water discharge system; (7) mine; (8) reclaim ponds; and (9) mine refuse disposal facility.

The disposition of each of the facilities or facility groups at the end of the Project life is different and has bearing on the reclamation costs. Table A-12 at the end of this section lists the reclamation costs associated with the Project.

Access Road - A complete reclamation estimate is included for the access road covering pavement, base, and bridge removal and revegetation of the disturbed areas. Although the proposed plan is for complete reclamation of the access road, there is the possibility the access road will remain in place at abandonment, since it is possible that housing or other development will take place along the road and a permanent need for the road will be established.

Railroad Spur - The railroad spur will be abandoned if no other commercial need is established and reclaimed at the time of facilities closure. Reclamation includes removal and salvage of rail, ties, ballast, and sub-ballast materials followed by minor grading and establishment of vegetation in the disturbed areas. The Swamp Creek crossing structure will be removed.

Costs presented for railroad reclamation are for these operations at the time of facilities closure; costs for initial vegetation, established with the railroad construction, are included in the initial construction cost for the railroad.

Haul Road and Tailings Transport System Corridor - The haul road and tailings transport system corridor will be abandoned at completion of mine operation. The buried transport pipes will remain in place and be plugged at the ends. A 0.5 foot soil layer will be placed over the haul road. Minor grading and establishment of a vegetative cover also will be performed. All of these costs are included in the final reclamation cost.

Mine/Mill Site Area - The mine/mill site area may be completely reclaimed at the end of the Project life if more productive uses cannot be made of the facilities. Buildings, equipment, utilities, and other surface facilities will be removed. Foundations and pavement will be broken up and will either be removed or remain in place according to depth of cover to reach final reclamation grades. Disturbed areas will be regraded and revegetated. For the mine/mill site area reclamation costs are based on the above work. Costs for areas of the mine/mill site that were reclaimed during original construction, and which become a part of the final reclamation plan, are included with the initial construction costs for the mine/mill site.

Mine Waste Disposal Facility - The mine waste disposal facility will be reclaimed in phases as the four tailings ponds are sequentially constructed, operated, and reclaimed over the Project life. Reclamation costs include the earthwork to establish planned grades on the pond, the top seal, the overdrain, the soil cover, and the vegetation. Costs for slope grading, vegetation, or other initial construction work that becomes a part of the final reclaimed system are included with the initial construction costs for the facility.

Reclaim Pond - Costs for the reclaim pond includes removal, synthetic liner disposal, regrading, and vegetation establishment.

Water Discharge System - Costs for reclamation of the water discharge system include discharge structure removal and plugging of the pipe at both ends, followed by regrading and revegetation of any disturbed areas. Establishment of initial vegetation is included with the initial construction costs for the water discharge system.

Mine - Costs for mine reclamation include the plugging and backfilling of the main shaft, the two exhaust air shafts, and other utility holes.

MRDF - The mine refuse disposal facility will be reclaimed in phases as the three cells are constructed and operated over the Project life. Reclamation costs include the top seal, soil cover and revegetation.

TABLE A-12

TOTAL ESTIMATE RECLAMATION COSTS FOR THE CRANDON PROJECT IN 1985 DOLLARS*

Facility	Revised Estimate ($K)
Access Road	278
Railroad Spur	448
Rock Haul Road/Tailings Transport Corridor	66
Buildings	4,074
Mine/Mill Site Area	1,614
Excess Water Discharge System	16
Mine	583
Reclaim Pond	1,690
Tailings Ponds	
Remove Fence	31
T-1	4,030
T-2	6,558
T-3	4,218
T-4	9,177
MRDF	198
Miscellaneous (Contingency @ 5%)	1,650
TOTAL RECLAMATION COSTS	34,631

*Estimate revised December 1985.

TABLE A-12 (continued)

Facility	Units (xK)	Unit Costs ($/Unit)	Costs ($K)
Access Road			
Paved with bituminous concrete 2.98 miles long x 2 each 12 ft. lanes x 3 in. thick			
Crushed aggregate base course 40 ft. wide x 12 in. thick			
Bridge over Swamp Creek Prestressed concrete with span of 129 ft.			
1. Remove bituminous concrete	42 yd^2	1.25	52
2. Dispose of bituminous concrete (on-site)	3.5 yd^3	4.20	15
3. Remove aggregate base course	23 yd^3	2.30	53
4. Remove Swamp Creek crossing			
a. Concrete demolition	0.4 yd^3	90.00	36
b. Steel demolition	0.6 ft	6.30	4
c. Dispose of concrete/steel (on-site)	0.4 yd^3	4.20	2
5. Regrading	70 yd^2	0.50	35
6. Replace topsoil (6 in.)	70 yd^2	0.80	56
7. Revegetate (hydraulic seeding)	70 yd^2	0.35	25
TOTAL ACCESS ROAD			278
Railroad Spur			
Single spur 2.7 miles long with 3 sidings each 3,280 ft. long - bed is 20 ft. wide with 1.5 ft. ballast/subballast			
Bridge over Swamp Creek = 66 ft. long x 20 ft. wide			
1. Remove track and ties	24 ft	10.50	252
2. Dispose of track/ties	3.3 yd^3	4.20	14
3. Remove ballast and subballast	27 yd^3	2.30	62
4. Remove Swamp Creek crossing			
a. Concrete demolition	0.3 yd^3	90.00	27
b. Steel demolition	0.3 ft	6.30	2
c. Dispose of concrete/steel (on-site)	0.5 yd^3	4.20	2
5. Regrading	54 yd^2	0.50	27
6. Replace topsoil (6 in.)	54 yd^2	0.80	43
7. Revegetate (hydraulic seeding)	54 yd^2	0.35	19
TOTAL RAILROAD SPUR			448

TABLE A-12 (continued)

Facility	Units (xK)	Unit Costs ($/Unit)	Costs ($K)
Rock Haul Road/Tailings Transport Corridor			
Rock haul road extends from plant site, paralleling the reclaim ponds and extends to MWDF area. Length = 11,614 ft. x 20 ft. wide			
Three pipelines are buried alongside the road; the tailings line (8 in. Ø HDPE) and two water lines (16 in. Ø HDPE). The pipelines will be plugged at both ends and remain buried.			
1. Remove road aggregate	9 yd^3	2.30	21
2. Plug pipelines with concrete			2
3. Regrading	26 yd^2	0.50	13
4. Replace topsoil (6 in.)	26 yd^2	0.80	21
5. Revegetate (hydraulic seeding)	26 yd^2	0.35	9
TOTAL ROCK HAUL ROAD/TAILINGS TRANSPORT CORRIDOR			66
Buildings			
Building sizes are: Concentrator - 174,235 ft^2 x 75 ft. high = 13.1 m $ft.^3$			
Services Building - 24,488 $ft.^2$ x 15 ft. high + 56,511 ft^2 x 25 ft. high = 1.8 m $ft.^3$			
Water Treatment - 27,000 ft^2 x 40 ft. high = 1.1 m ft^3			
Coarse Ore Storage - 23,600 ft^2 x 40 ft. high = 0.9 m $ft.^3$			
Miscellaneous Buildings - 40,000 ft^2 x 15 ft. high = 0.6 m $ft.^3$			
1. Demolition	17,500 ft^3	0.15	2,625
2. Remove foundations	5 ft	50.00	250
3. Remove slabs	322 ft^2	3.15	1,014
4. Remove stone base	46 yd^3	2.30	106
5. Dispose of concrete (on-site)	18 yd^3	4.20	75
6. Dispose of steel (on-site) (Bulk of steel reused or sold as scrap)	1 yd^3	4.20	4
TOTAL BUILDINGS			4,074

TABLE A-12 (continued)

Facility	Units (xK)	Unit Costs ($/Unit)	Costs ($K)
Mine/Mill Site Area			
The total disturbed area within the mine/mill site area is approximately 115 acres. Of the 115 acre total approximately 80 acres is covered by buildings, lots, roads, etc. and the remaining 34 acres is revegetated, landscaped or otherwise reclaimed in the first three years of the project life during the construction phase. At final reclamation, with road, lot and facility removal, the 80 acres will be regraded, topsoil will be replaced, and the area will be reseeded. A 10% allowance is provided in grading requirements to provide for blending the new grades into the existing areas. Underground pipe will remain buried.			
1. Railroad			
a. Remove track and ties	7 ft.	10.50	74
b. Dispose of track/ties	1 yd^3	4.20	4
c. Remove ballast/subballast	8 yd^3	2.30	18
2. Roads/Parking Lots			
a. Remove bituminous concrete	500 yd^2	1.25	625
b. Dispose of bituminous concrete (on-site)	42 yd^3	4.20	176
3. Regrading (88 acres)	426 yd^2	0.50	213
4. Replace topsoil (6 in. thick)	426 yd^2	0.80	341
5. Revegetate (hydraulic seeding)	426 yd^2	0.35	149
6. Remove site fencing	13 ft	1.05	14
TOTAL MINE/MILL SITE AREA			1,614

TABLE A-12 (continued)

Facility	Units (xK)	Unit Costs ($/Unit)	Costs ($K)
Excess Water Discharge System			
Pipeline will remain buried. Both ends of pipe plugged with concrete. Discharge structure removed with site reclaimed.			
1. Remove discharge structure (concrete demolition)	0.1 yd^3	90.00	9
2. Dispose of concrete (on-site)	0.1 yd^3	4.20	1
3. Remove riprap/ballast	0.2 yd^3	2.30	1
4. Pour concrete plugs at pipe ends			2
5. Regrading	1 yd^2	0.50	1
6. Replace topsoil	1 yd^2	0.80	1
7. Revegetate (hydraulic seeding)	1 yd^2	0.35	1
TOTAL EXCESS WATER DISCHARGE SYSTEM			16
Mine			
Concrete plugs 10 ft. thick to be poured in all 4 shafts. Concrete water barriers to be poured in the upper mine level. Toxic materials to be removed from mine (fuel tanks, transformers, explosive storage facilities).			
1. Concrete shaft plugs	0.5 yd^3	500	250
2. Backfill shafts from plugs to surface with crushed rock	5.4 yd^3	1.70	9
3. Concrete water barriers (5 in drifts, 11 in ore passes and raises, 4 in shafts)	0.6 yd^3	500	300
4. Salvage toxic materials			10
5. Remove top 10 ft. of shaft collar concrete liners			10
6. Regrade shaft areas			1
7. Replace topsoil and reseed			2
8. Security fencing for 3 shaft monitoring wells			1
TOTAL MINE			583

TABLE A-12 (continued)

Facility	Units (xK)	Unit Costs ($/Unit)	Costs ($K)
Reclaim Pond			
Liner, sludge and rock for slope protection removed and placed in tailings ponds. Embankments graded into pond and vegetated.			
1. Remove sludge, liners, rock	364 yd^3	1.65	600
2. Regrading (by scrapers)	275 yd^3	1.65	454
3. Regrading (by dozer)	240 yd^3	1.00	240
4. Regrading (by motor grader)	240 yd^2	0.50	120
5. Replace topsoil (6 in.)	240 yd^2	0.80	192
6. Revegetate (hydraulic seeding)	240 yd^2	0.35	84
TOTAL RECLAIM POND			1,690
Remove MWDF Fencing	30.8 ft	1.05	31
Mine Waste Disposal Facility			
Tailings Pond T-1 (Surface Area = 208 K yd^2)			
1. Place soil grading layer (by scraper)	370 yd^3	1.65	610
2. Place soil grading layer (by dozer)	40 yd^3	1.00	40
3. Grade soil layer	208 yd^2	0.50	104
4. Place/compact bentonite layer (2 each 4 in. lifts)	46 yd^3	17.70	814
5. Install 40 mil polyethylene liner	208 yd^2	3.10	645
6. Prepare drain material	46 yd^3	9.60	442
7. Place 8 in. sand/gravel drain	46 yd^3	1.55	71
8. Grade sand/gravel drain	208 yd^2	0.50	104
9. Place 5 ft. soil cover	620 yd^3	1.65	1,023
10. Grade soil cover surface	208 yd^2	0.50	104
11. Revegetate (hydraulic seeding)	208 yd^2	0.35	73
TOTAL POND T-1			4,030

TABLE A-12 (continued)

Facility	Units (xK)	Unit Costs ($/Unit)	Costs ($K)
Mine Waste Disposal Facility (Continued)			
Tailing Pond T-2 (Surface Area = 344 K yd^2)			
1. Place soil grading layer (by scraper)	590 yd^3	1.65	973
2. Place soil grading layer (by dozer)	66 yd^3	1.00	66
3. Grade soil layer	344 yd^2	0.50	172
4. Place/compact bentonite layer (2 each 4 in. lifts)	76 yd^3	17.70	1,345
5. Install 40 mil polyethylene liner	344 yd^2	3.10	1,066
6. Prepare drain material	76 yd^3	9.60	730
7. Place 8 in. sand/gravel drain	76 yd^3	1.55	118
8. Grade sand/gravel drain	344 yd^2	0.50	172
9. Place 5 ft. soil cover	984 yd^3	1.65	1,624
10. Grade soil cover surface	344 yd^2	0.50	172
11. Revegetate (hydraulic seeding)	344 yd^2	0.35	120
TOTAL POND T-2			6,558
Tailings Pond T-3 (Surface Area = 242 K yd^2)			
1. Place soil grading layer (by scraper) (25 yd. scraper)	324 yd^3	1.65	535
2. Place soil grading layer (by dozer)	36 yd^3	1.00	36
3. Grade soil layer	242 yd^2	0.50	121
4. Place/compact bentonite layer (2 each 4 in. lifts)	54 yd^3	17.70	956
5. Install 40 mil polyethylene liner	242 yd^2	3.10	750
6. Prepare drain material	54 yd^3	9.60	518
7. Place 8 in. sand/gravel drain	54 yd^3	1.55	84
8. Grade sand/gravel drain	242 yd^2	0.50	121
9. Place 5 ft. soil cover	540 yd^3	1.65	891
10. Grade soil cover surface	242 yd^2	0.50	121
11. Revegetate (hydraulic seeding)	242 yd^2	0.35	85
TOTAL POND T-3			4,218

TABLE A-12 (continued)

Facility	Units (xK)	Unit Costs ($/Unit)	Costs ($K)
Mine Waste Disposal Facility (Continued)			
Tailing Pond T-4 (Surface Area = 518 k yd^2)			
1. Place soil grading layer (by scraper)	730 yd^3	1.65	1,204
2. Place soil grading layer (by dozer)	81 yd^3	1.00	81
3. Grade soil layer	518 yd^2	0.50	259
4. Place/compact bentonite layer (2 each 4 in. lifts)	115 yd^3	17.70	2,036
5. Install 40 mil polyethylene liner	518 yd^2	3.10	1,606
6. Prepare drain material	115 yd^3	9.60	1,104
7. Place 8 in. sand/gravel drain	115 yd^3	1.55	178
8. Grade sand/gravel drain	518 yd^2	0.50	259
9. Place 5 ft. soil cover	1,218 yd^3	1.65	2,010
10. Grade soil cover	518 yd^2	0.50	259
11. Revegetate (hydraulic seeding)	518 yd^2	0.35	181
TOTAL POND T-4			9,177
Mine Refuse Disposal Facility (MRDF)			
1. Place/compact bentonite layer (top seal) 2 x 4 lifts	8 yd^3	17.70	142
2. Place 2 ft. soil cover	25 yd^3	1.65	41
3. Grade soil cover	4 yd^2	0.50	2
4. Place 6 inch top soil	6 yd^3	1.65	10
5. Grade top soil	4 yd^2	.50	2
6. Revegetate (hydraulic seeding)	4 yd^2	.35	1
TOTAL MRDF			198
Miscellaneous Contingency @ 5%			1,650
TOTAL RECLAMATION COST			34,631

SECTION A - ITEM 13

A description of land contiguous to the proposed mining site which applicant owns, leases or has an option to purchase or lease, is provided in Table A-13.

TABLE A-13

EXXON CONTROLLED PROPERTIES
CONTIGUOUS TO PROJECT BOUNDARY

Location	Description	Owner
T35N-R13E		
Town of Lincoln:		
Section 33	SE NW, W 1/2 SE, SE SE, Portion of SW NE Mining Lease	John Campshure 1813 9th Street, Apt. 29 Green Bay, WI 54304
Town of Nashville:		
Section 31	W 1/2 W 1/2 SE	Exxon Corporation 1251 Avenue of the Americas New York, N.Y. 10020
T35N-R12E		
Town of Nashville:		
Section 24	NE NE, W 1/2 NE, NW, S 1/2 Mining Lease or Mining Lease With Purchase Option	Mihalko Land and Logging Co. Route 1 Crandon, WI 54520
Section 25	NW NE	Exxon Corporation New York, N.Y. 10020
	SW NE, N 1/2 SW, SE SW North of Road Mining Lease	Raymond Hoffman, et ux Route 1, Box 301 Crandon, WI 54520
Section 36	NW, E 1/2 SW	Exxon Corporation New York, N.Y. 10020

Location	Description	Owner
Town of Nashville:		
Section 4	W 1/2 NE, N 1/2 SW, SW SW, NW SE Mining Lease	CFI Mineral Associates I c/o Connor Securities Co. P. O. Box 2320 Minneapolis, MN 55402 CFI Mineral Associates II 3229 North 8th Street Wausau, WI 54401 CFI Mineral Associates III (Wisconsin) 550 South Avenue Glencoe, IL 60022 CFI Mineral Associates IV 17 Bramble Lane Riverside, CT 06878

SECTION A - ITEM 14

The following information on minimization of disturbance to wetlands is presented in accordance with the requirements of Section NR 132.06 (4), Wisconsin Administrative Code.

In accordance with NR 132.06 (4), a primary goal of the Project facilities site selection process was the selection of sites that would result in the least overall adverse environmental impact. Avoidance of wetlands, to the extent practicable, was a primary consideration used to locate mining facilities, mine waste disposal facilities, and access corridors. Siting alternatives and their relationship to wetlands are described in Chapter 3 of the Environmental Impact Report. Figures A14-1 through A14-9 show the location of wetlands in relation to the proposed and alternative sites for Project facilities. Water draining off the reclaimed tailing ponds will enter the watershed areas shown on Figure A14-10. Further information on the water balance for the reclamation cap and the perimeter area of the mine waste disposal facility (MWDF) is presented in Ayres Associates (1985a,b).

Exxon was able to locate the mine and mill surface facilities at a site providing the least overall environmental impact and also avoid direct impact to any wetlands. However, as noted in NR 132.06 (4), in some cases it is virtually impossible to avoid some impact on wetlands for all facilities and still select sites that are most favorable, taking into account all pertinent environmental and social factors.

Because of the amount of land needed for some facilities, such as the MWDF, selection of sites with the least overall environmental impact has required limited wetland use. However, Exxon conducted, through its contractors, intensive studies to identify and characterize existing wetlands in the Project area. (See Crandon Project - Wetlands Assessment Reports by Normandeau Associates, Inc., and Interdisciplinary Environmental Planning Inc. [1982] and Interdisciplinary Environmental Planning, Inc. [1983]). These studies provided the basis for identification of potential disposal sites within Area 41, location of the access road and railroad spur corridors, and selection of the routes for the haul road/tailings transport pipeline corridor and water discharge pipeline. The results of these investigations also provided a qualitative comparison of wetlands impacted by proposed Project alternatives, using the evaluation criteria cited in NR 132.06 (4). The criteria include the wetlands biological functions; watershed functions; recreational, cultural and economic value; scarcity; and value as an aquatic study area, sanctuary and refuge.

The results of the siting evaluation process show that most of the proposed alternatives impact less wetlands or wetlands of lower value, considering all evaluative criteria, than the secondary alternatives. Table A14-1 identifies the proposed and secondary alternatives for the mine/mill site; MWDF site and access corridors; as well as the approximate acreage of each wetland impacted.

The proposed access road corridor will disturb less wetland area than Alternate A-1, but it will disturb 1.2 acres more wetland area than Alternate E, the only other viable alternate. The wetlands along

Route E are primarily shallow marsh wetlands which are relatively sparse communities in the study area. However, even if the wetlands along Route E were of less relative value than those along the proposed route, the overall social and environmental impacts associated with Route E are considered higher than the proposed route. This is because of Route E's proximity to residential areas, including the residential areas of the Sokaogon Chippewa Community. The proposed access road results in a reduction of overall traffic-related impacts to the northern part of the residential area of approximately 75 percent over what it would otherwise be if Route E is used to access the mine/mill facility.

The proposed railroad spur disturbs less wetland area than the other five routes (Table A14-1). This route, although longer than many of the other alternatives, and therefore more costly, was selected as the proposed alternate. It is also more distant from nearby osprey and eagle nests than most of the secondary alternatives. For these reasons it is felt that the proposed alternative represents the one with the least overall environmental impact.

Five potential routes were evaluated for the haul road/tailings transport pipeline corridor and each would affect less than 1 acre of wetlands (Table A14-1). The proposed route would disturb approximately 0.6 acre of wetlands and alternative routes 1, 3 and 4 would disturb about the same area. No wetlands greater than 0.25 acre in area would be disturbed by alternative route 5; however, this route would require the relocation of about 950 to 1,150-foot segment of Sand Lake Road and widening of the existing road corridor to accommodate the haul road and the buried pipelines. Route 5 would also be longer than

the proposed and other alternative routes. Route 2 was judged to have less overall impact when consideration was given to length of the route, wetland area affected, and potential disturbance to Skunk Lake and Sand Lake Road.

Two water discharge pipeline routes were evaluated for the Project with Route A being the proposed route. Even though Route A would have a greater impact on wetlands than Route B (Table A14-1), several other environmental factors were used in selecting the proposed route. Selection of Route B would require that water be discharged into a section of Swamp Creek designated as a Class II trout stream. Also, the discharge site for Route B is upstream of Rice Lake which is part of an extensive wetland system producing wild rice which is commercially and culturally important to the Mole Lake Sokaogon-Chippewa Community. When the overall potential for environmental impacts was considered, Route A was judged to have less impact on the environment.

Selection of the proposed MWDF area involved an intensive and phased process supported by several environmental and engineering design consultants. The selection process and a detailed explanation for the selection of the proposed area are provided in the Crandon Project Site Report - Review of Potential Alternatives - Mine Waste Disposal Areas (1982).

Based on federal and state concerns over the loss of wetlands and the regulatory trends which restrict the use of wetlands as disposal sites, Exxon eliminated lowland areas as potential areas in the last phase of the siting process. This decision was made as a result of

advice provided by the DNR. This eliminated three of the final five potentially viable areas under investigation.

The two viable Areas, 40 and 41, both contain wetlands. Within these areas and on land owned, leased or under option by the Applicant, it was not possible to locate the facility in an area not containing wetlands. As shown on Table A14-1, the proposed alternative Area 41 contains approximately 55 acres of wetlands, whereas the secondary alternate contains approximately 40 acres of wetlands. If minimization of wetland impacts was the only factor to consider, Area 40 would be a good alternative. However, when all environmental factors are considered, Area 41 represents the area that results in the least overall adverse environmental impact. This is primarily because Area 41 contains over twice the thickness of low permeability, fine-grained till above the water table than does Area 40. Also, Area 41, unlike Area 40, has very little domestic use of ground water down-gradient from the immediate area, which provides much greater attenuation and buffer capability for protection of the ground water system. These and other characteristics of Area 41 described in the siting report suggest that, although Area 41 contains 15 acres more wetland than Area 40, it is still the area with the least overall environmental impact.

Within Area 41, several disposal sites were evaluated. Site 41-114B was initially proposed for the Project. Alternative disposal sites within Area 41 included 41-103 and 41-121. Subsequent to the selection of site 41-114B, changes in the Project plan allowed a reduction in size of the MWDF. The revised facility is designated Site

41-114C and it is a smaller facility that primarily fits within the footprint of Site 41-114B.

The following comparative evaluation is primarily restricted to Sites 41-114B, 41-103 and 41-121 since site 41-114C is a refinement of Site 41-114B.

As shown on Table A14-1, Sites 41-103, 41-114C, and 41-121 will use less wetland than Site 41-114B. However, Site 41-103 is within 558 feet of Duck Lake. This does not meet the location criteria of NR 182.07(b) that the facility should not be located "within 1,000 feet of any navigable lake, pond or flowage." Also Site 41-103 does not provide as much soil buffer above the water table as does 41-114B. Therefore, although Site 41-114B may require more wetland disturbance than Site 41-103, use of Site 41-103 is prohibited by NR 182.07(b). The proposed site (41-114C) offers the greatest capacity to eliminate adverse impacts to surrounding ground and surface water ecosystems, including nearby wetlands. The additional wetland types involved are also perched wetlands of nominal to moderate value based on evaluation criteria cited in NR 132.06 (4) (Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc., 1982).

Alternative Site 41-121 would impact less wetland acreage than Site 41-114B and 9.5 acres more than Site 41-103 (Table A14-1). Preliminary construction plans indicate that the tailing pond bottoms for Site 41-121 would be considerably closer to the ground water table than the other alternative sites evaluated. This is viewed as a disadvantage since Area 41 soils have favorable attenuative capacities.

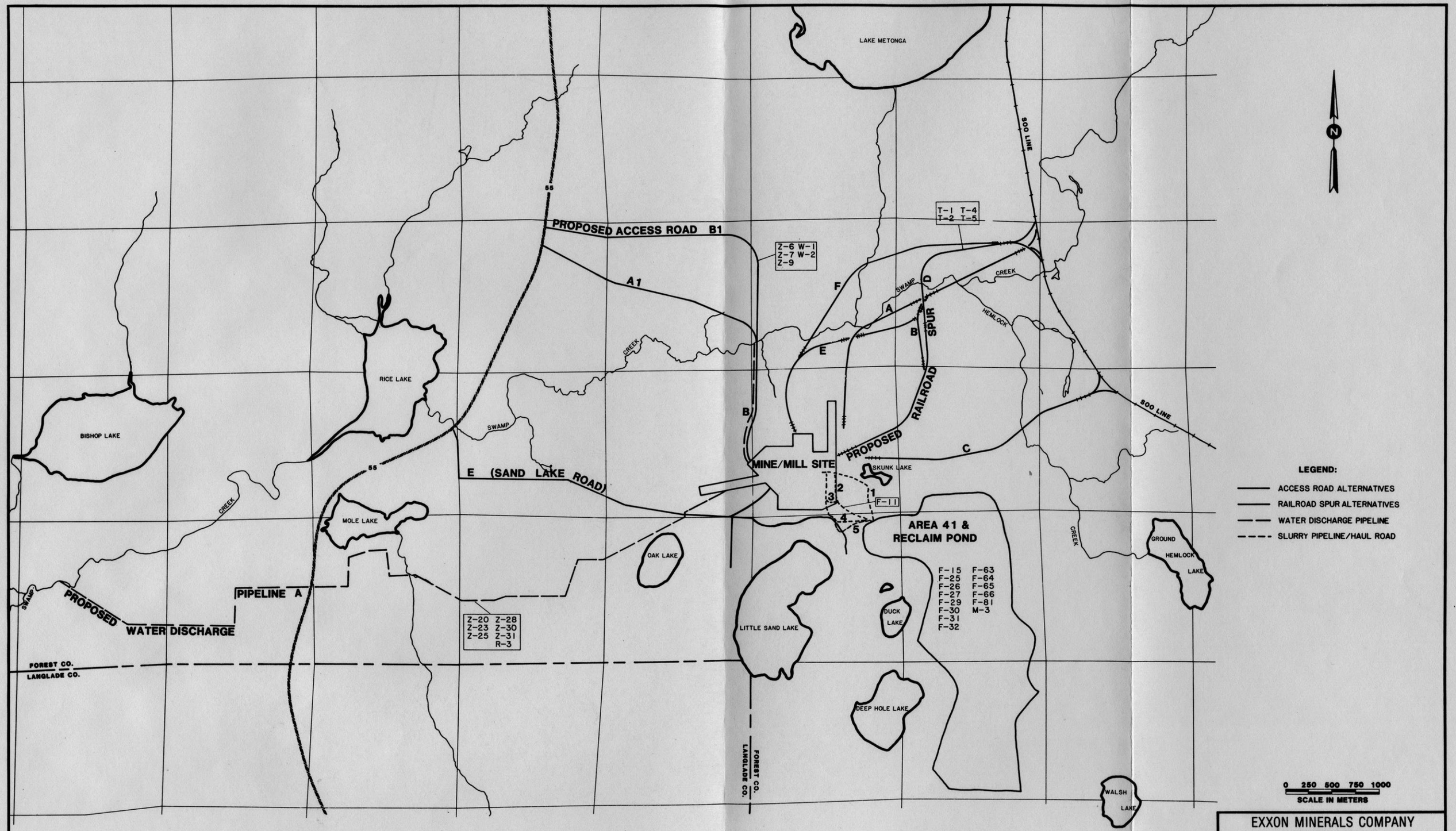
In conclusion, the siting process used to locate facilities for the Project ensured the selection of sites offering the least

adverse environmental impact in accordance with NR 132.06 (4), including, where viable, the minimization of impacts to wetlands.

TABLE A14-1

COMPARISON OF APPROXIMATE WETLAND ACRES IMPACTED
BY PROJECT ALTERNATIVES

FACILITIES		WETLANDS IMPACTED acres
Mine/Mill Facilities		
A	Proposed Site	0
B		0
Access Road		
B-1	Proposed Route	3.2
A-1		6.9
E		1.0
Railroad Spur		
D	Proposed Route	3.1
A		6.4
B		4.8
C		7.1
E		5.6
F		5.4
Mine Waste Disposal Facility Area		
Area 41	Proposed Area	55.0
Area 40		39.5
Mine Waste Disposal Facility Site		
41-114C	Proposed Site	45.0
41-114B		55.0
41-103		33.4
41-121		42.9
Haul Road/Tailing Transport Pipeline		
2	Proposed Route	0.6
1		0.4
3		0.6
4		0.4
5		0.0
Water Discharge Pipeline		
A	Proposed Route	6.8
B		0.6



REVISED	DATE	BY	DESCRIPTION
1	12-26-85	DRS	Updated Mine/Mill Site & MWDF Area

Typical Representation: Refinements May Be Made During Final Design.

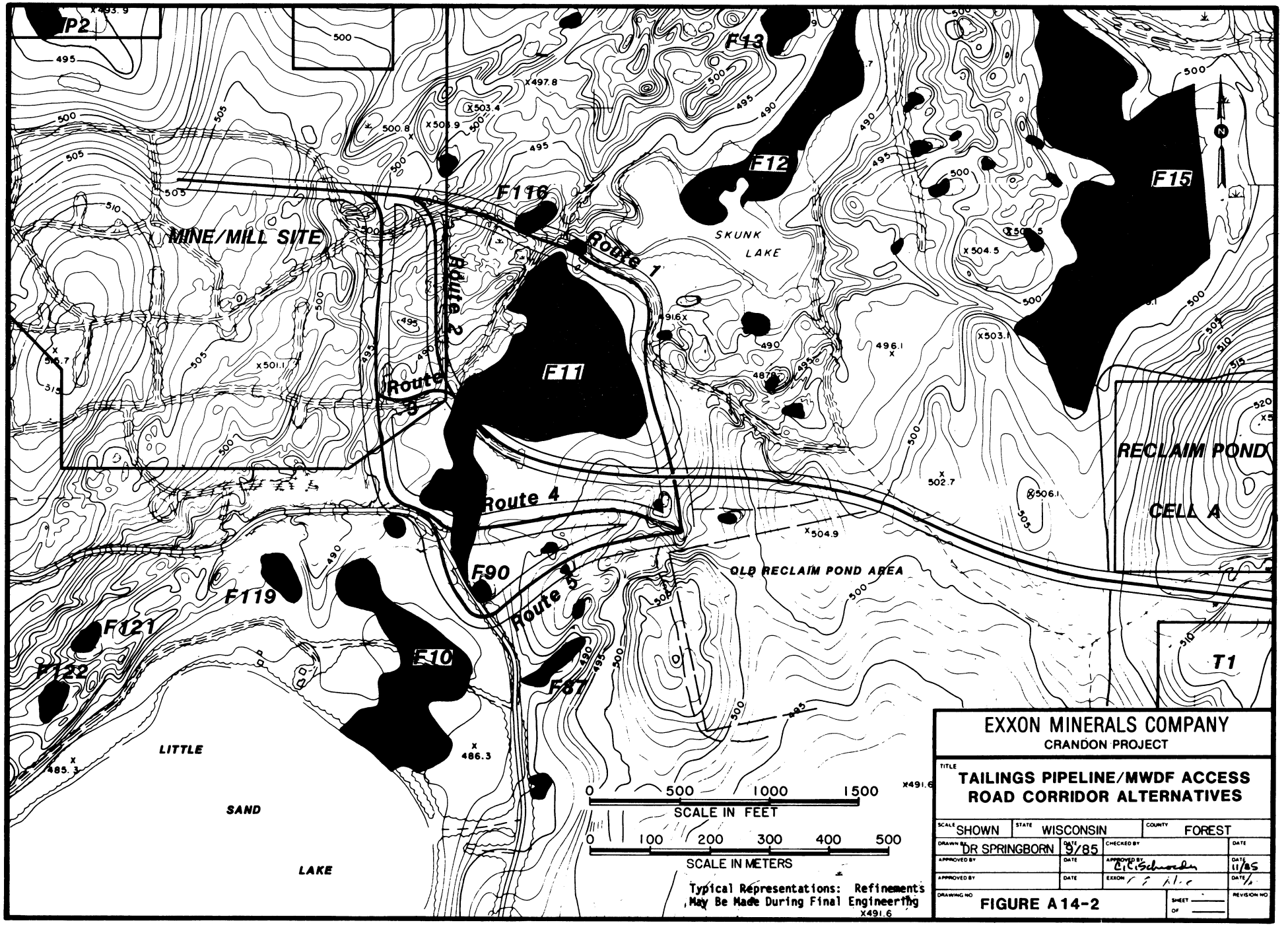
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WETLANDS ASSOCIATED WITH PROPOSED PROJECT FACILITIES

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY C.A. HACKER	DATE 12/82	CHECKED BY R.J. Kaun	DATE 12/16/82
APPROVED BY	DATE	APPROVED BY C.C. Schoch	DATE 12/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO.		SHEET OF	REVISION NO. 1

FIGURE A14-1

GBB 8/1981


P2
F13
F12
F15
F116
MINE/MILL SITE
SKUNK
LAKE
Route 1
Route 2
Route 3
F11
RECLAIM POND
CELL A
Route 4
F90
OLD RECLAIM POND AREA
Route 5
F119
F121
F122
F10
F87
T1
LITTLE
SAND
LAKE
0 500 1000 1500
SCALE IN FEET
0 100 200 300 400 500
SCALE IN METERS
Typical Representations: Refinements May Be Made During Final Engineering
X491.6
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
TAILINGS PIPELINE/MWDF ACCESS ROAD CORRIDOR ALTERNATIVES
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
DATE 9/85
CHECKED BY
DATE
APPROVED BY
DATE
APPROVED BY C.C. Schroeder
DATE 11/85
APPROVED BY
DATE
EXXON
DATE
DRAWING NO
FIGURE A14-2
SHEET
OF
REVISION NO

ALTERNATIVE WATER DISCHARGE ROUTE B

ROUTE A

MINE/MILL SITE

DISCHARGE

WATER

SKUNK LAKE

OAK LAKE

LITTLE SAND LAKE

DUCK LAKE

MOLE LAKE

BISHOP LAKE

WATER DISCHARGE POINT

SWAMP

CREEK

PIPELINE ROUTE

MATCHLINE

MATCHLINE (SEE PAGE 1)

0 600 1200 1800 METERS

LEGEND:
EXISTING CULVERT

NOTE: SHADED AREAS DESIGNATE WETLANDS

0 100 200 300 400 500
SCALE IN METERS

Typical Representations Refinements May Be Made During Final Design.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: LOCATION OF WETLANDS IN RELATION TO THE WATER DISCHARGE PIPELINE ROUTE

SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: R.C. DIETZ	DATE: 12/82	APPROVED BY: C.C. Schneider	DATE: 12/82
APPROVED BY	DATE	APPROVED BY	DATE
DRAWING NO			REVISION NO

FIGURE A14-3

SHEET 2 OF

ROUTE B-1

ROUTE A-1

SAND LAKE ROAD

ROUTE E

MINERAL SITE

NOTE: SHADED AREAS DESIGNATE WETLANDS

SCALE IN FEET
0 100 200 300 400 500

SCALE IN METERS
0 500 1000 1500

LEGEND:
EXISTING CULVERT

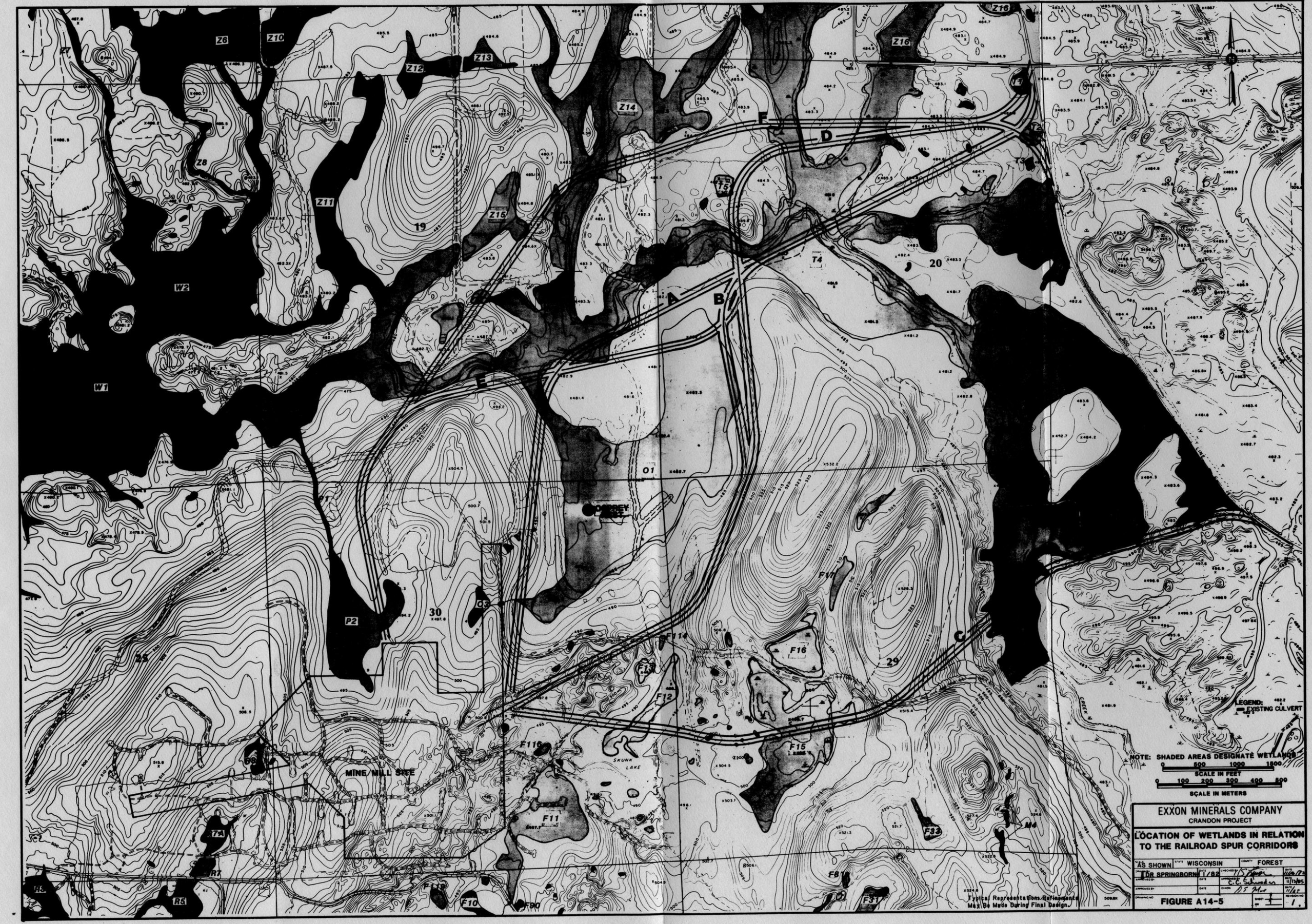
Typical Representation Only
May Be Made During Final Design

EXXON MINERALS COMPANY
CRANDON PROJECT

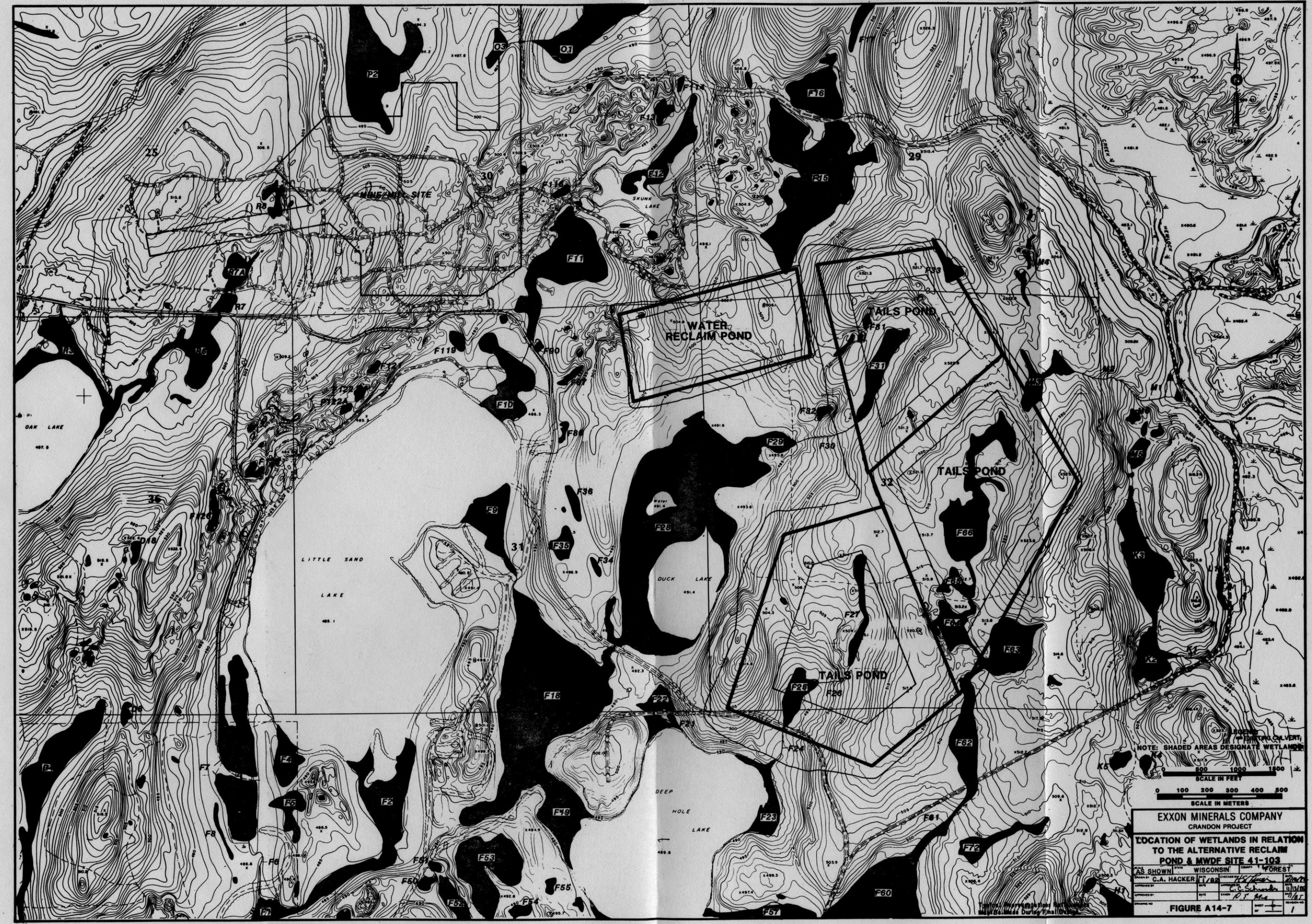
LOCATION OF WETLANDS IN RELATION TO THE ACCESS ROAD CORRIDORS

AS SHOWN | WISCONSIN | FOREST
DRAWN BY R.C. DIETZ | CHECKED BY | DATE 11/5/82
APPROVED BY | DATE | CHECKED BY | DATE
APPROVED BY | DATE | ENGR. | DATE
DRAWING NO. | SHEET NO. | REVISION NO. 1

FIGURE A14-4


Z6
Z10
Z7
Z12
Z13
Z14
Z16
Z8
Z11
Z15
19
20
W2
W1
A
B
D
F
E
T4
T5
T6
T7
O1
O3
CORREY CREEK
P2
30
25
29
F17
F16
F14
F13
F12
F15
F11
F10
F9
F8
F31
F32
M4
SKUNK LAKE
MINE/MILL SITE
7A
R7
R5
CREEK
LEGEND:
482.2 EXISTING CULVERT
NOTE: SHADED AREAS DESIGNATE WETLANDS
0 500 1000 1500
SCALE IN FEET
0 100 200 300 400 500
SCALE IN METERS
EXXON MINERALS COMPANY
CRANDON PROJECT
LOCATION OF WETLANDS IN RELATION TO THE RAILROAD SPUR CORRIDORS
AS SHOWN
WISCONSIN
FOREST
FOR SPRINGBORN
FIGURE A14-5
Typical Representations/Refinements May Be Made During Final Design


WATER RECLAIM PONDS
R1
R2
WASTE DISPOSAL P
MINE SOIL SITE
SKUNK LAKE
LITTLE SAND LAKE
DUCK LAKE
DEEP HOLE LAKE
OAK LAKE
NOTE: SHADED AREAS DESIGNATE WETLANDS
0 500 1000 1500
SCALE IN FEET
0 100 200 300 400 500
SCALE IN METERS
EXXON MINERALS COMPANY
CRANDON PROJECT
LOCATION OF WETLANDS IN RELATION TO THE ALTERNATIVE RECLAIM PONDS & MWDF SITE 41-114B
AS SHOWN
WISCONSIN
FOREST
R.C. DIETZ
FIGURE A14-6


MINE/MILL SITE
WATER RECLAIM POND
TAILS POND
TAILS POND
TAILS POND
SKUNK LAKE
LITTLE SAND LAKE
DUCK LAKE
DEEP HOLE LAKE
OAK LAKE
CREEK
CREEK
25
30
29
31
32
36
37A
R3
R5
R7
F1
F2
F4
F5
F6
F7
F8
F10
F11
F12
F13
F14
F15
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F89
F90
F91
F92
F93
P2
D16
D18
K1
K2
K3
K4
K5
K6
M1
M2
M3
M4
M5
M6
M7
M8
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M17
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M19
M20
M21
M22
M23
M24
M25
M26
M27
M28
M29
M30
M31
M32
M33
M34
M35
M36
M37
M38
M39
M40



EXXON MINERALS COMPANY

CRANDON PROJECT

LOCATION OF WETLANDS IN RELATION TO THE ALTERNATIVE RECLAIM POND & MWDF SITE 41-121

SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: C.A. HACKER	DATE: 1/82	CHECKED BY:	DATE:
APPROVED BY:	DATE:	APPROVED BY: C.C. Schroeder	DATE: 11/15/85
APPROVED BY:	DATE:	EXXON: D.F. Fiske	DATE: 11/85
DRAWING NO:		SHEET 1 OF 1	REVISION NO: 1

FIGURE A14-8

MINE/MILL SITE

WATER RECLAIM POND

BORROW AREA

CELL A

CELL B

CELL C

CELLS 1 2 3

MRDF

CSA

WASTE DISPOSAL PONDS

OAK LAKE

LITTLE SAND LAKE

SKUNK LAKE

DUCK LAKE

DEEP HOLE LAKE

NOTE: SHADED AREAS DESIGNATE WETLANDS

0 500 1000 1500

SCALE IN FEET

0 100 200 300 400 500

SCALE IN METERS

EXXON MINERALS COMPANY

CRANDON PROJECT

LOCATION OF WETLANDS IN RELATION TO THE PROPOSED RECLAIM POND & MWDF SITE 41-114C

SCALE SHOWN | STATE WISCONSIN | COUNTY FOREST

DRAWN BY GR SPRINGBORN | DATE 12/85 | CHECKED BY | DATE

APPROVED BY | DATE | APPROVED BY C.T. Schneider | DATE 8/15/86

APPROVED BY | DATE | ENGR. R.S. Moe | DATE 7/31/86

DRAWING NO. | SHEET OF | REVISION NO.

FIGURE A14-9

PROPOSED CONDITION DRAINAGE BOUNDARIES

NORTH

HEMLOCK CREEK

F-18

RECLAIM POND AREA

NORTH DRAINAGE SWALE

M-1

WEST DRAINAGE SWALE

EAST DRAINAGE SWALE

COMPLIANCE BOUNDARY

DUCK LAKE

SOUTH DRAINAGE SWALE

DEEP HOLE LAKE

F-23

F-57

SCALE: APPROX. 1" = 300'

LEGEND

- PROPOSED BASIN DIVIDE
- WETLAND AREA AND DESIGNATION
- TOE OF PROPOSED MWDF
- DRAINAGE DIRECTION
- RECLAIM POND AREA

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
FINAL RECLAMATION
DRAINAGE BOUNDARIES

SCALE: SHOWN | STATE: WISCONSIN | COUNTY: FOREST

DRAWN: DR SPRINGBORN 12/85 | CHECKED: C.C. Schneider 12/12/85

APPROVED: | DATE: | LAYOUT: D.R.S. 7/86 | DATE: 7/86

DRAWING NO: FIGURE A14-10 | SHEET OF | REVISION NO | DATE

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_____, 1985b, Water balance analyses for wetlands in the revised mine waste disposal facility area: Revisions November 1985. Eau Claire, Wisconsin.

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SECTION A - ITEM 15

MONITORING AND QUALITY ASSURANCE PLAN

CRANDON PROJECT

Exxon Minerals Company
Rhinelander, Wisconsin

Revised
December 1985

MONITORING AND QUALITY ASSURANCE PLAN

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MONITORING AND QUALITY ASSURANCE PLAN

1.0 INTRODUCTION

The Monitoring and Quality Assurance Plan (Monitoring Plan) developed for the Crandon Project (Project) is responsive to NR 132.06(3)(d) and NR 182.08(2)(e)8, and includes programs for ground water, surface water, aquatic ecology, air quality, and terrestrial ecology during the construction, operation and closure (reclamation) phases of the Project. As such, the Monitoring Plan is designed to provide data for evaluation of Project activities at the mine, mill, reclaim pond, mine refuse disposal facility (MRDF), mine waste disposal facility (MWDF), other associated activities, and their environs.

The focus and rationale of the Monitoring Plan are to provide information on the performance of the environmental protection designs and system operations for the Project. Other elements of the Monitoring Plan are intended to confirm the predictive tools used in the design and planning of the Project, and as a source of information for mitigative/contingency and reclamation planning. Further, because the mitigation planning incorporates techniques to prevent or eliminate various effects related to the Project, monitoring programs have been provided to obtain efficient, effective, and appropriate data.

Quality Assurance/Quality Control Procedures (QA/QC) will be required for all programs of the Monitoring Plan. Exxon Minerals Company (EMC) will require QA/QC submittals from all of its prospective contractors. Prior to initiating any monitoring program, specific QA/QC

documents will be developed for the individual tasks and submitted to the DNR for approval. These QA/QC documents typically would include: methodology for sample collection, transportation, and storage; techniques used for the sample analyses; data verification and evaluations to be performed; and presentation format for the information. Each approved QA/QC document will then contain the standard operating procedures for completing its particular monitoring program. The developed QA/QC documents will assure reliable and valid data collection and evaluation from the monitoring programs.

Finally, all monitoring programs will be discussed with Wisconsin Department of Natural Resources (DNR) personnel on a regular basis. Similarly, modifications to the Monitoring Plan will be discussed as required throughout its implementation. Further, all monitoring programs will be reviewed and discussed with the DNR prior to initiation.

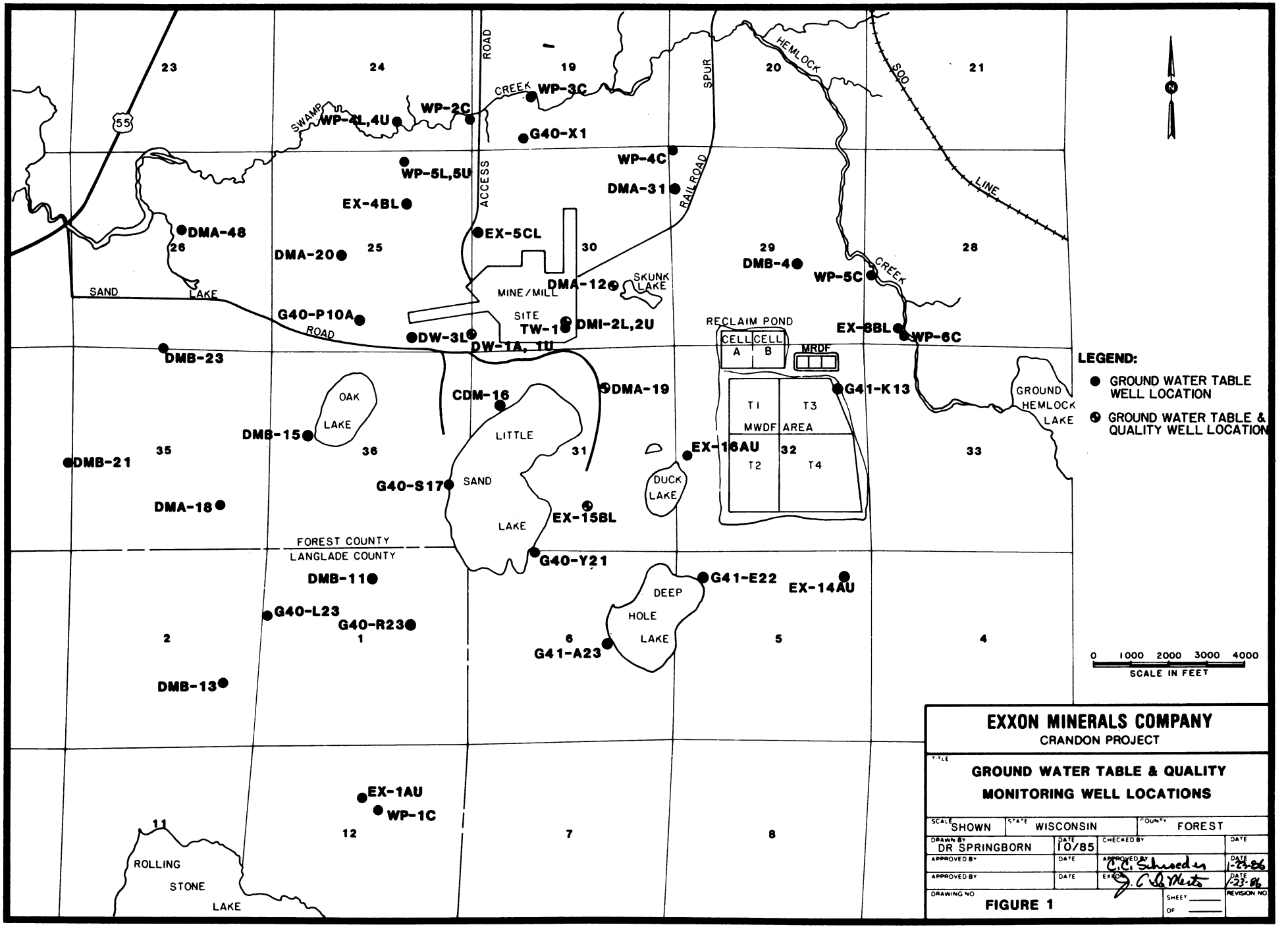
2.0 GROUND WATER

The ground water monitoring program is designed to be responsive to NR 132.06, NR 180.13, NR 182.075, and NR 182.08(2)(e)8. Its main objective as stated in NR 182.075, ". . . is to provide a site specific . . . minimizing (of) impacts on ground water quality, in order to assure that deviations from baseline ground water quality will be limited to deviations which will not violate the ground water quality standards . . . or render the ground water unfit for present or future use as determined by this section." It involves two subprograms: I - Background (Preconstruction), and II - Construction, Operation, Closure (Reclamation) Monitoring. Subprogram I will be conducted a minimum of one year prior to construction of any of the facilities, and Subprogram II will commence with initial construction activities and is designed to continue throughout operations and reclamation (including closure and long-term care).

2.1 Subprogram I -- Background (Preconstruction) Monitoring

2.1.1 Ground Water Table and Quality

The spacial relationships of the mine, mill, MRDF, MWDF, reclaim pond, and surface water bodies are shown on Figure 1. Also shown on this figure are the ground water sampling locations for Subprogram I (Table 1). The ground water table wells were selected based on the modeling predictions of ground water flow rates into the mine and the resulting reduction (drawdown) in the water table (D'Appolonia, 1985). The ground water table elevations (level) will be monitored from 45 wells (piezometers) surrounding the Project facilities (Figure 1).



EXXON MINERALS COMPANY

CRANDON PROJECT

TITLE

GROUND WATER TABLE & QUALITY MONITORING WELL LOCATIONS

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 1-22-86
APPROVED BY	DATE	EXXON J. C. Mertz	DATE 1-23-86
DRAWING NO **FIGURE 1**		SHEET OF	REVISION NO

Table 1. Subprogram I -- Background (Preconstruction) ground water monitoring program for the Crandon Project indicating wells, screen depth intervals, parameters measured, and sampling frequency.

Sampling Location	Screen Depth Interval[a]	Sampling Frequency	Parameters Measured
Monitoring Wells			
Ground Water Table and Quality			
CDM-16	485-484	Quarterly	1
DMA-12	482-480	Quarterly	2
DMA-18	473-472	Quarterly	1
DMA-19	480-479	Quarterly	2
DMA-20	470-469	Quarterly	1
DMA-31	479-478	Quarterly	1
DMA-48	464-463	Quarterly	1
DMB-4	480-477	Quarterly	1
DMB-11	478-475	Quarterly	1
DMB-13	475-472	Quarterly	1
DMB-15	478-475	Quarterly	1
DMB-21	463-460	Quarterly	1
DMB-23	449-446	Quarterly	1
DMI-2L	456-454(BR)[b]	Quarterly	2
DMI-2U	481-480	Quarterly	2
DW-1A	485-481	Quarterly	2
DW-1U	474-473	Quarterly	2
DW-3L	466-465	Quarterly	1
EX-1AU	443-442	Quarterly	1
EX-4BL	492-488	Quarterly	1
EX-5CL	480-475	Quarterly	1
EX-8BL	462-461	Quarterly	1
EX-14AU	482-478	Quarterly	1
EX-15BL	485-480	Quarterly	2
EX-16AU	460-459	Quarterly	1
G40-L23	476-473	Quarterly	1
G40-P10A	477-474	Quarterly	1
G40-R23	474-471	Quarterly	1
G40-S17	451-448	Quarterly	1
G40-X1	470-467	Quarterly	1
G40-Y21	482-480	Quarterly	1

Table 1 (continued)

Sampling Location	Type[c]	Screen Depth Interval[a]	Sampling Frequency	Parameters Measured
G41-A23		479-477	Quarterly	1
G41-E22		449-446	Quarterly	1
G41-K13		439-436	Quarterly	1
TW-1		476-471	Quarterly	1
WP-1C[d]		e	Quarterly	1
WP-2C[d]		e	Quarterly	1
WP-3C[d]		e	Quarterly	1
WP-4C[d]		e	Quarterly	1
WP-4L		461-460	Quarterly	1
WP-4U		470-468	Quarterly	1
WP-5C[d]		e	Quarterly	1
WP-5L		463-462	Quarterly	1
WP-5U		471-470	Quarterly	1
WP-6C[d]		e	Quarterly	1
MWDF				
DMB-6	I	485-482 (T)[b]	Monthly	2
EX-9AL	I	437-436 (BR)	Monthly	2
EX-9AU	I	447-446 (FSD)	Monthly	2
EX-9BL	I	464-463 (CSD)	Monthly	2
EX-9BU	I	486-480 (BT)	Monthly	2
EX-10 AU	B	451-450 (FSD)	Monthly	2
EX-12 AL	I	426-425 (LAC)	Monthly	2
EX-12 AU	I	444-443 (T)	Monthly	2
EX-12 BL	I	459-458 (CSD)	Monthly	2
EX-12 BU	I	482-477 (T)	Monthly	2
EX-13 BU	I	462-461 (CSD)	Monthly	2
EX-14 AL	B/C	432-431 (LAC)	Monthly	2 and 3
EX-14 AU	B/C	452-451 (FSD)	Monthly	2 and 3
EX-14 BL	B/C	465-464 (T)	Monthly	2 and 3
EX-14 BU	B/C	482-478 (CSD)	Monthly	2 and 3
EX-16 AL	B	450-449 (FSD)	Monthly	2
EX-16 AU	B	460-459 (T)	Monthly	2
EX-16 BL	B	476-471 (CSD)	Monthly	2
G41-E17	I	436-433 (BT)	Monthly	2
G41-E19A	B/C	467-464 (CSD)	Monthly	2
G41-H18B	I	468-465 (CSD)	Monthly	2
G41-K13	I	439-436 (CSD)	Monthly	2

Table 1 (continued)

Sampling Location	Type[c]	Screen Depth Interval[a]	Sampling Frequency	Parameters Measured
MW1-C[d]	B/C	e	Monthly	2 and 3
MW1-F[d]	B/C	e	Monthly	2 and 3
MW1-T[d]	B/C	e	Monthly	2 and 3
MW2-C[d]	B/C	e	Monthly	2 and 3
MW2-F[d]	B/C	e	Monthly	2 and 3
MW2-T[d]	B/C	e	Monthly	2 and 3
MW3-C[d]	B/C	e	Monthly	2
MW3-F[d]	B/C	e	Monthly	2
MW3-T[d]	B/C	e	Monthly	2

a. Elevation in meters above mean sea level (MSL).
b. T = till; BR = bedrock; BT = basal till; CSD = coarse stratified drift; FSD = fine stratified drift; LAC = lacustrine.
c. B = background; C = compliance; I = intermediate; B/C = background and/or compliance.
d. Proposed new well.
e. Screen depth interval for new wells will be determined from the hydrostratigraphy during installation.

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

Initially, 7 of the 45 wells will also be monitored for ground water quality (Figure 1). The objective of the ground water quality measurements is to obtain a long-term record of the ground water quality related to Project activities. Subprogram I data will initiate the long-term record by providing the initial background measurements.

The ground water quality parameters measured will be "indicator parameters" which give a rapid and general quantification of the ground water quality. These parameters will be the "core" parameters which will be consistently monitored throughout the Project and represent the parameters meeting the requirements of NR 132.11 and NR 182.13. If these "indicator parameters" are found to have a statistically significant difference ($P \geq .05$) among the wells sampled, further analyses for these and appropriate additional parameters will be considered to further evaluate the situation and the need for implementation of contingency and mitigation measures.

Monitoring of these wells for ground water table elevations and quality will begin one year prior to the construction phase. Initial piezometer and ground water quality measurements will be obtained on a quarterly basis (Table 1).

2.1.2 MWDF

The Subprogram I ground water monitoring program for the MWDF has been developed to include monitoring near the compliance boundary, and at intermediate points between the facility and the compliance boundary to meet the requirements of NR 182.075 and NR 182.13. Ground water monitoring will utilize the following types of wells:

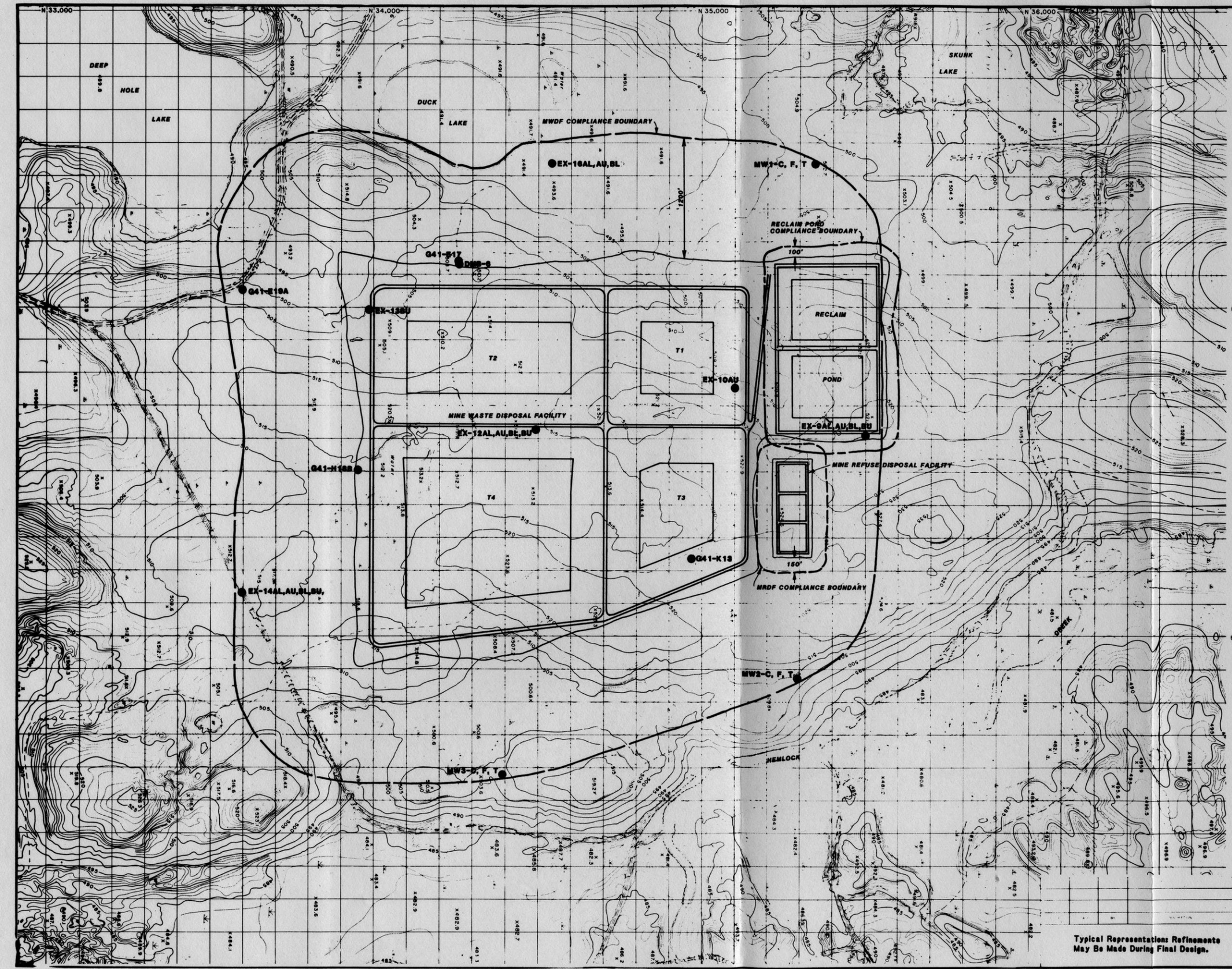
1) Compliance boundary wells to monitor ground water quality and potentiometric surface (water table level) at or near the compliance boundary;

2) Intermediate wells to monitor ground water quality and water table levels within and outside the compliance boundary; and

3) Background wells to monitor ground water quality and water table levels within and outside the compliance boundary.

Wells associated specifically with the MWDF ground water Subprogram I monitoring are shown on Figure 2. This well system consists of 22 existing wells and 9 wells to be installed during the early stages of construction of the MWDF for a total of 31 monitor wells. Table 1 provides a summary list of these wells and includes the type, the hydrostratigraphic unit to be monitored, and the screen depth interval.

The compliance boundary wells will also function as background wells in Subprogram I. These wells (EX-14AL, AU, BL, BU, G41-E19A, MW1-C, F, T, MW2-C, F, T, and MW3-C, F, T) are located near the compliance boundary of the MWDF. They as well as the EX-16 AL, AU, BL background wells are intended to provide reference ground water quality and water table data during MWDF construction, but prior to any tailings disposal (Table 1).



GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

Typical Representations: Refinements May Be Made During Final Design.

EXXON MINERALS COMPANY
CRANDON PROJECT

MWDF BACKGROUND MONITORING WELL LOCATIONS

SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: DR SPRINGBORN	DATE: 11/85	RECOMMENDED: C.C. Schneider	DATE: 1-22-86
APPROVED BY:	DATE:	APPROVED: J.P. Whitmore	DATE: 1-22-86
DRAWING NO: FIGURE 2		SHEET OF	REVISION NO

These monitoring wells will also function as background wells during facility operation since they are located to assure that one of them is always upgradient of the ground water table drawdown and lateral movement (i.e., flow). However, initial ground water quality monitoring from the intermediate and compliance boundary wells is scheduled during the construction phase as another set of background measurements.

Table 1 presents the specific well depths, the parameters to be measured, and the sampling intervals for each ground water table, quality, and MWDF sampling location of Subprogram I. The parameters measured are those contained in the federal and state primary and secondary drinking water standards, with the exception of the organic pesticides. General indicator parameters such as water level and specific conductance will also be measured.

2.2 Subprogram II -- Construction, Operation, and Closure (Reclamation) Monitoring

Monitoring during the construction, operation and closure (reclamation) phases is collectively referenced as operations monitoring. The operations ground water monitoring program also has the objective of compliance with the requirements of NR 132.06, NR 180.13, NR 182.075 and 182.13, and will utilize the sampling locations included in Subprogram I monitoring. The selected well locations will also include monitoring for the reclaim pond (RP1-D, RP2-D, and EX-9AL, AU, BL, BU), preproduction ore storage pad (PPO-1D), and mine refuse disposal facility (RD1-D, T and RD2-D, T).

In addition, lysimeters will be used for monitoring the bottom liner of the individual tailing ponds and refuse disposal cells. The objective of the lysimeters is to give an indication of the effectiveness of the drainage layer and liner at the bottom of the tailing ponds and refuse disposal cells by monitoring the amount of water percolating through these barriers. Water quality of any seeping water can also be measured from the collection segments of the liner lysimeters.

Initially, 2 lysimeters will be installed beneath the liner of the first tailing pond. This same design is planned for the other tailing ponds but changes to the location and/or number of lysimeters may occur as the results of the first tailing pond's monitoring program are evaluated.

2.2.1 Ground Water Table and Quality

The well locations utilized to measure the ground water piezometric surface will be the same as in Subprogram I. The ground water table measurements will also be utilized to provide data related to the Hydrologic Impact Contingency Plan. The data collected from the ground water table wells will be an integral part of the evaluation of the accuracy of the predicted changes to the ground water table and its possible associated effects to surface water. Ground water quality measurements will also be obtained at a minimum on a quarterly basis (Table 2).

Table 2. Subprogram II - Construction, Operation, and Closure (Reclamation) ground water monitoring program for the Crandon Project indicating wells, screen depth intervals, lysimeters, other sampling points, parameters measured, and sampling frequency.

Sampling Location	Screen Depth Interval[a]	Sampling Frequency	Project Years	Parameters Measured
Monitoring Wells				
Ground Water Table and Quality				
CDM-16	485-484	Quarterly	1-66	1
DMA-12	482-480	Quarterly	1-66	2
DMA-18	473-472	Quarterly	1-66	1
DMA-19	480-479	Quarterly	1-66	2
DMA-20	470-469	Quarterly	1-66	1
DMA-31	479-478	Quarterly	1-66	1
DMA-48	464-463	Quarterly	1-66	1
DMB-4	480-477	Quarterly	1-66	1
DMB-11	478-475	Quarterly	1-66	1
DMB-13	475-472	Quarterly	1-66	1
DMB-15	478-475	Quarterly	1-66	1
DMB-21	463-460	Quarterly	1-66	1
DMB-23	449-446	Quarterly	1-66	1
DMI-2L	456-454	Quarterly	1-66	2
DMI-2U	481-480	Quarterly	1-66	2
DW-1A	485-481	Quarterly	1-66	2
DW-1U	474-473	Quarterly	1-66	2
DW-3L	466-465	Quarterly	1-66	1
EX-1AU	443-442	Quarterly	1-66	1
EX-4BL	492-488	Quarterly	1-66	1
EX-5CL	480-475	Quarterly	1-66	1
EX-8BL	462-461	Quarterly	1-66	1
EX-14AU	482-478	Quarterly	1-66	1
EX-15BL	485-480	Quarterly	1-66	2
EX-16AU	460-459	Quarterly	1-66	1
G40-L23	476-473	Quarterly	1-66	1
G40-P10A	477-474	Quarterly	1-66	1
G40-R23	474-471	Quarterly	1-66	1
G40-S17	451-448	Quarterly	1-66	1
G40-X1	470-467	Quarterly	1-66	1
G40-Y21	482-480	Quarterly	1-66	1

Table 2 (continued)

Sampling Location	Type[c]	Screen Depth Interval[a]	Sampling Frequency	Project Years	Parameters Measured
G41-A23		479-477	Quarterly	1-66	1
G41-E22		449-446	Quarterly	1-66	1
G41-K13		439-436	Quarterly	1-66	1
TW-1		476-471	Quarterly	1-66	1
WP-1C[b]		d	Quarterly	1-66	1
WP-2C[b]		d	Quarterly	1-66	1
WP-3C[b]		d	Quarterly	1-66	1
WP-4C[b]		d	Quarterly	1-66	1
WP-4L		461-460	Quarterly	1-66	1
WP-4U		470-468	Quarterly	1-66	1
WP-5C[b]		d	Quarterly	1-66	1
WP-5L		463-462	Quarterly	1-66	1
WP-5U		471-470	Quarterly	1-66	1
WP-6C[b]		d	Quarterly	1-66	1
Reclaim Pond and Preproduction Ore Storage Pad					
RP1-D[b]	C	d	Quarterly	1-29	2
RP2-D[b]	C	d	Quarterly	1-29	2
EX-9AL	I	437-436	Quarterly	1-29	2
EX-9AU	I	447-446	Quarterly	1-29	2
EX-9BL	I	464-463	Quarterly	1-29	2
EX-9BU	I	486-480	Quarterly	1-29	2
PPO-1D[b] (Preproduction Ore Storage Pad)	P	d	Quarterly	1-29	2
MRDF					
RD1-D[b]	I	d	Quarterly	1-66	2
RD1-T[b]	I	d	Quarterly	1-66	2
RD2-D[b]	I	d	Quarterly	1-35	2
RD2-T[b]	I	d	Quarterly	1-35	2
Liner Lysimeters		Beneath Liner	Quarterly	1-66	2
MWDF					
CW1-D[b]	P	d	Quarterly	4-66	2
CW1-T[b]	P	d	Quarterly	4-66	2
CW2-D[b]	P	d	Quarterly	4-66	2
CW2-T[b]	P	d	Quarterly	4-66	2
CW3-D[b]	P	d	Quarterly	4-66	2
CW3-T[b]	P	d	Quarterly	4-66	2
CW4-D[b]	P	d	Quarterly	4-66	2
CW4-T[b]	P	d	Quarterly	4-66	2
DMB-6	I	485-482	Quarterly	1-66	2
EX-9AL	I	437-436	Quarterly	1-32	2
EX-9AU	I	447-446	Quarterly	1-32	2
EX-9BL	I	464-463	Quarterly	1-32	2
EX-9BU	I	486-480	Quarterly	1-32	2

Table 2 (continued)

Sampling Location	Type[c]	Screen Depth Interval[a]	Sampling Frequency	Project Years	Parameters Measured
EX-12AL	I	426-425	Quarterly	1-12	2
EX-12AU	I	444-443	Quarterly	1-12	2
EX-12BL	I	459-458	Quarterly	1-12	2
EX-12BU	I	482-477	Quarterly	1-12	2
EX-14AL	B/C	432-431	Quarterly	1-66[e]	2[e]
EX-14AU	B/C	452-451	Quarterly	1-66[e]	2[e]
EX-14BL	B/C	465-464	Quarterly	1-66[e]	2[e]
EX-14BU	B/C	482-478	Quarterly	1-66[e]	2[e]
EX-16AL	B	450-449	Quarterly	1-66	2
EX-16AU	B	460-459	Quarterly	1-66	2
EX-16BL	B	476-471	Quarterly	1-66	2
G41-E17	I	436-433	Quarterly	1-66	2
G41-E19A	B/C	467-464	Quarterly	1-66	2
G41-H9	B	449-446	Quarterly	4-66	2
G41-H18B	I	468-465	Quarterly	22-66	2
G41-K13	I	439-436	Quarterly	1-11	2
IW1-D[b]	I	d	Quarterly	8-66	2
IW1-T[b]	I	d	Quarterly	8-66	2
IW2-D[b]	I	d	Quarterly	8-66	2
IW2-T[b]	I	d	Quarterly	8-66	2
IW3-D[b]	I	d	Quarterly	15-66	2
IW3-T[b]	I	d	Quarterly	15-66	2
IW4-D[b]	I	d	Quarterly	15-66	2
IW4-T[b]	I	d	Quarterly	15-66	2
IW5-D[b]	I	d	Quarterly	22-66	2
IW5-T[b]	I	d	Quarterly	22-66	2
IW6-D[b]	I	d	Quarterly	22-66	2
IW6-T[b]	I	d	Quarterly	22-66	2
IW7-D[b]	I	d	Quarterly	22-66	2
IW7-T[b]	I	d	Quarterly	22-66	2
MW1-C[b]	B/C	d	Quarterly	1-66[e]	2[e]
MW1-F[b]	B/C	d	Quarterly	1-66[e]	2[e]
MW1-T[b]	B/C	d	Quarterly	1-66[e]	2[e]
MW2-C[b]	B/C	d	Quarterly	1-66[e]	2[e]
MW2-F[b]	B/C	d	Quarterly	1-66[e]	2[e]
MW2-T[b]	B/C	d	Quarterly	1-66[e]	2[e]
MW3-C[b]	B/C	d	Quarterly	1-66	2
MW3-F[b]	B/C	d	Quarterly	1-66	2
MW3-T[b]	B/C	d	Quarterly	1-66	2

Table 2 (continued)

Sampling Location	Screen Depth Interval[a]	Sampling Frequency	Project Years	Parameters Measured
Reclamation Cap Moisture Content	Above and Beneath Top Seal	Quarterly	10-66	4
Liner Lysimeters	Beneath Liner	Quarterly	4-66	2
Leachate	Underdrain	Quarterly; Annual	4-34	2;3
Mine Wells				
9 New Wells	Mine Shafts	Quarterly	30-66	2

a. Elevation in meters above mean sea level (MSL).
b. Proposed new well.
c. B = background; C = compliance; I = intermediate; B/C = background and/or compliance; P = performance.
d. Screen depth interval for new wells will be determined from the hydrostratigraphy during installation.
e. Parameter lists 2 and 3 will be measured in the year following each tailing pond reclamation cap completion and the final year of closure.

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

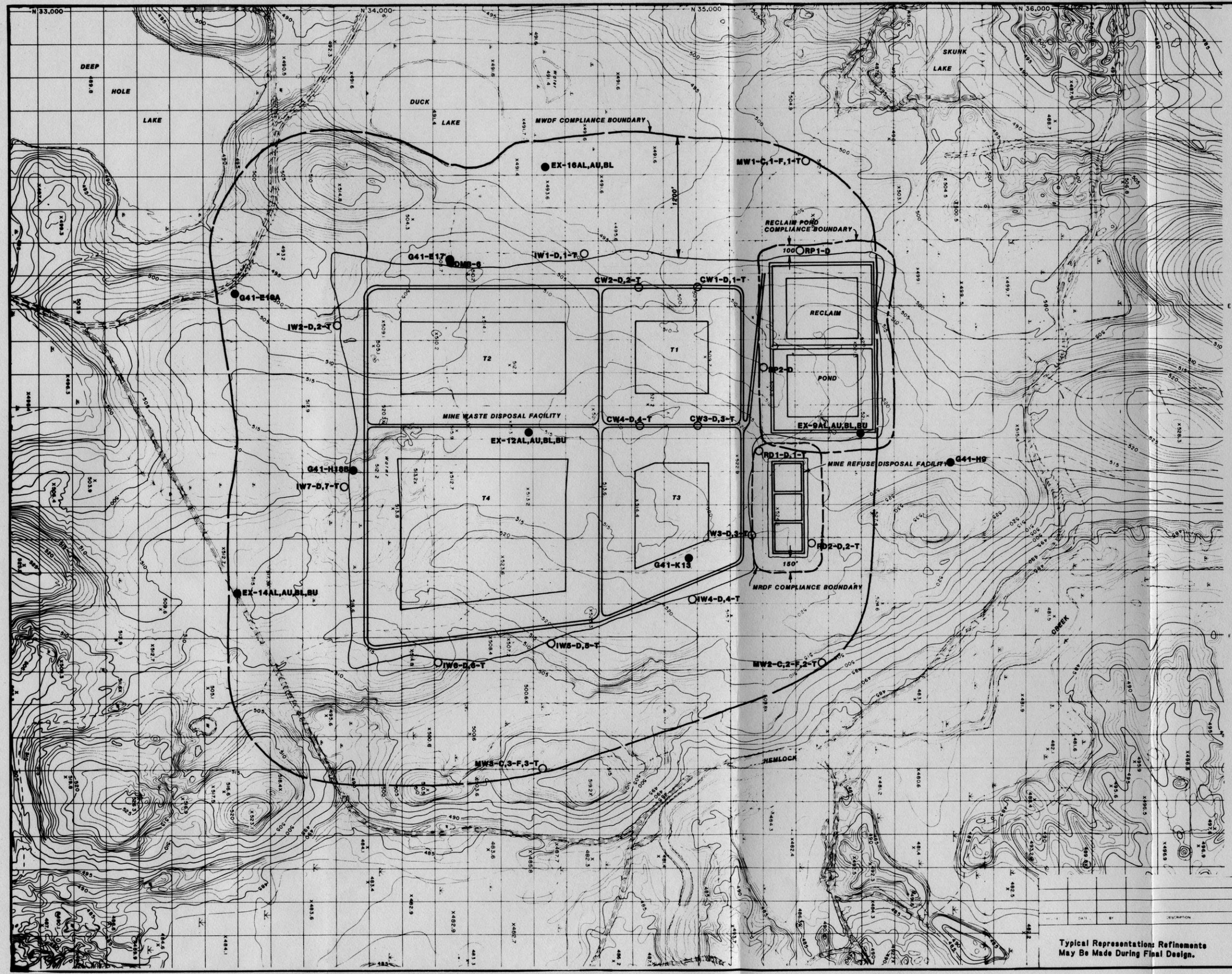
2.2.2 Reclaim Pond, MRDF and Preproduction Ore Storage Pad

The reclaim pond operation phase ground water monitoring wells (RP1-D, RP2-D and EX-9AL, AU, BL, BU) will be sampled initially during pond construction. Similarly, one well will be constructed with development of the preproduction ore storage pad north of the mine/mill site to monitor ground water quality beneath this facility. In addition, three lysimeters, one beneath each refuse disposal cell, and two wells will be used to monitor the MRDF. Ground water measurements from these wells and the lysimeters will be obtained quarterly (Table 2).

2.2.3 MWDF

Well locations which will be utilized for Subprogram II monitoring of the MWDF are the same as for those presented in Subprogram I with the addition of sampling at intermediate wells constructed as the other tailing ponds are developed and an additional background well G41-H9 (Figure 3 and Table 2). Ground water quality measurements from these wells will be obtained at a minimum on a quarterly basis (Table 2).

Intermediate wells are located within the MWDF or between the MWDF and the compliance boundary (Figure 3 and Table 2). These wells will be monitored during operations to supplement the MWDF performance monitoring for Tailing Pond T1 (i.e., performance wells - CW series) and by the collection lysimeters beneath the pond bottom.



LEGEND

- ● EXISTING WELLS
- ○ WELLS TO BE INSTALLED

KEY TO WELL IDENTIFICATION

IW 6-T, 6-D
- IW- INTERMEDIATE WELL
- T - SCREENED IN TILL
- D - SCREENED IN DRIFT
- 6 - WELL I.D. NUMBER

MW 3-C, 3-F, 3-T
- MW-COMPLIANCE BOUNDARY MONITORING WELL
- C - SCREENED IN COARSE DRIFT
- F - SCREENED IN FINE DRIFT
- T - SCREENED IN TILL
- 3 - WELL I.D. NUMBER

CW 4-T, 4-D
- CW - CREST WELL
- T - SCREENED IN TILL
- D - SCREENED IN DRIFT
- 4 - WELL I.D. NUMBER

EX-11 AU, AL, BU, BL
- A - DEEP BORE HOLE
- B - SHALLOW BORE HOLE
- U - UPPER PIEZOMETER SCREEN
- L - LOWER PIEZOMETER SCREEN

RD2-D, 2-T
- T - SCREENED IN TILL
- D - SCREENED IN DRIFT

RP1-D
- D - SCREENED IN DRIFT

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

Typical Representation: Refinements May Be Made During Final Design.

EXXON MINERALS COMPANY
CRANDON PROJECT

MWDF GROUND WATER MONITORING WELL LOCATIONS

SCALE: SHOWN	STATE: WISCONSIN		COUNTY: FOREST
DRAWN BY: DR SPRINGBORN	DATE: 11/85	CHECKED BY:	DATE
APPROVED BY:	DATE	C.L. Schneider	DATE: 1-23-86
APPROVED BY:	DATE	J.R. Mentz	DATE: 1-23-86
DRAWING NO.			SHEET OF

FIGURE 3

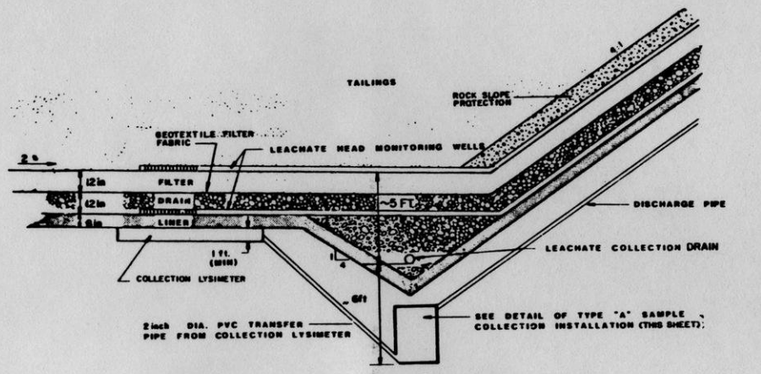
REVISION NO

Compliance boundary wells have been located to provide a relatively uniform distribution of sampling points along the compliance boundary and to assure an upgradient well location for background measurements in the statistical analysis of the monitored ground water quality parameters. Additional wells (MW1-C, F, T; MW2-C, F, T; MW3-C, F, T) are planned to supplement those already in existence at or near the compliance boundary (Figure 3).

Lysimeters to determine seepage quantity will be established during construction of the ponds beneath the liner within each pond. Each collection lysimeter will be constructed immediately beneath the liner on the pond bottom (Figure 4). Initially, two lysimeters will be established for the first tailing pond; and after evaluation of the results of this monitoring program, the other tailing ponds may be adjusted for number and location of the proposed lysimeters.

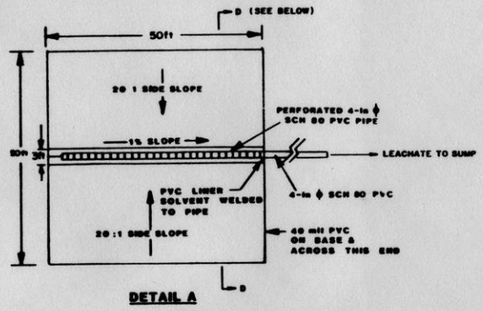
Liquids that may collect in these lysimeters will flow by gravity to sumps located either at the internal perimeter of the pond basin or at the outside toe of the pond embankment in the case of one lysimeter to be located in Pond T1 (Figure 4). Seepage collected from this Pond T1 lysimeter will be directed to the exterior of the pond to facilitate gravity removal and manual collection of samples (Figure 4). This is the only location within the MWDF that facilitates this type of collection procedure.

Access to the remainder of the sumps will be through a pipe constructed beneath the liner of the earth embankment. A water level sensor will be installed in each sump along with a replaceable



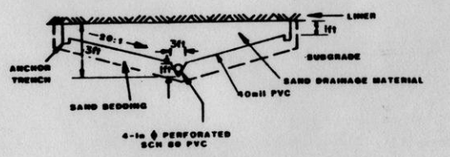
SECTION A-A (FROM SHEET 32)

TYPICAL LINER PERFORMANCE & LEACHATE HEAD MONITORING INSTRUMENTATION INSTALLATION



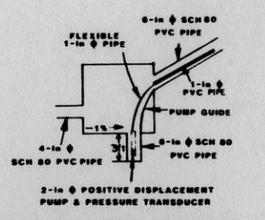
DETAIL A

PLAN VIEW

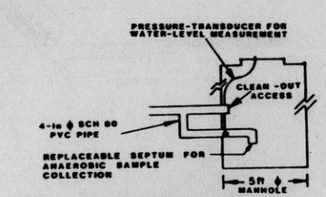


SECTION D-D

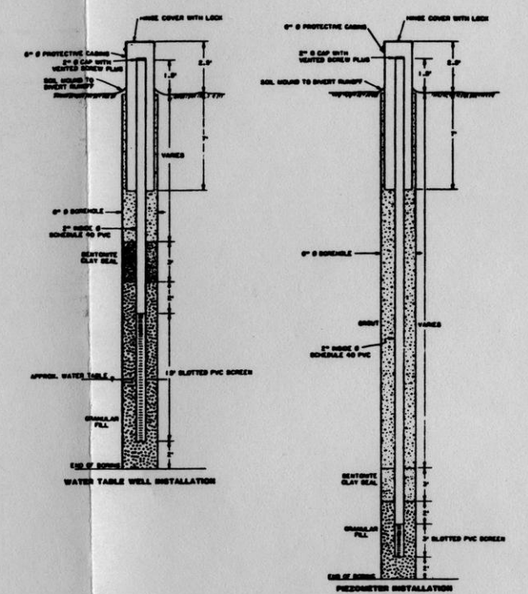
COLLECTION LYSIMETER CROSS SECTION



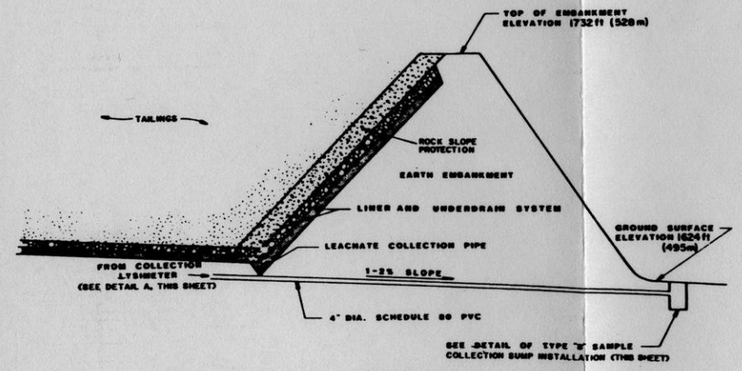
TYPE "A" SAMPLE COLLECTION SUMP INSTALLATION



TYPE "B" SAMPLE COLLECTION SUMP INSTALLATION



TYPICAL MONITORING WELL INSTALLATIONS



SECTION C-C (FROM SHEET32)

GRAVITY DRAIN LYSIMETER, POND T1

REVISED	DATE	BY	DESCRIPTION

Typical Representation: Refinements may be made during final design.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE **MWDF MONITORING WELLS & LYSIMETER DETAILS**

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY JMM & ACD	DATE 10/83	C.O. Schroeder	12/1/83
APPROVED BY	DATE	APPROVED BY R.K. Wallace	DATE 12/1/83
APPROVED BY	DATE	ENGR D.F. Mac	DATE 12/1/83
DRAWING NO FIGURE 4		SHEET 35 OF 36	REVISION NO 0

submersible pump for sample collection (Figure 4). The access pipe will be large enough to allow servicing of the water level sensor and pump and, if required, replacement of either.

Piezometric surface observation and leachate sample collection wells (lysimeter wells) will be installed in conjunction with the other lysimeters in each of the tailing ponds to provide data for comparison with water level estimates that were assumed during the MWDF design. These lysimeter wells will be constructed in pairs to monitor leachate level in the tailings as well as in the drainage layer immediately above the liner overlying a lysimeter (Figure 4). They will be constructed of high strength plastic pipe and be of sufficient diameter to facilitate pump extraction of collected leachate.

The lysimeter wells will be installed during embankment construction and will extend laterally and parallel to the pond liner along the bottom and the internal embankment slope of the pond (Figure 4). Replaceable submersible pumps will be installed in these lysimeter wells for sampling of the leachate. Water level sensors will also be installed in each well (Figure 4).

Overall facility performance will primarily depend on the integrity of the reclamation cap and top seal. Therefore, a moisture content measuring system will be installed to monitor top seal performance. The specific type of moisture content measuring system proposed for installation in each pond will be determined at the time of reclamation to assure the use of the latest technology. However, the number and location of these systems for the later ponds will also be determined after evaluation of the results from the monitoring conducted for the first tailing pond.

Table 2 lists the parameters to be monitored for the MWDF lysimeters and wells. The specific well locations to be sampled, the parameters to be measured, and the sampling frequency are based on the data obtained from the waste characterization (Exxon Minerals Company, 1984) and attenuation (D'Appolonia, 1982) studies, as well as the predictive tools presently used for the Crandon Project (D'Appolonia, 1985).

In addition to the well and lysimeter locations, samples for water quality measurements will be collected from the water being pumped from the underdrain system (leachate). Water quality parameters will be measured on at least a quarterly basis and have been selected utilizing the results of the waste characterization studies.

2.2.4 Mine Wells

The only additional wells proposed at this time for the closure phase will be to monitor the mine reclamation (Table 2). Three wells will be located within the reclaimed shafts or other boring locations (i.e., backfill delivery borehole) to sample mine water levels and quality (Table 2). Six wells will also be located to allow measurements of the ground water in the glacial drift immediately above and adjacent to the reclaimed mine (Table 2). These wells will be monitored on a quarterly schedule during the closure phase.

All Subprogram II ground water monitoring will be as indicated in Table 2, and will continue into reclamation until stabilization of the ground water table is measured throughout the year. After stabilization has been determined, the ground water table monitoring program may be adjusted, with continued quarterly measurements at the ground water quality wells, mine wells, and the MWDF.

The ground water table wells will be plugged and closed in accordance with DNR well abandonment procedures after recovery and stabilization of the ground water table has occurred and been verified from the data analysis. Similarly, all of the ground water quality monitoring wells (7), mine wells (9), and the MWDF wells and lysimeters will be maintained and sampled during the closure phase.

Methods of ground water sample collection, preservation, and analysis will be in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association. Sample comparisons for determination of any statistically significant differences among the wells (i.e., ground water quality and MWDF monitoring wells) will be completed using multiple analysis of variance tests. In the event of unnormalized data, the analysis of variance will utilize log-normal distribution for comparison testing.

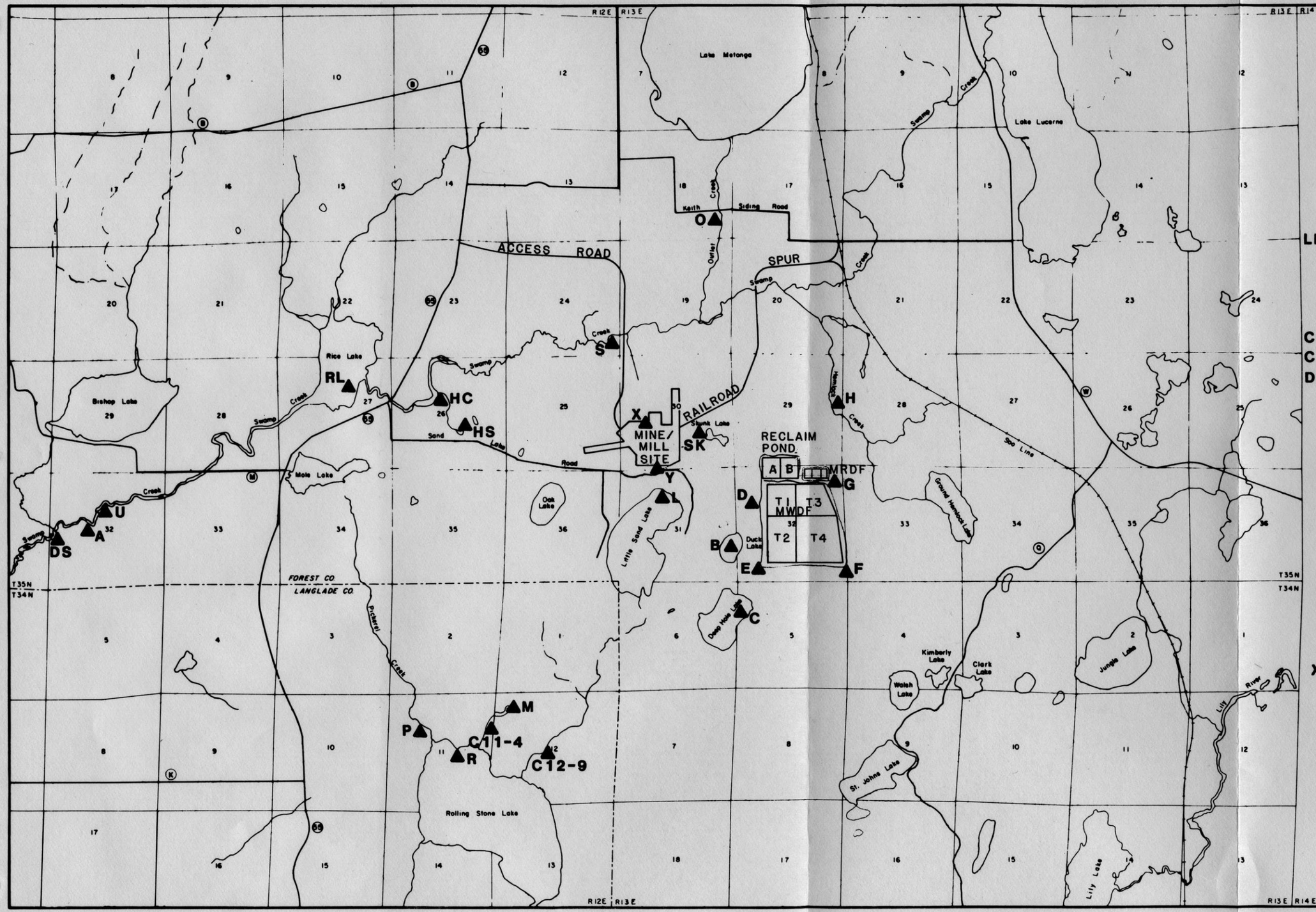
All data will be provided to the DNR quarterly until stabilization of the ground water table. After stabilization of the ground water table, the data will be submitted on a semi-annual or annual basis depending upon the parameter measured. An annual summary of the ground water monitoring program will also be provided to the DNR.

3.0 Surface Water

One objective of the surface water monitoring program is to obtain water quality, quantity, and sediment chemistry data at the proposed water treatment plant discharge location. Another objective is to obtain water quality and quantity data on Swamp Creek above Rice Lake and several other water bodies which may be affected by construction and operation of the Project. Sampling station S is designed to be at a location on Swamp Creek which is downstream of potential Project activities and would monitor any changes in water quality resulting from them. The lake level and stream flow rate gages will also be utilized in the data collection and analysis for the Hydrologic Impact Contingency Plan.

The surface water monitoring program has been designed to measure the physical and chemical parameters necessary to evaluate the Project's impact on surface waters in the vicinity of the mining site and to confirm that the aquatic environment is not being adversely affected. Basically, the program establishes monitoring related to potential impacts associated with the treated water discharge to Swamp Creek below Rice Lake and to other potential surface water impacts which may occur because of mine dewatering activities, any potential MWDF seepage which may reach surface water through the ground water, and surface water drainage via the various retention structures of the surface facilities. This program incorporates monitoring the DNR will require at these locations as part of the WPDES Permit.

Surface water monitoring will include 7 creeks, 6 lakes, and 2 springs in the vicinity of the mine/mill site (Figure 5). Water monitoring at Rice Lake will be contingent upon access approval from the Mole Lake Chippewa Tribal Council. Sampling locations, parameters to be



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
SURFACE WATER & AQUATIC ECOLOGY MONITORING LOCATIONS

SCALE SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Skaggs	DATE 1-23-86
APPROVED BY	DATE	EXXON J. Galletta	DATE 1-23-86
DRAWING NO **FIGURE 5**		SHEET 1 OF 1	REVISION NO

measured, and the frequency of sample collections are presented in Table 3. Meteorological data (i.e., precipitation, evaporation) will be obtained as part of the air quality monitoring program (see Section 5.0).

The surface water monitoring program will be initiated approximately 12 months prior to construction and continue through operations. A modified program, which will reflect the then current Project activities, will be conducted for the initial ten years of the closure phase. This modified program will be submitted to the DNR for approval at least six months prior to its implementation.

Monitoring of Swamp Creek at the water treatment plant discharge location (U, A, DS; Figure 5) will be conducted only during times of actual discharge. The parameters measured will coincide with those presented in Table 3. Initial monitoring will be continuous at sampling location A (i.e., within the discharge pipe) for the effluent dissolved oxygen, pH, flow rate, and specific conductance. Total dissolved solids and total suspended solids will be measured after collection of a daily composite sample from the discharge pipe. Stations U, A (i.e., in Swamp Creek), and DS will be located as close as possible to monitoring locations previously used for data collection (See Ecological Analysts, 1984).

The United States Geological Survey (USGS) continuous recording gage for stream flow rate at State Highway 55 will be operated throughout the Project. Exxon will discuss with the USGS and DNR the appropriate mechanisms for maintaining the operation and data submittal from this gage.

Duplicate sediment samples for chemical analysis will be collected annually (i.e., in May) at locations U, A, and DS in Swamp Creek. Chemical parameters for analysis are presented in Table 3.

Table 3. The surface water monitoring program for the Crandon Project indicating sampling locations, parameters measured, and sampling intervals.

Sampling Location	Sampling Frequency and Specific Locations	Parameters Measured
Swamp Creek Above Rice Lake	Annually, Monthly (at staff gages 2, 3 and 5A)	1, 5
Swamp Creek Below Rice Lake	Quarterly (at Location U)	1
	Monthly (at Locations A, and DS)	1
	Continuous (at Station A)	2
Swamp Creek (Sediment) Below Rice Lake	Annually (at Locations U, A and DS)	3
Creek 11-4	Monthly (at staff gage 30) Weekly (flow rate only)	5
Creek 12-9	Monthly (at staff gage 23) Weekly (flow rate only)	5
Hemlock Creek	Annually, Monthly (at staff gage 6)	1, 5
Hoffman Creek	Annually, Monthly (at staff gage E)	1, 5
Outlet Creek	Monthly (at staff gage 4)	5
Pickerel Creek	Monthly (at staff gage 19)	5
Duck Lake	Quarterly, Monthly (at lake gage 12)	4, 5
Deep Hole Lake	Quarterly, Monthly (at lake gage 13)	4, 5
Hoffman Springs	Quarterly, Monthly (at lake gage 31)	4, 5
Little Sand Lake	Quarterly, Monthly (at lake gage 7)	4, 5
Martin Springs	Monthly	5

Table 3 (continued)

Sampling Location	Sampling Frequency and Specific Locations	Parameters Measured
Skunk Lake	Quarterly, Monthly (at lake gage 15)	4, 5
Rice Lake*	Quarterly, Monthly	4, 5
Rolling Stone Lake	Monthly (at lake gage 9)	5
Drainage Basins and Sedimentation Ponds	Weekly, when discharging (at Locations D, E, F, G, X and Y)	4

*Rice Lake monitoring will be contingent upon access approval from the Mole Lake Chippewa Tribal Council.

1. Chemical analysis for: aluminum, arsenic, biological oxygen demand (BOD), cadmium, chromium (+3 and +6), copper, cyanide, hardness, iron, lead, manganese, mercury, selenium, silver, sodium, sulfates, total alkalinity, total dissolved solids, total organic carbon, total sulfur, total suspended solids, and zinc. Field measurements for: dissolved oxygen, pH, specific conductance, stream discharge and velocity, temperature, and water levels.

2. Continuous monitoring for effluent 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, manganese, mercury, selenium, silver, sulfate, sulfur (total), and zinc.

4. Chemical analysis for: alkalinity, hardness, oil and grease, sulfate, total dissolved solids, and total suspended solids. Field measurements for: pH, specific conductance, stream discharge and velocity, temparature, and water level.

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

Data from the surface water monitoring program will be provided to the DNR on a quarterly basis (if available), and summarized in the annual report. WPDES monitoring requirements and reporting schedules will be as specified in the permit. The surface water monitoring program will also be evaluated with the renewal sequence of the WPDES and Mine Permits. Revisions as required will be proposed at those times.

4.0 AQUATIC ECOLOGY

The objectives of the aquatic ecology monitoring program are the same as those presented in Section 3.0, Surface Water. This program will combine biological sampling with the physical and chemical parameter measurements of the surface water monitoring program. Data from this program will also be used to evaluate effects which can be included in the analyses of the Hydrologic Impact Contingency Plan. The biological sampling will be conducted semi-annually (spring and late summer) in Swamp Creek below and above the wastewater treatment plant discharge structure, Swamp Creek above Rice Lake and Hoffman Creek. The following biological parameters will be determined for the fish populations: species composition, relative abundance, length, weight, catch per unit effort (selected species only), and condition factor (selected species only).

During the late summer (i.e., August), fish sampling will occur at location DS and will include separate composite samples of two forage species, such as black bullhead and white sucker, and one predator species, such as yellow perch or northern pike. Each of the three composite samples shall consist of a minimum of three fish of the same age class (e.g., 2-3 years) for the forage and predator species. If possible, the same species will be analyzed each year. The sample collections will be frozen and a whole fish analysis completed in the laboratory. The metals analyzed in the laboratory will be arsenic, cadmium, chromium (total), copper, lead, manganese, mercury, selenium, silver, and zinc.

If sufficient numbers of fish cannot be collected for a forag- and/or predator species after a reasonable sampling effort during the day of collection, no tissue analyses will be conducted for that species. The timing of collections will be coordinated with the DNR to enhance the probability of collecting sufficient numbers of each species for tissue analysis.

Sessile populations of fish food organisms (i.e., benthic macroinvertebrate populations) will also be sampled. Samples will be collected upstream (U), at the stream discharge location (A), and downstream (DS; Figure 5). These sampling locations will coincide with those of the baseline monitoring program (see Ecological Analysts, 1984).

Benthic macroinvertebrates will be collected during the early spring, before major snow melting, and late summer, during stream low flow rate/high temperature conditions, in the areas of sampling locations U, A and DS. Four samples of actual substrates using appropriate bottom samplers will be collected from each location. Macroinvertebrates will be hand picked and composited by genus and/or species from each substrate sample in the lab.

Samples of the most numerous (common) taxa from these collections will be segregated by size class into four groups. These four groups will represent the feeding habits of "functional groupings" of the species and are: sediment dependent, filter feeders, sediment associated, and predator. The actual substrate composite samples consisting of benthic macroinvertebrate tissue with exoskeletons will be analyzed in the laboratory for the same metals as the fish (see Table 3).

If sufficient numbers of each "functional group" cannot be obtained after a reasonable sampling effort during the day of

collection, no tissue analyses will be conducted for that "group" or "groups." The timing of the collections will be coordinated with the DNR to enhance the probability of collections with sufficient numbers of each "functional group" for analysis. The exact number of specimens to be collected at each location and other details for specimen handling and preparation prior to analysis will be mutually agreed upon at a later date by the DNR and Exxon Minerals Company.

Biological parameters of the benthic macroinvertebrate populations will include their species composition, total numbers, density per unit area, biomass and dominant species. If the data analysis of the benthic macroinvertabrate populations for species composition, total numbers, and density per unit area indicates a statistically significant difference ($P \geq .05$) between the downstream and other sampling locations (U and A), additional sampling locations will be established further downstream. These additional downstream locations will coincide with stations 5 and 6 of the Ecological Analysts, Inc. 1984 study. These stations will be sampled until the data indicate that benthic macroinvertebrate populations at station DS are not statistically different from those at stations U and A. The early spring and late summer samplings will be collected at the same time as the surface water program.

The aquatic ecology monitoring program will be initiated with the early spring sampling, prior to construction activities, and will continue for the first three years of the operation phase. Monitoring of Swamp Creek at the water treatment plant discharge location (U, A, DS; see Figure 5) will be conducted only during times of actual discharge. The sampling program will be repeated every five years after the third year of the operation phase until the water treatment plant discharge is discontinued during reclamation.

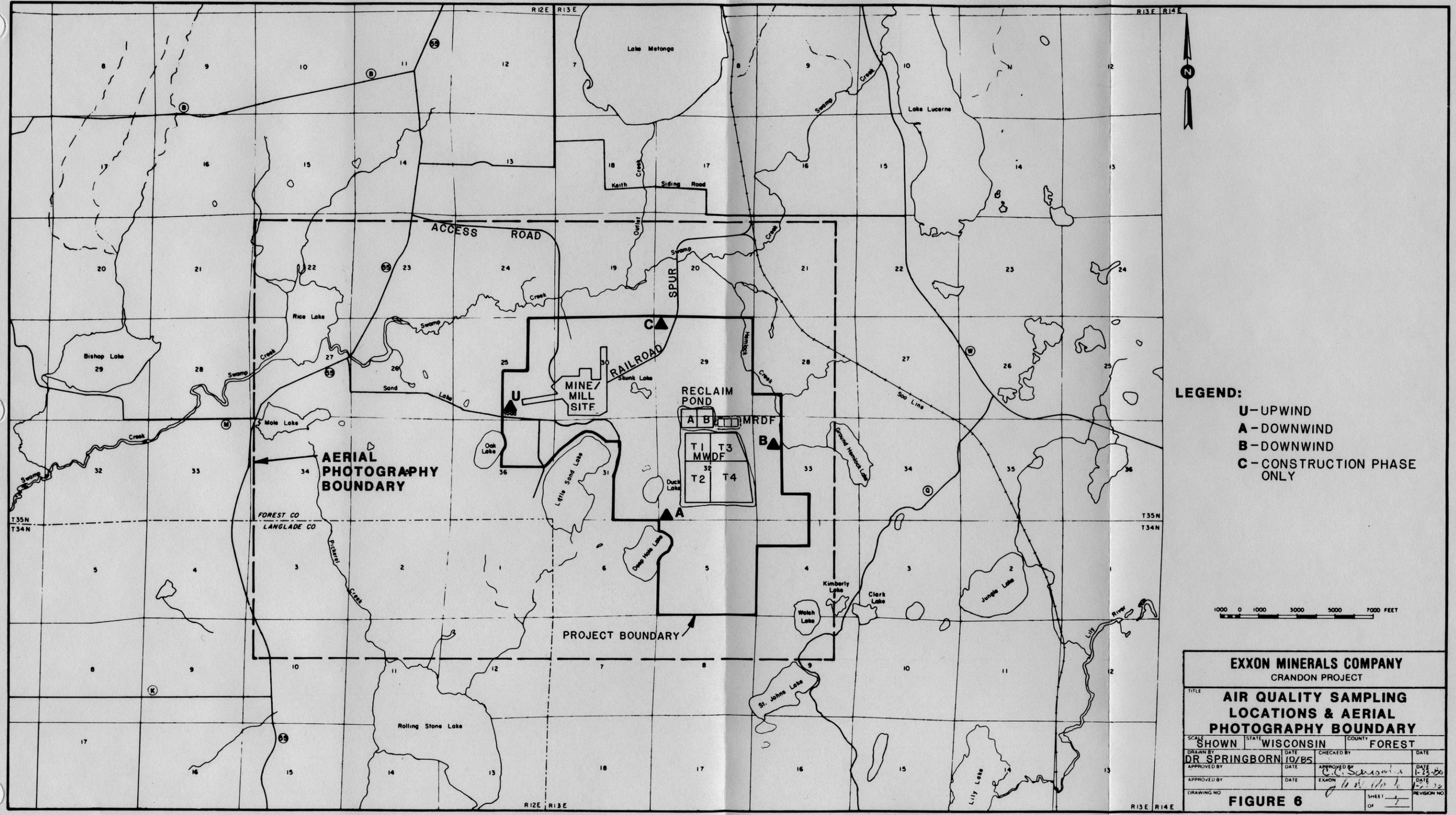
In addition, an acute bioassay study will be conducted annually and a chronic bioassay study will be performed once every five years on the water treatment plant discharge as part of the WPDES permit. The chronic bioassay studies will be performed just preceding and in conjunction with the WPDES reissuance. The bioassay studies will be initiated in the year of the construction phase when the actual discharge will occur. Specifics of the bioassay studies will be discussed with the DNR prior to their implementation.

5.0 AIR QUALITY

The air quality monitoring program objective is to evaluate Project emissions to assure that state and federal standards are maintained at all facilities. This entails not only air emission control equipment monitoring but also the air quality throughout the mine/mill site and MWDF. The air quality monitoring equipment will be located close to property boundary areas that represent potential access regions to the public. One upwind and two downwind sampling locations will be established to monitor air quality for the prevailing summer and winter meteorological conditions. In addition, a third downwind sampling location for monitoring during the construction phase of the Project will be established at the property boundary by the railroad spur. Figure 6 indicates the proposed locations for air quality sampling (U, A, B, and C).

A 30 foot meterological tower will be located at the upwind monitoring station. Meteorological data will be collected during all phases of the Project. The parameters to be measured include wind speed and direction, precipitation and evaporation rates, temperature, and barometric pressure. All data collected will be provided to the DNR and will be compatible with the DNR reporting system.

Total suspended particulates (TSP) will be monitored at all sampling locations. The samplers used will be able to distinguish particles larger and smaller than 10 microns in diameter. The samplers and the monitoring program will be operated under a quality control document to assure a greater than 90 percent data recovery.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
AIR QUALITY SAMPLING LOCATIONS & AERIAL PHOTOGRAPHY BOUNDARY

SCALE	STATE	COUNTY
SHOWN	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	10/85		
APPROVED BY	DATE	APPROVED BY	DATE
		C.C. Swanson	1-23-86
APPROVED BY	DATE	EXXON	DATE
			1-23-86

DRAWING NO **FIGURE 6** SHEET 1 OF 1 REVISION NO

During the first two years of the construction phase, TSP monitoring will occur for 24 hours every day during active excavation, loading and dumping activities at the upwind and downwind sampler nearest the activities. However, as the earthwork decreases during periods when heavy equipment activity such as excavation is not occurring, and probably by the end of the second year of construction activities, the TSP monitoring will change to a six day pattern in coordination with the DNR statewide air quality sampling program. The DNR will be notified prior to reducing the sampling frequency to six days.

The only exception to this pattern of TSP monitoring during the last two years of the construction phase will be for the development of the tailing ponds. When earthwork activities for construction of a tailing pond occur, the TSP sampling frequency will revert to a three day sequence. This sampling pattern will also be used during reclamation activities at Tailing Pond T1. For both situations, the normal six day sampling sequence in coordination with the DNR statewide program will be utilized when there is no construction activity and for those samplers which are not close to excavation, loading or dumping activities.

Sampling will occur for 24 hours every sixth day of the operation phase. If an exceedance of the TSP standards occurs during the operation phase at any of the sampling stations, which is attributable to the Project, sampling will revert to a 3-day sequence for one year at the location of the exceedance. This sampling sequence will be in coordination with the DNR statewide air quality sampling program. Data supplied will also be compatible with the DNR reporting system.

Particulate characterizations will be completed on 7 percent of the TSP filters. The filters will be selected randomly to assure a reliable and valid data set. In the event that TSP quantities on any filter exceed the air quality standards, that filter will undergo particulate characterization.

The particulate characterizations will be analyzed quantitatively. Quantitative analysis will be completed for particle types (i.e., biological, mineralogical). Size determinations for the particles will be semi-quantitative. In addition to particulate characterizations, one TSP filter from each sampling station will be analyzed annually for arsenic, cadmium, chromium, copper, lead, manganese, mercury, and zinc in conjunction with the soil, vegetation, and small mammal monitoring programs described in Section 6.0.

Asbestiform fiber monitoring and stack source testing will occur only during the Project operation phase. Asbestiform fiber monitoring will occur daily for two weeks during October (i.e., driest autumn month; see Black, 1978) of the fourth and fifth years of the operation phase. If abestiform fibers are determined at a quantity which warrants further analysis, the sampling program will be continued into the sixth year of the operation phase.

Stack source sampling will be necessary for the east and west exhaust raises, as well as other stacks for which the Air Permit requires such testing. Stack source testing will be designed to meet the requirements of the New Source Performance Standards (NSPS) for the metallic minerals processing industry.

In addition, as part of the air permit, a Malfunction Prevention and Abatement Plan (MPAP) in accordance with NR 154.06(9)

will be developed and discussed with the DNR. The MPAP will incorporate inspection and maintenance of the air pollution control equipment associated with the stack sources within the monitoring plan.

The air quality monitoring program will be initiated approximately six months prior to construction activities and is designed to continue throughout operations. After active reclamation activities have ceased, the meteorological instruments and one TSP sampler will be operated for two more years. After this time, no air quality monitoring will be conducted for the remaining years of closure.

Detailed aspects of the air quality monitoring program, including monitoring station locations, will be discussed with the DNR before finalization and implementation. A quality assurance document compatible with the DNR Air Monitoring Section industrial certification requirements will be provided prior to the start of the air quality monitoring program.

6.0 TERRESTRIAL ECOLOGY

The main objective of the terrestrial ecology monitoring program is to enable an evaluation of any air emission or ground water table drawdown related effect on the vegetation and its associated animals. Similarly, any surface water discharge which may affect the terrestrial ecosystems will be monitored in this program.

The terrestrial ecology monitoring program will be closely associated with the air quality monitoring program and the MWDF inspection program of NR 182.12(2) and (4)(a) and 182.14(1)(d). In any of these programs, an exceedance of air quality standards or a detected terrestrial ecosystem effect will prompt further evaluation. Any program requiring this further evaluation will be designed to address the observed site-specific effects.

The terrestrial ecology monitoring program will determine general conditions of the site area ecosystems, including wetlands, within a radius of approximately 3 miles of the mine/mill site. This area will include Rice Lake (see Figure 6). This will be accomplished by color infrared (CIR) aerial photography at a scale of 1:7920 (i.e., approximately eight inches to the mile), which will be obtained at the same time as that of the inspection program (NR 182.12(2), (4)(a), and 182.14(1)(d)), if possible. If the MWDF construction and inspection program aerial photography schedule does not coincide with the timing requirements for the terrestrial ecology monitoring, separate flights will be utilized to obtain the information.

The CIR aerial photography will be used to detect any vegetative stress or other changes exhibited in the terrestrial or wetland ecosystems. In the event any such stress or change is indicated, an evaluation of its particular cause and any resultant

environmental consequence will be completed. Again, this evaluation would be designed to address the observed site-specific effects.

If data from the air quality or MWDF inspection program indicate a need for either more frequent aerial photography or particular terrestrial ecosystem quantitative analyses, they will be designed, planned, and conducted at that time. Similarly, should the CIR aerial photography indicate a more frequent or specific sampling study, it would be designed and evaluated.

The terrestrial ecology monitoring program will be initiated with the aerial photography required by NR 182.14(1)(d) prior to MWDF construction activities and is designed to continue through operations and reclamation. Therefore, the aerial photography will be obtained the year prior to the start of the construction phase activities and will continue on a schedule of the year preceding and after completion of the development of each tailing pond. It will end with the completion of active reclamation activities.

All aerial photography will be obtained during July to coincide with sensitive growth phases of the potentially affected ecosystems. A copy of the CIR photos will be available to the DNR within 90 days of the flight. Any analysis of the photography will be provided to the DNR with the annual report for the mine permit. If stress conditions are detected, the DNR will be notified earlier than the annual report and discussion of further monitoring programs will be initiated.

In addition, an annual program of sampling soil, vegetation, and a common small mammal population will be conducted along a predominantly downwind transect during the operation of Tailing Ponds T1 and T2. The transect will be sampled in August or September at the end

of the growing season, and the sampling will be spaced to include at least 3 collection points along the transect from the MWDF to the property fencing. Samples of soil, vegetation, and selected animal tissue and/or organs will be analyzed in the laboratory for arsenic, cadmium, chromium (total), copper, lead, manganese, mercury, selenium, silver, and zinc.

If sufficient numbers of a small mammal population cannot be collected after a reasonable sampling effort, the number collected will be analyzed and reported as such. The timing of collections will be coordinated with the DNR.

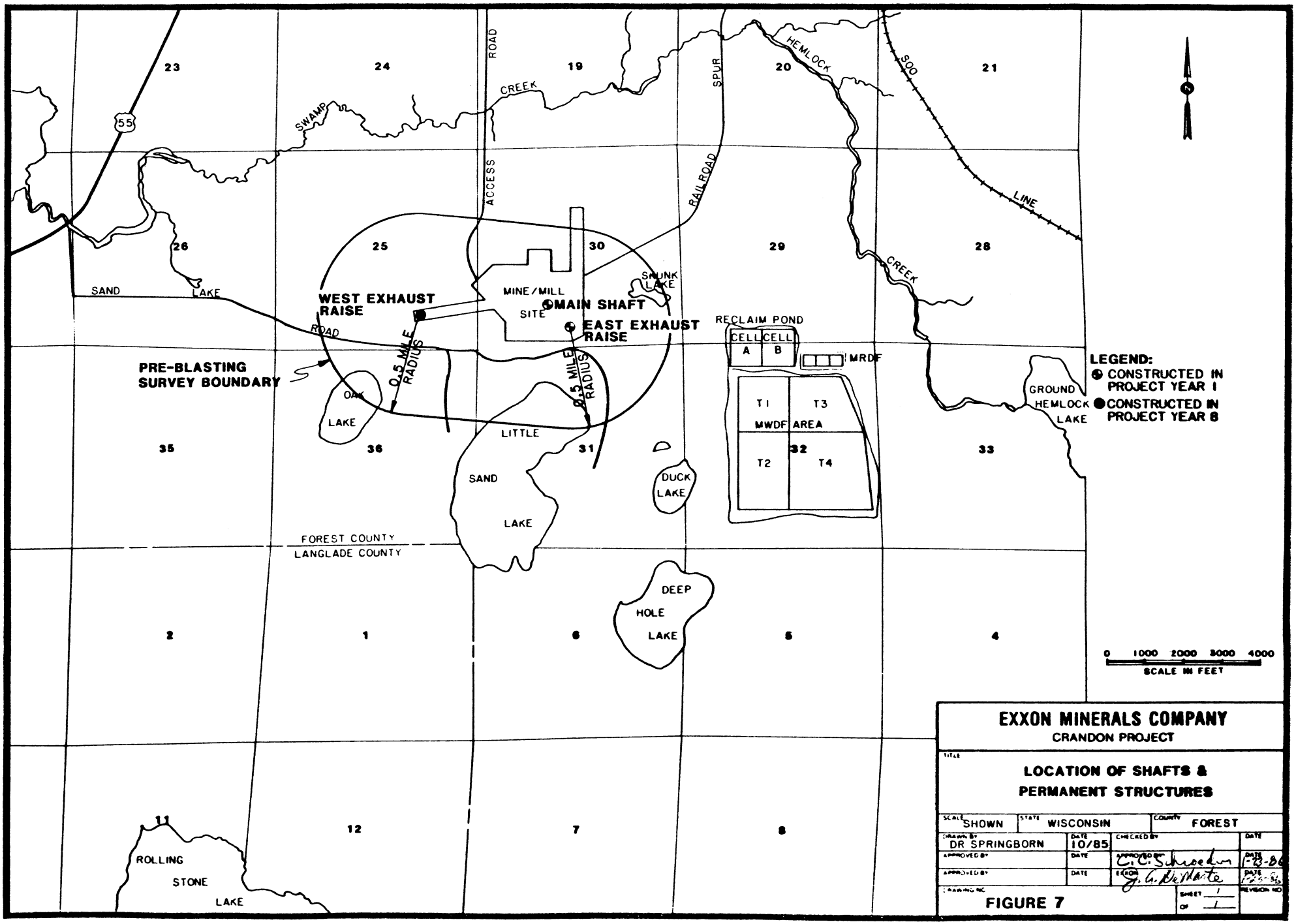
The DNR has indicated that their regional monitoring programs for animal populations will continue and include the Project site area. Amphibians, birds and large mammal surveys will be included in the DNR programs. The data important to the Project site area will be forwarded by the DNR to Exxon for inclusion in the annual report where appropriate.

7.0 BLASTING SURVEYS

As part of the mine permit requirements (NR 132.07(5)), EMC will conduct a pre-blasting survey of all permanent structures within an 0.5 mile radius of the main shaft and exhaust raises (Figure 7). All blasts will be designed to preclude damaging seismic or air blast effects immediately adjacent to all mine openings to the surface. Therefore, neither seismic stress nor air blast concussion of a magnitude sufficient to cause structural damage is expected immediately adjacent to the shaft collars.

However, the pre-blasting survey will be initiated before the construction phase activities and the data will be provided to the DNR and other appropriate agencies prior to any site blasting. The survey will be conducted by state licensed professionals and will include property inspections (with the consent of the owners), and photographs. Items to be inspected include:

1) building foundations,
2) concrete slabs,
3) exterior and interior masonry,
4) building structural framing,
5) exterior and interior wall treatments,
6) ceiling and floor treatments,
7) windows and doors (framing and glass),
8) visible plumbing,
9) exterior utility services,
10) exterior structures (i.e., antennas, flag poles), and
11) miscellaneous items as required),



EXXON MINERALS COMPANY
CRANDON PROJECT

LOCATION OF SHAFTS & PERMANENT STRUCTURES

SCALE: SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: DR SPRINGBORN	DATE: 10/85	CHECKED BY: C.C. Schroeder	DATE: 1-13-86
APPROVED BY:	DATE:	APPROVED BY: J. A. DeMarte	DATE: 12-30-85
APPROVED BY:	DATE:	EXXON	SHEET 1 OF 1

FIGURE 7

Copies of the pre-blasting survey inspection sheets, photographs and property condition report will be submitted to each property owner as well as the appropriate state agencies. File copies will also be available at the mine/mill offices.

Actual site blast monitoring during operations will be limited to verification of design parameters during initial mine construction and operation events. This monitoring would be designed to verify blast parameters and actual performance. It would include survey equipment such as portable velocity seismographs, air wave detectors and sound pressure instruments. These surface blasting effects monitoring programs will be conducted only for engineering purposes to supplement programs for testing underground safety and rock mechanics design parameters. The actual surface effects of the underground development and ore production blasting is expected to be negligible. Results of these surveys will be kept on file at the mine/mill site offices.

8.0 SUMMARY

The proposed monitoring plan is responsive to NR 132.06 (3)(d), NR 132.11, NR 180.13, NR 182.075, NR 182.08(2)(e)8, and NR 182.13 as related to the construction, operation and closure (reclamation) phase activities of the Project. The basic reporting structure for transferring the data and results of the monitoring programs will be the annual report required by NR 132, or as required by the various other permits. In the event that these monitoring programs require initiation of further studies, such data and information will be forwarded to the DNR.

9.0 REFERENCES CITED

Black, C., 1978. Personal communication. Professor, Nicolet College and Technical Institute. January: Rhinelander, Wisconsin.

D'Appolonia Consulting Engineers, Inc., 1982. Soil attenuation study, Volumès I and II, Exxon Minerals Company, Crandon Project: D'Appolonia, Pittsburgh, PA.

_____, 1985. Hydrologic impact assessment methodology and results: D'Appolonia, Pittsburgh, PA.

Ecological Analysts, Inc., 1984. Chemistry and hydrology in Swamp Creek, 1984: Ecological Analysts, Inc., Northbrook, IL.

Exxon Minerals Company, 1985. Mine waste disposal facility feasibility report (NR 182.08), December, 1985: Rhinelander, WI.

SECTION B - FINANCIAL RESPONSIBILITY

SECTION B - ITEM 1

A copy of applicant's and parent company's most recent annual report and most recent (1984) Form 10-K as filed with the Securities and Exchange Commission establishing that applicant is competent to conduct mining in a manner consistent with the requirements and purpose of ss. 144.80 - 144.94, Wis. Stats., is attached.

(ORIGINAL ON FILE WITH DNR)

1984

SECURITIES AND EXCHANGE COMMISSION
WASHINGTON, D.C. 20549

FORM 10-K

ANNUAL REPORT PURSUANT TO SECTION 13 OF THE SECURITIES EXCHANGE ACT OF 1934

For the year ended December 31, 1984 — Commission File Number 1-2256

EXXON CORPORATION

(Exact name of registrant as specified in its charter)

NEW JERSEY	13-5409005
(State or other jurisdiction of incorporation or organization)	(I.R.S. Employer Identification Number)

1251 AVENUE OF THE AMERICAS, NEW YORK, N.Y. 10020-1198
(Address of principal executive offices) (Zip Code)

212-333-1000
(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of Each Class	Name of Each Exchange on Which Registered
Capital Stock, no par value (773,910,178 shares outstanding at March 1, 1985)	New York Stock Exchange
Thirty Year 6% Debentures due November 1, 1997	New York Stock Exchange
Thirty Year 6½% Debentures due July 15, 1998	New York Stock Exchange
Registered securities guaranteed by Registrant:	
Exxon Pipeline Company	
Thirty Year 4¼% Debentures due January 1, 1987	New York Stock Exchange
Thirty Year 5⅝% Debentures due June 1, 1997	New York Stock Exchange
Thirty Year 6⅝% Debentures due December 1, 1998	New York Stock Exchange
Twenty-Five Year 8⅞% Debentures due October 15, 2000	New York Stock Exchange
Twenty-Five Year 8¼% Debentures due March 1, 2001	New York Stock Exchange
Thirty Year 9% Debentures due October 15, 2004	New York Stock Exchange
Exxon Finance N.V.	
Five Year 11% Notes due October 1, 1987	New York Stock Exchange
Seven Year 10½% Notes due November 1, 1989	New York Stock Exchange
Reliance Electric Company	
Twenty Year 9⅝% Debentures due December 15, 1994	New York Stock Exchange
Twenty-Five Year 7¼% Debentures due February 15, 1996	New York Stock Exchange

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ✓ No .....

The aggregate market value of the voting stock held by non-affiliates of the registrant on March 1, 1985, based on the closing price on that date of $48¼ on the New York Stock Exchange consolidated tape was in excess of $37,000,000,000.

Documents Incorporated by Reference:

1984 Annual Report to shareholders (Parts I and II)
Proxy Statement dated March 25, 1985 (Parts I and III)

SECTION B - ITEM 2

Applicant will comply with the financial responsibility provisions of Section NR 132.09, Wis. Admin. Code, by making a financial commitment satisfactory to the Department. Such commitment to the extent allowable by law will be in terms of self-bonding, or satisfying the net worth requirements established by the Department as provided in ss. 144.443, Wis. Stats. These commitments will be finalized prior to issuance of the Mining Permit.

SECTION C - FEE

A certified check, No. 8309, dated December 21, 1982, for ten thousand ($10,000) Dollars, drawn on the Crandon National Bank, Crandon, Wisconsin, was submitted with the Mine Permit application in December 1982 to cover the costs of evaluating the application.

CRANDON PROJECT

SECTION D

REVISED
MINE PLAN

EXXON MINERALS COMPANY
RHINELANDER, WISCONSIN

DECEMBER 1985

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1.0 INTRODUCTION

The Mine Plan was prepared in accordance with s. 144.85(3)(a), Wisconsin Statutes and Section NR 132.07, Wisconsin Administrative Code and is submitted to the Wisconsin Department of Natural Resources (DNR), Mine Reclamation Section. Presented in Table 1.1 is an index which cross-references the Mine Plan contents with the applicable section of the Wisconsin Administrative Code mentioned above.

This Plan is based on engineering and other studies completed to date. The material presented here is representative of the type and size of facilities to be constructed and operated as part of the Crandon Project. Some modification in the details of the facilities and treatment systems are likely during final design. *

The Mine Plan is intended to be a self-contained document; however, for information purposes only, some cross-referencing with the Reclamation Plan, Mine Waste Disposal Feasibility Report, Mine Refuse Disposal Feasibility Report, WPDES Permit Application and the High Capacity Well Approval Applications was necessary. The referenced documents are not contained in this Mine Plan.

---

*Vertical lines in the margin indicate revisions have been made within the text and Tables.

TABLE 1.1

INDEX OF REGULATORY COMPLIANCE

Regulatory Requirement	Mining Plan Section No.	Mining Plan Title
NR 132.07(1);(2);(3)(f);(4)(a),(d),(h),(j)	2.0	Description of Facilities
NR 132.07(3)(a)	2.1	Mine
NR 132.07(3)(d),(e);(4)(f)	2.2	Mill
NR 132.07(2);(3)(c);(4)(a),(b),(d)(f),(g),(i)	2.3	Mine Waste Disposal Facilities
NR 132.07(3)(f),(g),(r),;(4)(b)(f)	2.4	Ancillary Facilities
	3.0	Construction and Operation Procedures
NR 132.07(3)(a),(b),(f),(g);(4)(a),(d),(g)(i)	3.1	Construction
NR 132.07(3) (a),(c),(d),(e),(f),(g);(4) (c),(e),(f)	3.2	Operations
NR 132.07(3) (b),(c),(f),(g);(4)(b),(f),(k)	3.3	Mine Waste Disposal Operations
NR 132.07(3)(f),(g),(k);(4)(f)	3.4	Ancillary Facilities
NR 132.07(4)(a)(b)(d)(e)(g)(h)(i)	3.5	Erosion Control
NR 132.07(3)(f),(g),(h);(4)(i)(k)(l)	4.0	Environmental Protection
NR 132.07(3)(i);(4)(m)	5.0	Risk Assessment
NR 132.07(3)(j);(4)(m)	6.0	Emergency Notification
NR 132.07(3)(l)	7.0	Geological/Geotechnical Investigations
NR 132.07(5)	8.0	Preblasting Survey

2.0 DESCRIPTION OF FACILITIES

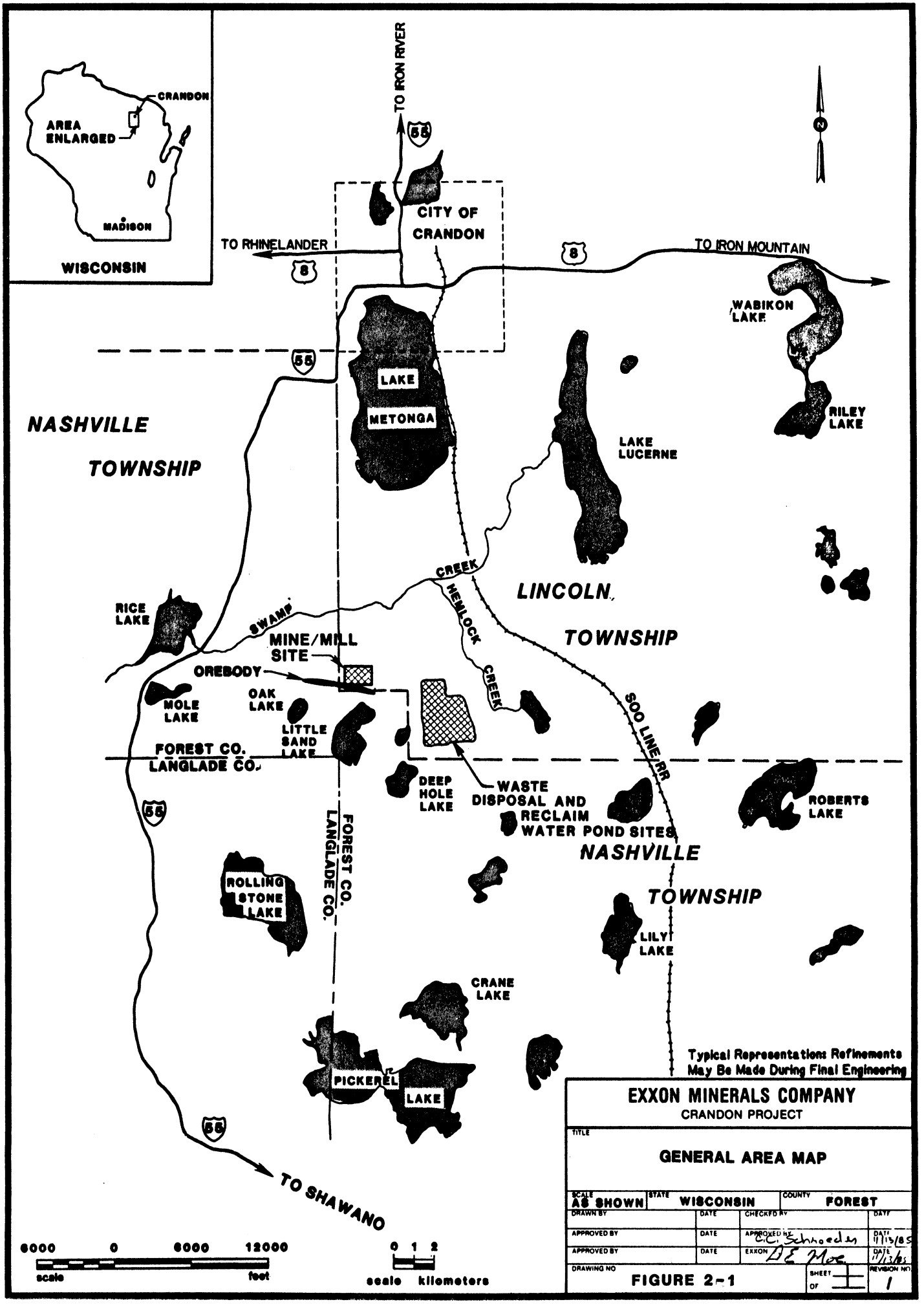
Overview - The Project facilities are located 2 miles east of State Highway 55 on Sand Lake Road (Figure 2-1). The east-west striking deposit occurs in Section 25, Township 35 North, Range 12 East, Nashville Township, and in Section 30, Township 35 North, Range 13 East, Lincoln Township. Physiographically, the deposit lies 0.25 miles north of Little Sand Lake and 1 mile south of Swamp Creek.

Figures 2-2 and 2-3 present the Project boundaries of the area to be permitted and the land ownership within and adjacent to the Project area, respectively.

The locations of major Project facilities are shown on Figure 2-4 with the existing power and telephone utility lines. A more detailed view of the mine/mill surface facilities is shown on Figure 2-5.

The mine will be underground. The location of the orebody dictates the location of the main shaft, headframe, and air exhaust exits.

The mine/mill surface facilities will be located in an area surrounding or adjacent to the main shaft and headframe. The mine/mill surface facilities will require an area of about 115 acres. A portion of this area will be covered by buildings, roadways, parking lots, and ancillary facilities. The remaining area will either retain its natural state or, if disturbed, will be landscaped for erosion control and general aesthetics.


CRANDON
AREA ENLARGED
MADISON
WISCONSIN
TO IRON RIVER
55
CITY OF CRANDON
TO RHINELANDER
8
TO IRON MOUNTAIN
WABIKON LAKE
RILEY LAKE
LAKE METONGA
NASHVILLE TOWNSHIP
LAKE LUCERNE
CREEK
HEMLOCK CREEK
LINCOLN TOWNSHIP
RICE LAKE
SWAMP
MINE/MILL SITE
OREBODY
MOLE LAKE
OAK LAKE
LITTLE SAND LAKE
FOREST CO.
LANGLADE CO.
SOO LINE RR
DEEP HOLE LAKE
WASTE DISPOSAL AND RECLAIM WATER POND SITES
ROBERTS LAKE
NASHVILLE TOWNSHIP
ROLLING STONE LAKE
FOREST CO. LANGLADE CO.
LILY LAKE
CRANE LAKE
PICKEREL LAKE
TO SHAWANO
6000 0 6000 12000
scale feet
0 1 2
scale kilometers
Typical Representations Refinements May Be Made During Final Engineering
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
GENERAL AREA MAP
SCALE AS SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY
DATE
CHECKED BY
DATE
APPROVED BY
DATE
APPROVED BY C.C. Schroeder
DATE 11/13/85
APPROVED BY
DATE
EXXON D.E. Moe
DATE 11/13/85
DRAWING NO
FIGURE 2-1
SHEET OF
REVISION NO 1

MOLE LAKE INDIAN RESERVATION

PIPELINE ROUTE

PIPELINE

ROUTE

Typical Representation : Refinements May Be Made During Final Engineering

LEGEND

PROJECT SITE

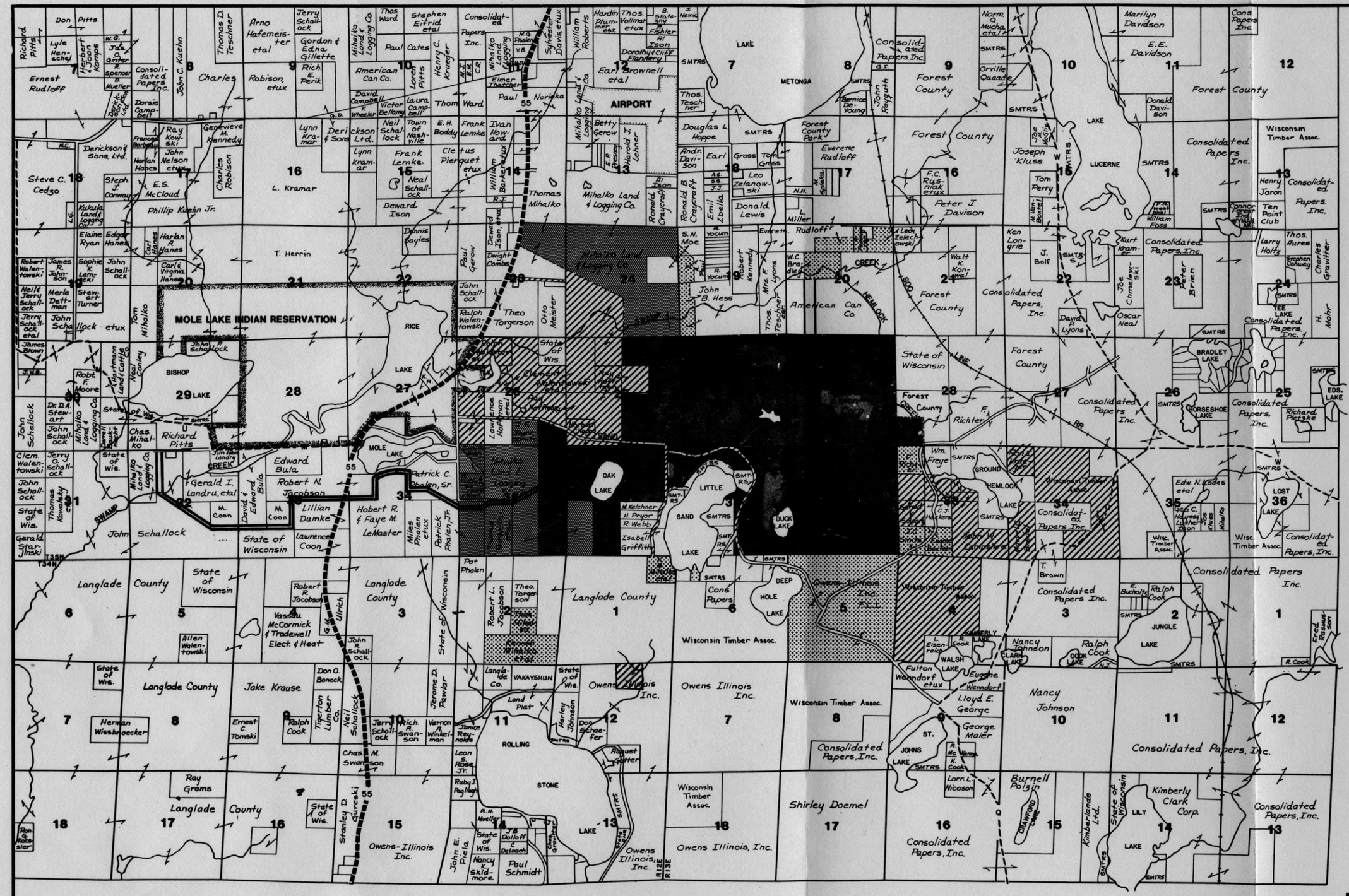
REVISED	DATE	BY	DESCRIPTION
2	10-17-85	DRS	UPDATED LAND OWNERSHIP
1	4-10-84	DRS	CHANGE PIPELINE ROUTE

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
PROJECT SITE BOUNDARY

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY D.R. SPRINGBORN	DATE 8/82	CHECKED BY D.S.	DATE 11/29/82
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. Moe	DATE 11/13/85
DRAWING NO. FIGURE 2-2		SHEET — OF —	REVISION NO. 2

GBB 5/1981


MOLE LAKE INDIAN RESERVATION
AIRPORT
Mihalko Land & Logging Co.
Forest County
Consolidated Papers, Inc.
Consolidated Papers Inc.
American Can Co.
Owens Illinois Inc.
Owens-Illinois Inc.
Wisconsin Timber Assoc.
Langlade County
State of Wisconsin
Kimberly Clark Corp.
Kimberlands Ltd.
Nancy Johnson
Ralph Cook
Jake Krause
Vassau McCormick & Tradewell Elect. & Heat
Tigerton Lumber Co.
Neil Schallock
Ray Grams
Herman Wissbroecker
Allen Walentowski
Ernest C. Tomaski
Stanley D. Gureski
Owens-Illinois Inc.
Shirley Doemel
Burnell Polzin
Consolidated Papers, Inc.
Wisconsin Timber Assoc.
Owens Illinois, Inc.
Owens Illinois Inc.
Mihalko Land & Logging Co.
Forest County Park
Evercette Rudloff
Peter J. Davison
Ken Longrie
Joseph Kluss
Tom Perry
Ten Point Club
Consolidated Papers, Inc.
Wisconsin Timber Assoc.
Consolidated Papers Inc.
Nancy Johnson
Ralph Cook
Fulton Wenndorf etux
Lloyd E. George
George Maier
Lorr. L. Nicoson
Burnell Polzin
Kimberly Clark Corp.
Consolidated Papers, Inc.
Consolidated Papers Inc.
Consolidated Papers, Inc.
Consolidated Papers, Inc.
Consolidated Papers Inc.
Consolidated Papers, Inc.
Consolidated Papers, Inc.
Consolidated Papers,

88° 59' E 690,000 58' E 691,000 57' E 692,000 56' E 693,000 55' E 694,000 54' E 695,000 53' E 696,000 E 697,000 E 698,000 88° 52'

N 40,000 N 39,000 N 38,000 N 37,000 N 36,000 N 35,000 N 34,000 N 33,000 N 32,000 N 31,000

48° 31' 30' 29' 28' 45° 27'

CRANDON MUNICIPAL AIRFIELD

LAKE METONGA

TOWN OF NASHVILLE
TOWN OF LINCOLN

CREEK

HIGHWAY 55

SWAMP

RICE LAKE

MOLE LAKE

ACCESS ROAD

RAILROAD SPUR

RAILROAD

HEMLOCK CREEK

MINE/MILL SITE

SKUNK LAKE

MWDF ACCESS ROAD

RECLAIM POND

CSA

MRDF

MWDF

TOWN OF LINCOLN

TOWN OF NASHVILLE

PIPELINE

OAK LAKE

POTABLE WATER WELL

LITTLE SAND LAKE

DUCK LAKE

DEEP HOLE LAKE

WALSH LAKE

ST JOHNS LAKE

ROLLING STONE LAKE

MATCHLINE SEE INSERT

WATER DISCHARGE

FOREST COUNTY
LANGLADE COUNTY

T 35 N
FOREST CO
LANGLADE CO
T 34 N

T 35 N
T 34 N

TOWN OF LINCOLN
TOWN OF NASHVILLE

LANGLADE COUNTY
FOREST COUNTY

12-9

INSERT

Bishop Lake

Creek

Swamp

Mole Lake

MATCHLINE

ROUTE

WATER DISCHARGE POINT

PIPELINE

0 600 1200 1800
SCALE IN METERS

TOWN OF NASHVILLE

LEGEND:

— PROJECT BOUNDARY

—P—P— POWER LINE

—T—T— TELEPHONE LINE

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS FOR 2 METER CONTOUR INTERVAL MAPPING.

CONTOUR INTERVAL 2 METER BASED ON MEAN SEA LEVEL DATUM

HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

DATE OF PHOTOGRAPHY : APRIL 28 , 1976

AERO-METRIC ENGINEERING PROJECT NO. 117815

0 250 500 750 1000 Meters

SCALE 1:12,500

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
PROJECT ACTIVITIES, ELECTRIC POWER & TELEPHONE UTILITY LINES (EXISTING)

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN DR SPRINGBORN	DATE 12/82	CHECKED BY T S Quinn		DATE 01/29/86	
APPROVED BY	DATE	APPROVED BY A. C. Schroeder		DATE 1-28-86	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO. FIGURE 2-4			SHEET — OF —	REVISION NO. 1	

E 693 200
E 693 400
E 693 600
E 693 800
E 694 000
E 694 200
E 694 400
E 694 600
E 694 800
E 695 000

N 36 600
N 36 400
N 36 200
N 36 000
N 35 800
N 35 600
N 35 400

ROAD

ACCESS

EXPLOSIVE STORAGE

SURFACE DRAINAGE BASIN NO. 3

PRE-PRODUCTION ORE STORAGE

SURFACE DRAINAGE BASIN NO. 2

RAILROAD SPUR

CONCENTRATE THICKENERS
ZINC
COPPER
LEAD
CONCENTRATOR
WATER TREATMENT PLANT
WATER TANKS
PUMP HOUSE
PUMP CHAMBER
TAILINGS THICKENER
TRACK SCALE
DISCHARGE LAGOONS
FUEL STATION
REAGENT BULK STORAGE
CEMENT SILOS
MARCONAFLO'S
BALL STORAGE
LUBE STORAGE
COLD STORAGE
COVERED COARSE ORE STORAGE
FINE BACKFILL BIN
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN
SUBSTATION
NATURAL GAS METER STATION
SERVICES BLDG.
COLLAR HOUSE
HEADFRAME
MINE FRESH AIR INTAKE & HEATER
CORE PROCESSING & STORAGE
HOIST HOUSE COMP. STATION
TRUCK SCALE
GATE HOUSE
COMP. COOLER
ELEC. ROOM
BULK FUEL STORAGE
BACKFILL HOLE NO. 1
PARKING
BACKFILL HOLE NO. 2
FUEL TANKS
SURFACE DRAINAGE BASIN NO. 1
COVERED STORAGE
SANITARY WASTE TREATMENT PLANT
TIMBER & STEEL STORAGE
TOPSOIL STORAGE AREA
MULCH STORAGE AREA
HAUL ROAD
TO MINE WASTE DISPOSAL FACILITY
EAST EXHAUST RAISE
SURFACE FANS
WEST EXHAUST RAISE
SURFACE FANS
WATER DISCHARGE PIPELINE

0 50 100 150
SCALE IN METERS
0 100 200 300 400 500
SCALE IN FEET

NOTE: OVERSIZE COPY OF THIS FIGURE IS CONTAINED IN THE FOLLOWING POCKET

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MINE/MILL SURFACE FACILITIES

SCALE SHOWN | STATE WISCONSIN | COUNTY FOREST
DRAWN BY DR SPRINGBORN | DATE 8/85 | CHECKED BY | DATE
APPROVED BY | DATE | APPROVED BY | DATE
APPROVED BY | DATE | DRAWING NO

FIGURE 2-5

SHEET

E 693 200
E 693 400
E 693 600
E 693 800
E 694 000
E 694 200
E 694 400
E 694 600
E 694 800
E 695 000
N 36 600
N 36 400
N 36 200
N 36 000
N 35 800
N 35 600
N 35 400
N
ROAD
ACCESS
EXPLOSIVE STORAGE
SURFACE DRAINAGE BASIN NO. 3
PRE-PRODUCTION ORE STORAGE
SURFACE DRAINAGE BASIN NO. 2
RAILROAD
SPUR
CONCENTRATE THICKENERS
ZINC
COPPER
LEAD
CONCENTRATOR
WATER TREATMENT PLANT
WATER TANKS
PUMP HOUSE
PUMP CHAMBER
REAGENT BULK STORAGE
TAILINGS THICKENER
TRACK SCALE
DISCHARGE LAGOONS
FUEL STATION
CEMENT SILOS
MARCONAFLO'S
BALL STORAGE
LUBE STORAGE
COLD STORAGE
COVERED COARSE ORE STORAGE
FINE BACKFILL BIN
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN
COVERED STORAGE
SANITARY WASTE TREATMENT PLANT
TIMBER & STEEL STORAGE
SUBSTATION
NATURAL GAS METER STATION
SERVICES BLDG.
COLLAR HOUSE
HEADFRAME
MINE FRESH AIR INTAKE & HEATER
CORE PROCESSING & STORAGE
TOPSOIL STORAGE AREA
HOIST HOUSE
COMP. STATION
TRUCK SCALE
GATE HOUSE
COMP COOLER
ELEC ROOM
MULCH STORAGE AREA
BULK FUEL STORAGE
BACKFILL HOLE NO. 1
PARKING
BACKFILL HOLE NO. 2
FUEL TANKS
SURFACE DRAINAGE BASIN NO. 1
HAUL ROAD
SURFACE FANS
WEST EXHAUST RAISE
WATER DISCHARGE PIPELINE
SURFACE FANS
EAST EXHAUST RAISE
TO MINE WASTE DISPOSAL FACILITY
0 50 100 150
SCALE IN METERS
0 100 200 300 400 500
SCALE IN FEET

REVISED	DATE	BY	DESCRIPTION
0	10-31-85		NEW DWG RELEASE

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MINE/MILL SURFACE FACILITIES

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 8/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schwedes	DATE 11/5/85
APPROVED BY	DATE	EXXON D.F. Alm	DATE 11/12/85
DRAWING NO.		SHEET OF	REVISION NO.

FIGURE 2-5

GBB 11/1981

The mine waste disposal facility (MWDF) will be located in an area approximately 1 mile southeast of the mine/mill site. This facility, consisting of four tailings ponds, will be designed and constructed for safe surface disposal of tailings generated from mining and milling the ores. The tailings ponds will be constructed and reclaimed in stages over the operational life of the mine, and will ultimately occupy about 365 acres. One reclaim water pond with two cells will be located adjacent to the northwest side of the MWDF and will ultimately encompass approximately 50 acres. A mine refuse disposal facility (MRDF) will be located north of tailing pond T3 and east of the reclaim pond. This facility will require an area of approximately 15 acres.

The mine/mill site and the MWDF area will be connected by a corridor containing the MWDF access road and the slurry and reclaim water pipelines. This corridor will extend from the eastern side of the mine/mill site to the southwest corner of the reclaim pond.

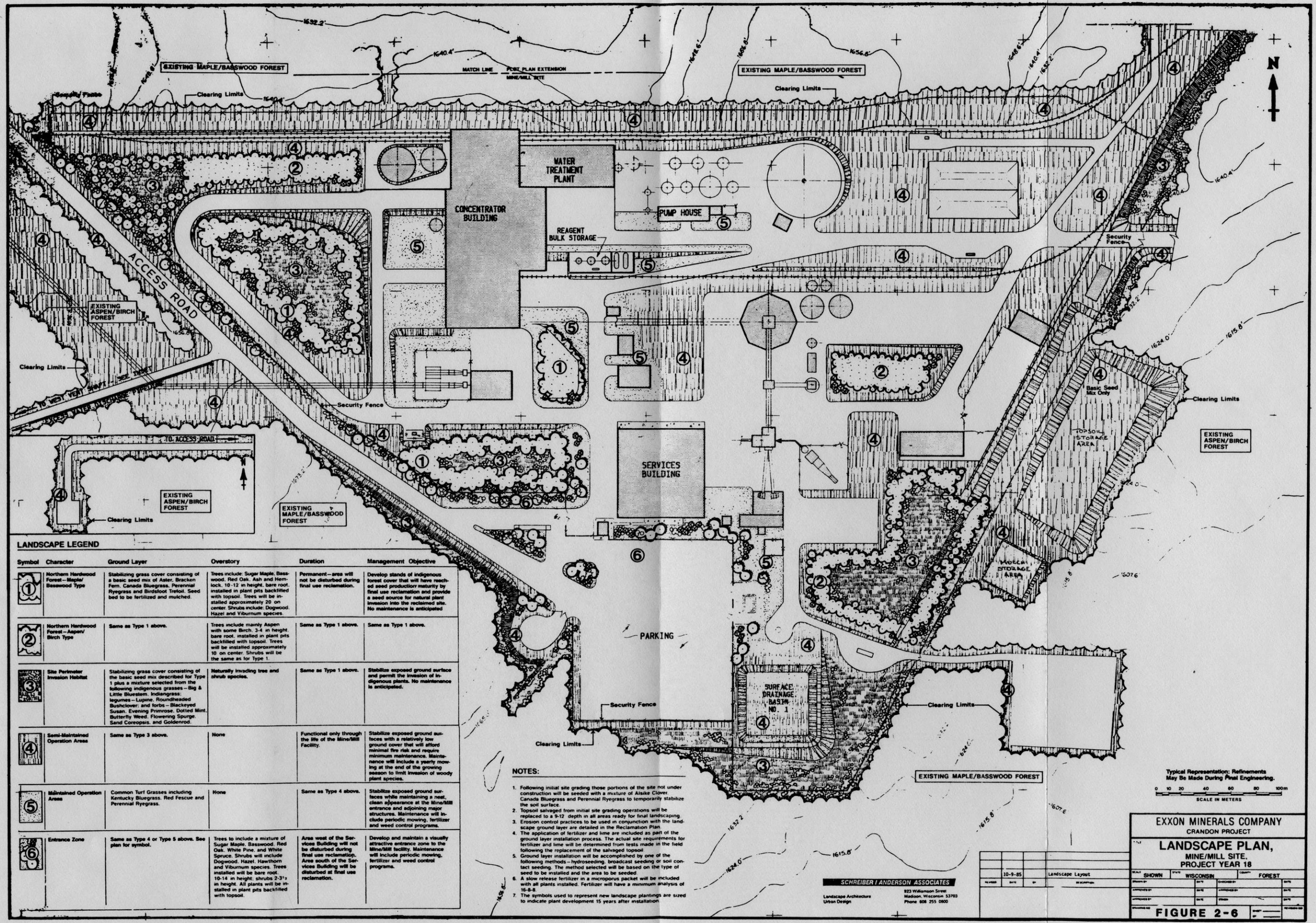
The access road will connect the mine/mill site to State Highway 55 at a point about 3 miles northwest of the site. The railroad spur will connect the mine/mill site to the Soo Line Railroad at a point about 2.7 miles northeast of the site. An excess water discharge pipeline will extend from the mine/mill site area to Swamp Creek about 6 miles to the west.

2.0.1 Aesthetics and Landscaping

Considerations were given during planning of the mine site to achieve the aesthetic standards described in NR 132.17 and 132.18(1)(e). The site area contains most of the visual amenities that are common to northern Wisconsin. The Project surface facilities will impact these aesthetics to a limited degree.

Visually, the most prominent feature of the Project will be the main shaft headframe. The visual impact of the tower structure's projection above the horizon will be mitigated by use of headframe exterior materials of a color selected to be compatible with the surrounding background. Headframe exterior surfaces will also be of a rough texture to minimize structure reflectivity.

Landscaping of the mine/mill site area with trees, shrubs, and grasses will moderate the appearance of the surface facility site area. Reclamation activities associated with the facilities will ensure plant growth and aid in erosion control. Figures 2-6, 2-7 and 2-8A depict the overall plantings and landscape plan within the site areas. Figures 2-8B and 2-8C show artist renderings of the mine/mill site area and an oblique view of the Project around year 20.



LANDSCAPE LEGEND

Symbol	Character	Ground Layer	Overstory	Duration	Management Objective
①	Northern Hardwood Forest – Maple/ Basswood Type	Stabilizing grass cover consisting of a basic seed mix of Aster, Bracken Fern, Canada Bluegrass, Perennial Ryegrass and Birdsfoot Trefoil. Seed bed to be fertilized and mulched.	Trees include: Sugar Maple, Basswood, Red Oak, Ash and Hemlock, 10-12 in height, bare root, installed in plant pits backfilled with topsoil. Trees will be installed approximately 20 on center. Shrubs include: Dogwood, Hazel and Viburnum species.	Permanent – area will not be disturbed during final use reclamation.	Develop stands of indigenous forest cover that will have reached seed production maturity by final use reclamation and provide a seed source for natural plant invasion into the reclaimed site. No maintenance is anticipated
②	Northern Hardwood Forest – Aspen/ Birch Type	Same as Type 1 above.	Trees include mainly Aspen with some Birch, 3-4 in height, bare root, installed in plant pits backfilled with topsoil. Trees will be installed approximately 10 on center. Shrubs will be the same as for Type 1.	Same as Type 1 above.	Same as Type 1 above.
③	Site Perimeter Invasion Habitat	Stabilizing grass cover consisting of the basic seed mix described for Type 1 plus a mixture selected from the following indigenous grasses – Big & Little Bluestem, Indiangrass; legumes – Lupine, Roundheaded Bushclover; and forbs – Blackeyed Susan, Evening Primrose, Dotted Mint, Butterfly Weed, Flowering Spurge, Sand Coreopsis, and Goldenrod.	Naturally invading tree and shrub species.	Same as Type 1 above.	Stabilize exposed ground surface and permit the invasion of indigenous plants. No maintenance is anticipated.
④	Semi-Maintained Operation Areas	Same as Type 3 above.	None	Functional only through the life of the Mine/Mill Facility.	Stabilize exposed ground surfaces with a relatively low ground cover that will afford minimal fire risk and require minimum maintenance. Mace. Maintenance will include a yearly mowing at the end of the growing season to limit invasion of woody plant species.
⑤	Maintained Operation Areas	Common Turf Grasses including Kentucky Bluegrass, Red Fescue and Perennial Ryegrass.	None	Same as Type 4 above.	Stabilize exposed ground surfaces while maintaining a neat, clean appearance at the Mine/Mill entrance and adjoining major structures. Maintenance will include periodic mowing, fertilizer and weed control programs.
⑥	Entrance Zone	Same as Type 4 or Type 5 above. See plan for symbol.	Trees to include a mixture of Sugar Maple, Basswood, Red Oak, White Pine, and White Spruce. Shrubs will include Dogwood, Hazel, Hawthorn and Viburnum species. Trees installed will be bare root, 10-14 in height; shrubs 2-3½ in height. All plants will be installed in plant pits backfilled with topsoil.	Area west of the Services Building will not be disturbed during final use reclamation. Area south of the Services Building will be disturbed at final use reclamation.	Develop and maintain a visually attractive entrance zone to the Mine/Mill facility. Maintenance will include periodic mowing, fertilizer and weed control programs.

NOTES:

1. Following initial site grading those portions of the site not under construction will be seeded with a mixture of Alsike Clover, Canada Bluegrass and Perennial Ryegrass to temporarily stabilize the soil surface.
2. Topsoil salvaged from initial site grading operations will be replaced to a 9-12" depth in all areas ready for final landscaping.
3. Erosion control practices to be used in conjunction with the landscape ground layer are detailed in the Reclamation Plan.
4. The application of fertilizer and lime are included as part of the ground layer installation process. The actual site requirements for fertilizer and lime will be determined from tests made in the field following the replacement of the salvaged topsoil.
5. Ground layer installation will be accomplished by one of the following methods – hydroseeding, broadcast seeding or soil contact seeding. The method selected will be based on the type of seed to be installed and the area to be seeded.
6. A slow release fertilizer in a microporus packet will be included with all plants installed. Fertilizer will have a minimum analysis of 16-8-8.
7. The symbols used to represent new landscape plantings are sized to indicate plant development 15 years after installation.

Typical Representation; Refinements May Be Made During Final Engineering.

0 10 20 40 60 80 100m
SCALE IN METERS

SCHREIBER / ANDERSON ASSOCIATES
Landscape Architecture
Urban Design
923 Williamson Street
Madison, Wisconsin 53703
Phone 608 255 0800

	10-9-85	Landscape Layout	

EXXON MINERALS COMPANY
CRANDON PROJECT

LANDSCAPE PLAN,
MINE/MILL SITE,
PROJECT YEAR 18

SCALE SHOWN | STATE WISCONSIN | COUNTY FOREST

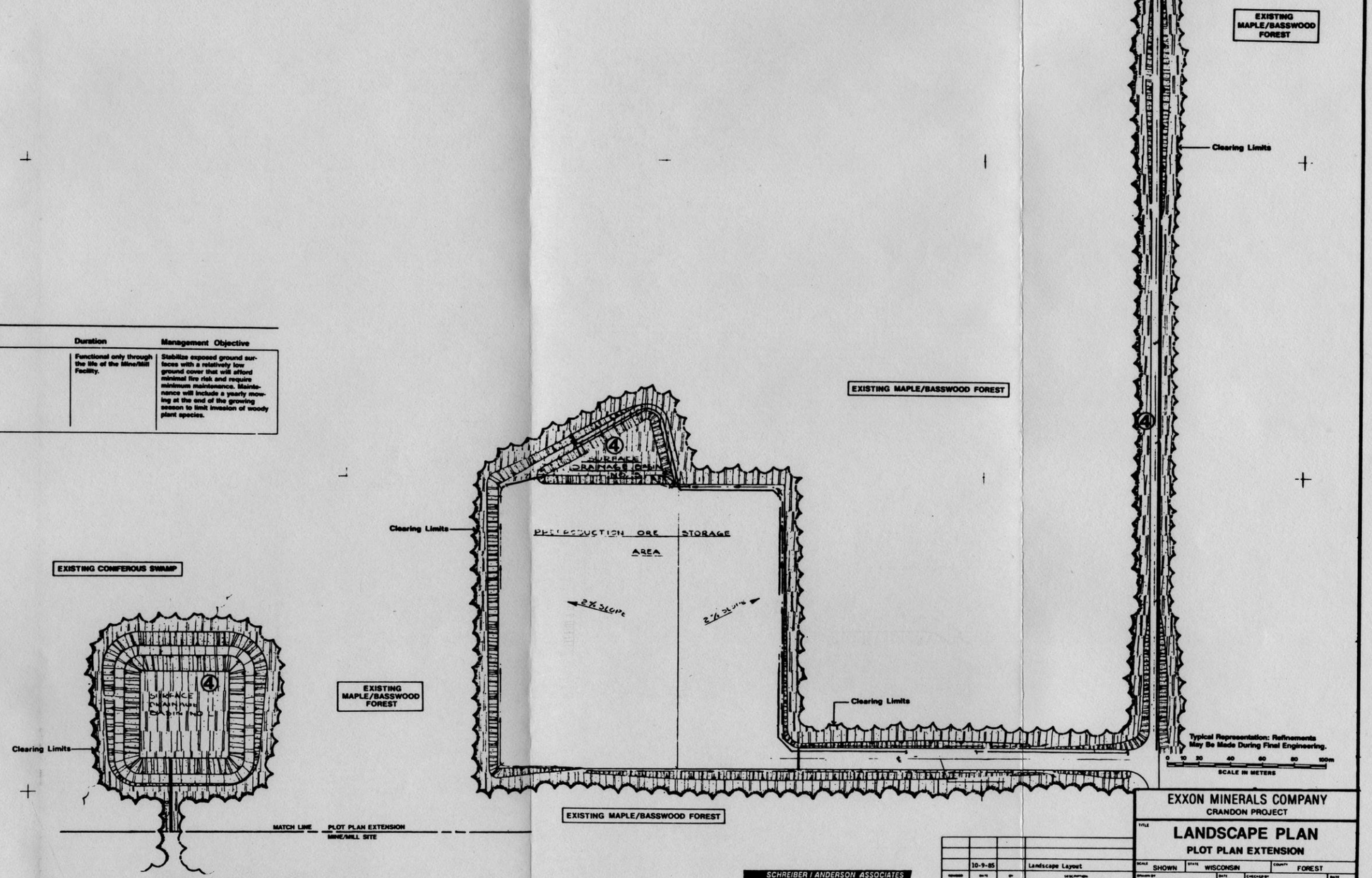
FIGURE 2-6

LANDSCAPE LEGEND

Symbol	Character	Ground Layer	Overstory	Duration	Management Objective
④	Semi-Maintained Operation Areas	Stabilizing grass cover consisting of the basic seed mix described above, plus a mixture selected from the following indigenous grasses—Blue stem, Indian Grass; legumes—Lupine, Roundheaded Bushclover; and forbs—Blackeyed Susan, Evening Primrose, Dotted Mint, Butterfly Weed, Flowering Spurge, Sand Coreopsis, Stiff Goldenrod.	None	Functional only through the life of the Mine/Mill Facility.	Stabilize exposed ground surfaces with a relatively low ground cover that will afford minimal fire risk and require minimum maintenance. Maintenance will include a yearly mowing at the end of the growing season to limit invasion of woody plant species.

NOTES:

1. See Landscape Plan—Mine/Mill Site for applicable notes.



SCHREIBER / ANDERSON ASSOCIATES
Landscape Architecture
Urban Design
923 Williamson Street
Madison, Wisconsin 53703
Phone 608 255 0800

	10-9-85		Landscape Layout
NUMBER	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
LANDSCAPE PLAN
PLOT PLAN EXTENSION

SCALE	STATE	COUNTY
SHOWN	WISCONSIN	FOREST

DRAWN BY — DATE — CHECKED BY C.G. Schneider — DATE 11/85
APPROVED BY — DATE — ENGINEER OF RECORD — DATE 11/15/85
APPROVED BY — DATE
APPROVED FOR CONSTRUCTION — SHEET — OF — REVISION NO.

FIGURE 2-7

EXISTING UPLAND FOREST

Clearing Limits

Special Erosion Control Area

Perimeter Access Road

EXISTING UPLAND FOREST

EXISTING DECIDUOUS SWAMP

RECLAIM POND AREA

Clearing Limits

EXISTING UPLAND FOREST

EXISTING UPLAND FOREST

Special Erosion Control Area

EXISTING DECIDUOUS SWAMP

BORROW AREA

Special Erosion Control Area

MINE REFUSE DISPOSAL FACILITY

EXISTING CONIFEROUS SWAMP

CONSTRUCTION SUPPORT AREA

EXISTING UPLAND FOREST

T1

T2

T3

T4

Clearing Limits

Clearing Limits

EXISTING UPLAND FOREST

Special Erosion Control Area

Perimeter Access Road

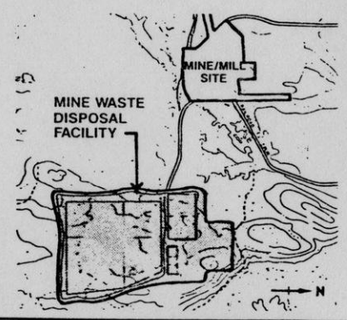
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SCALE IN FEET

NOTES:

1. See Table 3.1 for listing of plant species to be used in reclamation.



SCHREIBER / ANDERSON ASSOCIATES

Landscape Architecture
Urban Design

923 Williamson Street
Madison, Wisconsin 53703
Phone 608 255 0800

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY

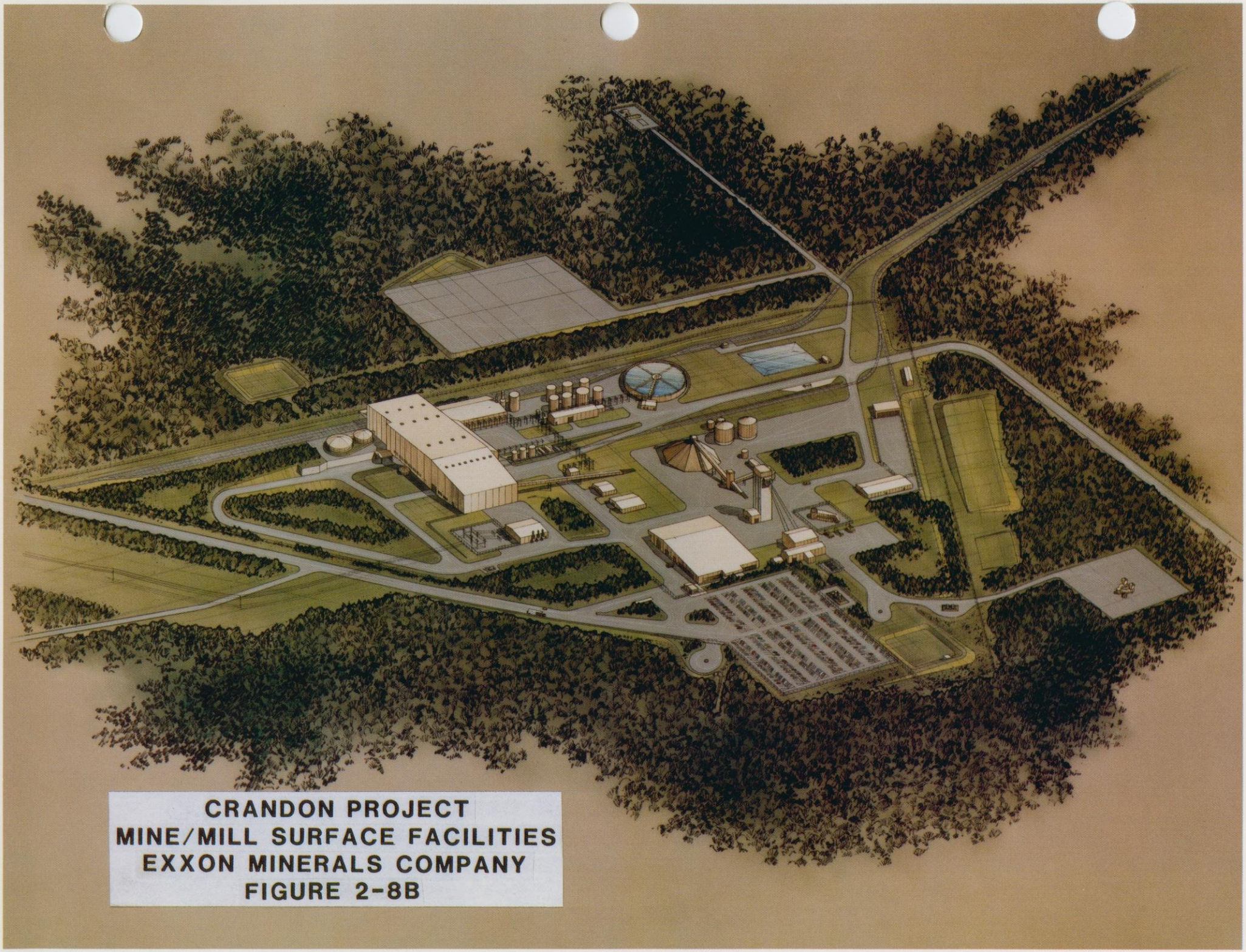
CRANDON PROJECT

TITLE: CONCEPTUAL LANDSCAPE PLAN,
MINE WASTE DISPOSAL FACILITY,
YEAR 5 OF LONG-TERM CARE PERIOD

SCALE	STATE	COUNTY
AS SHOWN	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE 7/86
APPROVED BY	DATE	DRAWING NO.	DATE 1-12-88
APPROVED BY	DATE	SHEET	REVISION

FIGURE 2-8A



CRANDON PROJECT
MINE/MILL SURFACE FACILITIES
EXXON MINERALS COMPANY
FIGURE 2-8B



ARTIST RENDERING
CRANDON PROJECT FACILITIES
YEAR 20
FIGURE 2-8C

2.1 Mine

The mine will consist of the main shaft and ventilation shafts which will extend from the surface into the mine, and of underground levels developed to gain access to the ore. Ore will be blasted and extracted from stopes and the ore will be handled through a material handling and primary crushing system. Primary crushed ore will be hoisted up the main shaft to the surface. Mine surface facilities will include a headframe and collar house, hoist and compressor house, and mine air heaters.

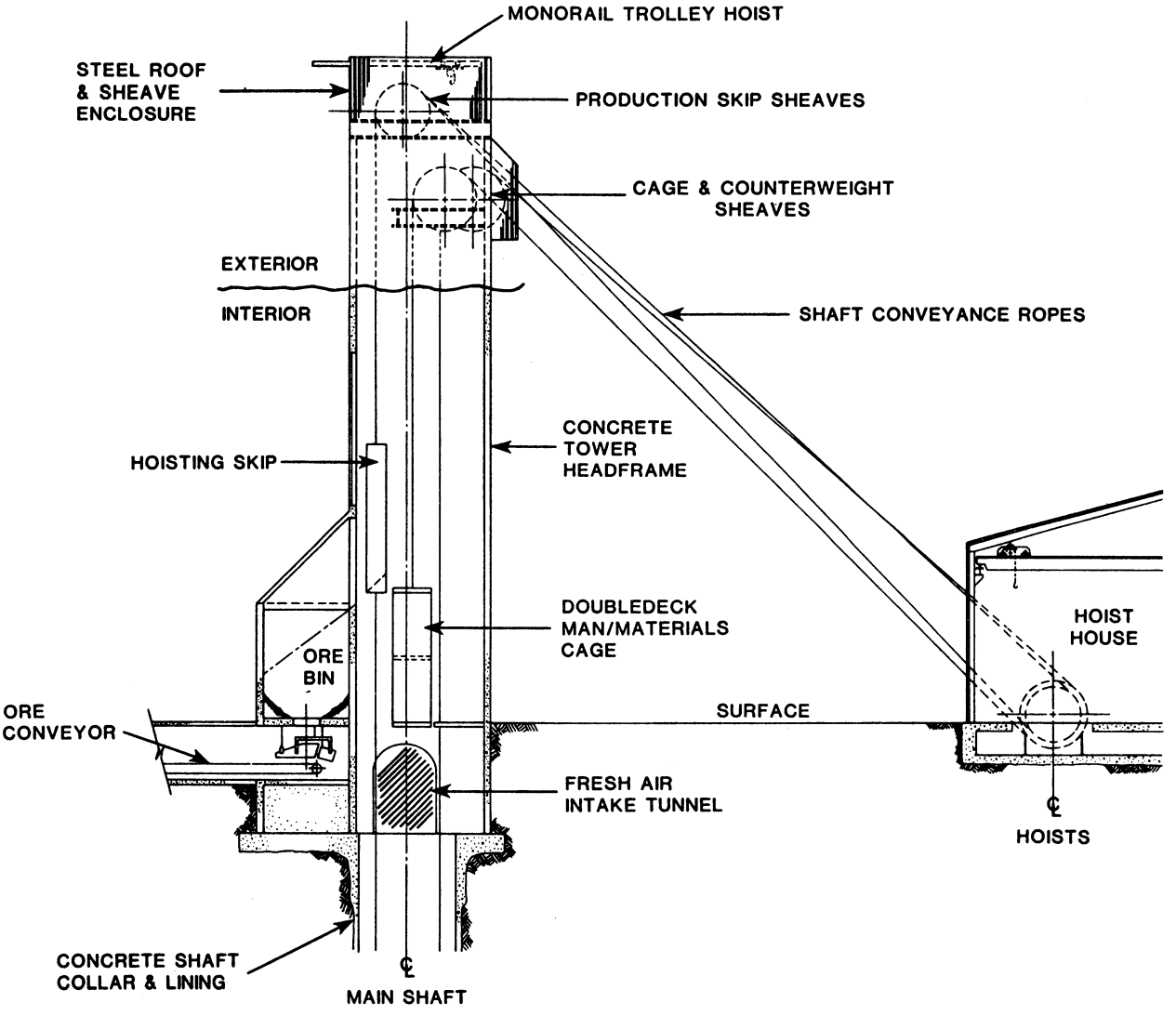
2.1.1 Mine Surface Facilities

The mine surface facilities are shown on Figure 2-5.

2.1.1.1 Headframe and Collar House

A concrete tower headframe will be positioned over the main shaft to house the sheave wheels for the ground mounted drum-type mine production and service hoists (Figure 2-9). This enclosed structure will be approximately 155 feet high with plan dimensions of about 32 x 36 feet. Headframe appurtenances will include steel roof and sheave enclosures, the ore bin at ground level on the north wall and the collar house adjacent to the west side of the structure.

Two skips hoisted by the production hoist will empty mined ore/rock into the headframe discharge bin. The contents of this bin will be fed onto a conveyor belt which will transfer ore to the coarse ore storage building or waste rock to the backfill crushing plant.



LOOKING EAST

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **MAIN SHAFT HEADFRAME/HOISTS**

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
C. ADAMS	8/85		
APPROVED BY	DATE	APPROVED BY	DATE
		EXXON C.C. Schroeder	11/85
APPROVED BY	DATE	EXXON D.E. Mac	DATE 11/13/85

DRAWING NO. **FIGURE 2-9** SHEET ___ OF ___ REVISION NO

Access to the main shaft cage for men, equipment and materials will be through the headframe collar house at the surface elevation. This facility will provide a protected staging area for men, equipment and materials to be transported down the shaft. Mine services, such as compressed air, water, and electrical cables, will also enter the shaft through the headframe.

2.1.1.2 Hoist and Compressor House

Mine production and service hoisting equipment will be housed in a building directly south of the main shaft (Figure 2-5). A ground mounted double drum unit will be installed for ore/waste rock hoisting with skips in balance. The man and materials service cage hoist will also be a ground mounted unit. This hoist house structure will also contain the electric driven air compressors for supply of both mine and plant compressed air service.

2.1.1.3 Mine Air Heaters

Fresh air will enter the mine through the main shaft. At maximum demand, approximately 850,000 cubic feet per minute of fresh air will be required in the mine. About 25 percent of this air will be heated by natural gas fired heaters during the winter to maintain a minimum air stream temperature of 40° F in the main shaft. The air heaters will be located to the east of the main shaft. Each heater will be equipped with a fan to maintain the proper flow of air through the heater. The heated air will be mixed with unheated air entering the shaft through the intake portal.

2.1.2 Mine Underground Facilities

Mine underground facilities are discussed in the following subsections. Table 2.1 shows the approximate dimensions of surface openings for the mine.

2.1.2.1 Main Shaft

Principal access to the mine will be through the main shaft shown on Figure 2-5. This facility will provide access to the mine for the purposes of transporting men and materials, as well as for the hoisting of ore and waste rock to the surface. The facility will also house various services, including electric power conductors and water lines. Intake air for mine ventilation will enter through this facility.

Present plans call for a vertical shaft approximately 1,810 feet deep with a diameter of 22 to 24 feet.

A sump will be excavated in the bottom of the completed shaft to collect water draining from mine levels above. Pumps installed in this sump will transfer the collected water to a larger main sump installation on a level above the shaft bottom for eventual pumping to the surface.

Shaft conveyances will include two ore hoisting skips and a main man and materials service cage.

2.1.2.2 Ventilation Shafts

Fresh air will enter the mine through the fresh air portal immediately east of the main shaft headframe. At each end of the

TABLE 2.1

APPROXIMATE DIMENSIONS OF SURFACE OPENINGS

MINE OPENING	DIAMETER
Main Shaft	22-24 feet
Exhaust Ventilation Shafts (East and West)	16-18 feet

orebody, exhaust air moved by surface mounted fans will reach the surface through exhaust ventilation shafts. The fans will provide the main motive force for the mine ventilation system. About 50 percent of the total air required in the mine will exit through each exhaust ventilation shaft. The exhaust ventilation shafts will be concrete-lined in the zone through the overburden. At each exhaust shaft collar, two large diameter main mine ventilation fans will be installed in parallel (i.e., a total of four main fans will be installed). Each fan will have a motor-operated damper to isolate it from airflow when work on the fan is required. Each fan will be equipped with the necessary controls, switches, and monitors. Exhaust air will be monitored underground for carbon monoxide, carbon dioxide, and NO_x concentrations.

Air from the mine will be exhausted vertically to ensure maximum noise dampening and dispersion. Placement of mine exhaust fans on the surface will assure maximum reliability and operability of essential switches and electrical components. The location of the fans and road access to them is shown on Figure 2-5.

2.1.2.3 Drifts

The nearly vertical orebody will be divided into main mining levels approximately 300 to 400 feet apart. The main level drifts will be large enough to provide clearance for the load-haul-dump (LHD) vehicles and trucks used in the mining process. Main levels will intersect the main shaft for man and materials access and intake ventilation. The layout of a typical main level plan is shown on

Figure 2-10. Lateral access drifts will be located in the hanging wall and footwall of the orebody and will extend beyond the strike length of the ore zone to provide access to the exhaust air raises at the extreme ends of the orebody. The lateral extent of a mine level at a given point in time will depend upon the need for access to ore passes, ventilation openings and active orebody mining blocks.

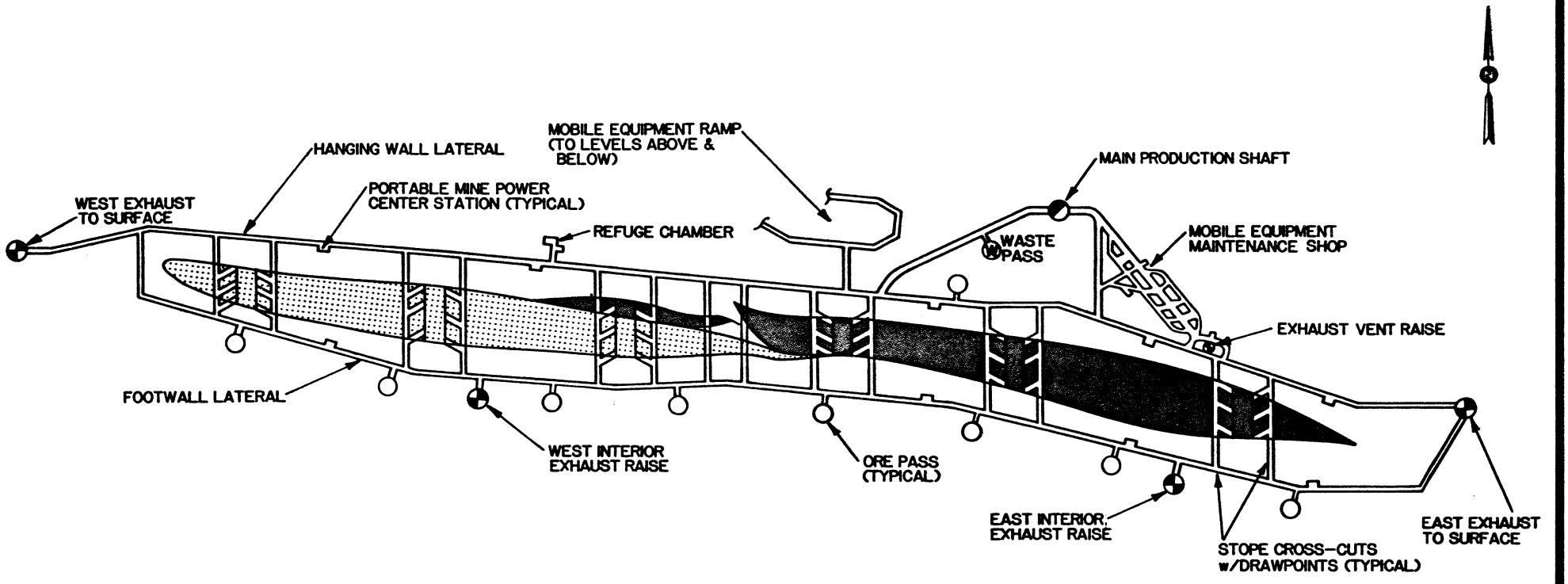
A ramp decline will connect mine levels to allow movement of equipment, supplies, and personnel throughout the mine. This centrally located decline is shown schematically on Figure 2-11.

2.1.2.4 Stopes

For production purposes the orebody will be divided into mining blocks or stopes. The stopes will be accessed at the top and midpoint by sublevel drifts for drilling and blasting and at the bottom by main level drifts for removal of broken ore (Figure 2-12).

The mining methods and stope sequences planned for extraction of the orebody were selected to maintain mine area rock mass stability and prevent surface subsidence. A permanent bridge, or crown pillar, of bedrock directly beneath the glacial overburden will be purposely excluded from mining activity. This bedrock barrier will maintain surface stability and prevent subsidence of overburden materials.

Beneath the crown pillar, stoping methods and sequences will be arranged to maintain local rock mass integrity and avoid disturbance of the crown pillar. All mining methods planned provide for backfilling of stopes following ore extraction. Mining of the zinc and copper ores will generally proceed from depth and the deposit extremities toward the



MASSIVE ORE

STRINGER ORE

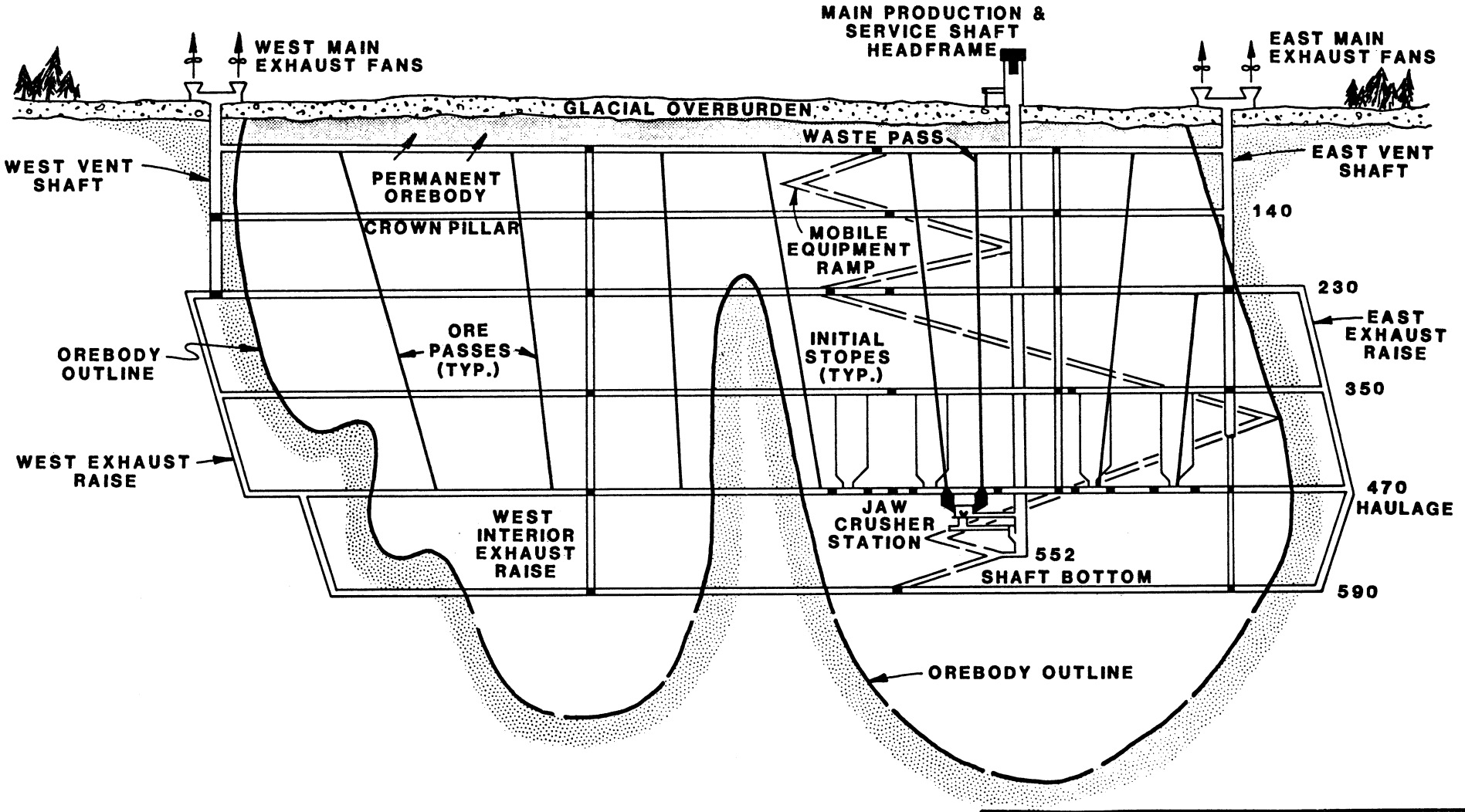
Typical Representations Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MAIN MINE LEVEL (350) CONCEPTUAL PLAN

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY E.R. Schmidt	DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. Hess	DATE 11/12/85
DRAWING NO **FIGURE 2-10**		SHEET OF	REVISION NO 1



Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
UNDERGROUND MINE LONGITUDINAL SECTION SCHEMATIC (LOOKING NORTH)

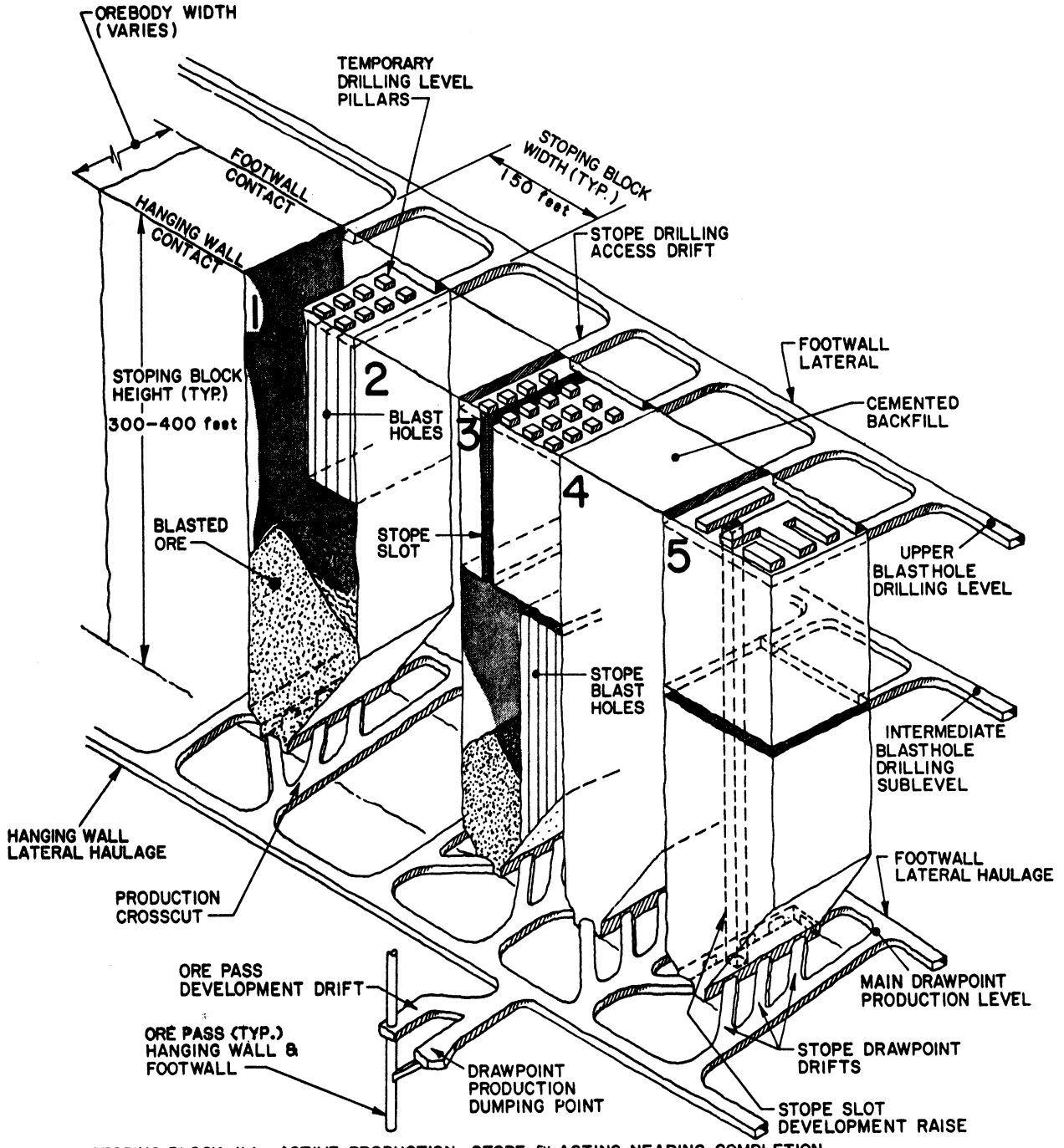
SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	9/85		
APPROVED BY	DATE	APPROVED BY	DATE
		C.C. Schroeder	11/85
APPROVED BY	DATE	EXXON D E Mar	DATE 11/15/85

DRAWING NO
FIGURE 2-11

SHEET ____ OF ____

REVISION NO



STOPING BLOCK #1—ACTIVE PRODUCTION—STOPE BLASTING NEARING COMPLETION

STOPING BLOCK #2—ALTERNATE STOPING BLOCK/PILLAR—TO BE MINED AFTER BACKFILLING ADJACENT STOPES

STOPING BLOCK #3—ACTIVE PRODUCTION—INITIAL STAGES OF STOPE BLASTING

STOPING BLOCK #4—DEPLETED STOPE BLOCK—CEMENTED BACKFILL IN PLACE

STOPING BLOCK #5—STOPE BLOCK PARTIALLY DEVELOPED

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CONCEPTUAL STOPING SEQUENCE

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE 7/82	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schweden	DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. Mac	DATE 11/15/85
DRAWING NO FIGURE 2-12		SHEET OF	REVISION NO 1

Typical Representations Refinements May Be Made During Final Engineering

surface, with mining directly below the permanent crown pillar planned for the final portion of the orebody life. These practices, combined with the fact that approximately 10 percent of the potentially minable ore will be left in place as pillars throughout the mine, will assure perpetual stability of the mine area bedrock surface and glacial overburden.

2.1.2.5 Mine Electrical Power System

Electrical power will be supplied to the underground mine facilities from the surface substation at 13,800 volts. In the event of a power outage on the surface, auxiliary power will be supplied from on-site standby generators to maintain limited ventilation and pumping capability in the mine and to hoist underground personnel to the surface if necessary.

Power will be distributed at 13,800 volts throughout the mine to load centers located near the operating equipment. Some load centers, such as those for the fans and pumps, will be permanently installed. Other load centers servicing mobile equipment, such as electric-hydraulic drills and booster compressors, will be semi-portable and will be relocated periodically. Total peak mine load is expected to be about 8,500 kW, including the main production hoist. Separate electrical systems will be used to initiate all production blasts in the mine. Table 2.2 provides a representative list of major mine equipment requiring electrical power.

TABLE 2.2

MAJOR MINE EQUIPMENT REQUIRING ELECTRICAL POWER

EQUIPMENT
Production Hoist
Cage Hoist
Escape Hoist
Fans
Crusher
Conveyors & Feeders
Booster Fans & Heaters
Pumps
Electric/Hydraulic Drills
Booster Compressors
Surface Compressors
Raiseboring Machines

2.1.2.6 Communications System

The mine communication system will consist of a cable network, a radio system, and telephone and paging system. Each system is dependent on the cable network for communications between levels and to the surface. The cable network will contain a spare line, allowing for parallel communications paths to the surface at all times.

2.1.2.7 Explosives

During operation of the mine, several days' supply of blasting materials will be stored in underground magazines. Typically, two magazine areas will be located near each main mine level. Materials stored will include water gel explosives, ammonium nitrate/fuel oil (ANFO) blasting agents, detonating cord, and electric and non-electric blasting caps.

Explosives and detonators will be stored in separate magazines constructed and located in accordance with applicable State and Federal mine safety regulations. Magazine excavations will be clearly identified, constructed with non-sparking interiors and will have controlled access by authorized personnel only.

2.1.2.8 Maintenance Facilities

Daily service and inspection, periodic preventive maintenance, component replacement, and repair of mobile mining equipment will be conducted in an underground mobile equipment service shop. This area will resemble a surface truck garage. All mobile and portable mining equipment will have access to this shop via the mine ramp or main shaft service cage.

2.1.2.9 Mining Equipment

The proposed mining method will employ mobile mining equipment in the unit operations including drilling, blasting, mucking, and support services. Most of this equipment will be rubber-tired and diesel-powered. The major exceptions will be the crawler-mounted production drills, booster compressors, raise boring machines and portable mine power centers. Major mobile and portable equipment types are presented in Table 2.3.

Mine structural materials, machinery, and mobile equipment will typically enter the mine through the main production/service shaft. The service hoist and cage will be designed to accommodate the heaviest and largest mechanical components required to construct and operate the mine. The larger mobile mining vehicles may be separated at the center articulation joint for transport underground.

2.1.2.10 Ore Transport Facilities

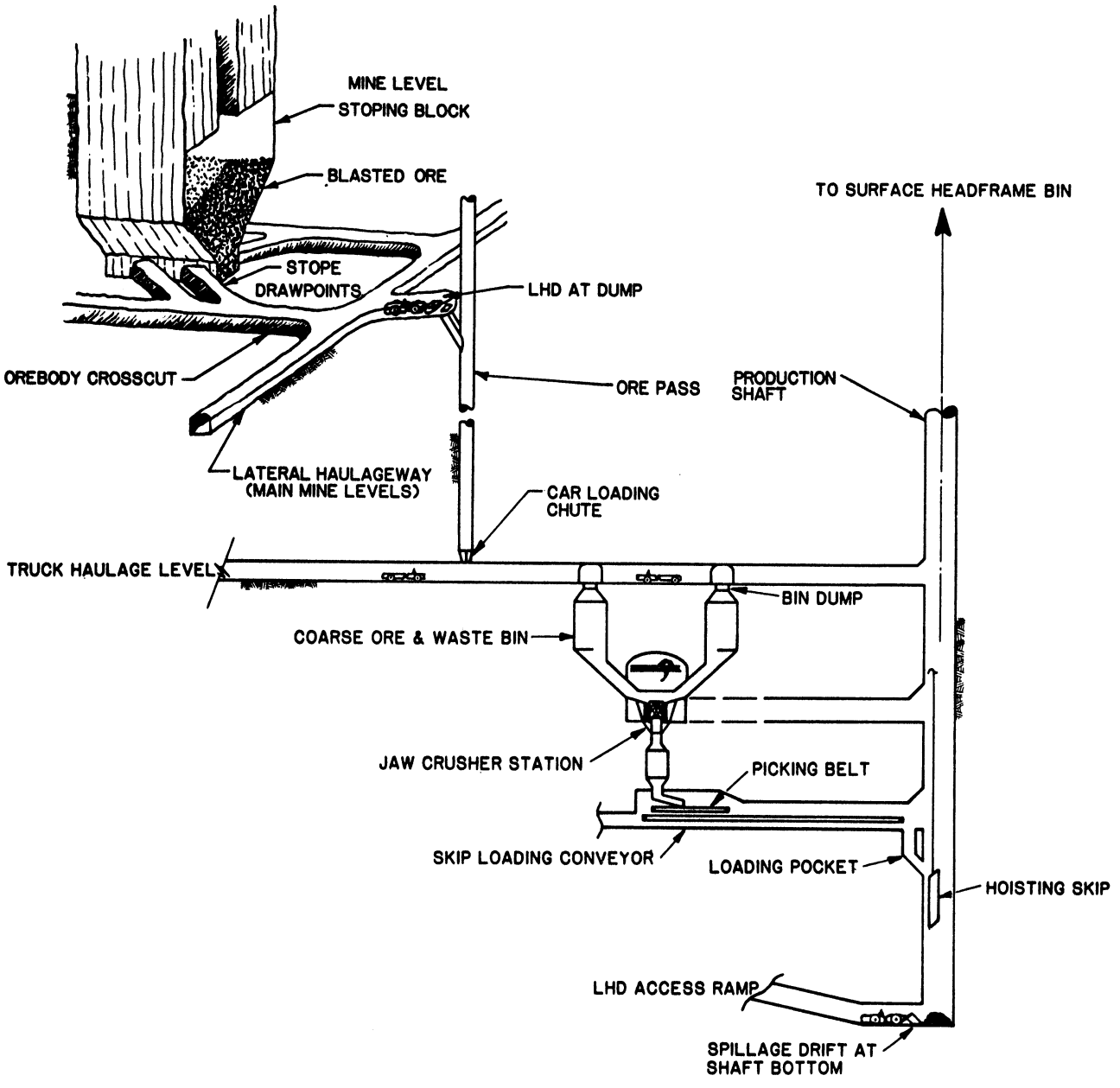
Ore will be removed from the stopes on drawpoint levels at approximate 300 to 400-foot vertical intervals using rubber-tired, diesel-powered load-haul-dump (LHD) units. For stope drawpoints on the lower levels, LHDs and trucks will haul directly to the crusher coarse feed bins. Typically, ore will be transported by an LHD to steeply dipping ore passes leading down to the main haulage level. Ore and waste passes will be spaced at convenient locations along the orebody to limit the haulage distance. A schematic representation is presented on Figure 2-13.

TABLE 2.3

TYPICAL UNDERGROUND MOBILE EQUIPMENT LIST

DESCRIPTION
Diesel Powered Rubber-tired Mobile Units
Load-haul-dump (LHD) (0.5 to 13 yd^3)
Haulage Truck (26 to 40 ton)
Hydraulic Drill Jumbo - Twin Boom
Pneumatic Drill Jumbo - Triple Boom
Roofbolting Jumbo - Twin Boom
Fan Drill Jumbo - Twin Boom
Secondary Breakage Drawpoint Drill
Scissors Lift Service Truck
Utility Flatbed Truck
Explosives Transport/Loading Truck
Lubrication/Service Truck
Personnel Carrier (12 persons)
Utility Tractor
Ambulance/Emergency Vehicle
Forklift (3 to 6 ton)
Road Grader/Dozer
Concrete Delivery Truck
Portable Mining Equipment
Crawler Mounted Stope Blasthole Drill
Booster Air Compressor
Electric/Hydraulic Diamond Core Drill
Raise Boring Machine (6 to 8 feet diameter)
Concrete/Shotcrete Mixer-Placer
Grout Pumping Unit
500kVA Mine Power Substation

NOTE: This is a typical equipment list for a mine of this design. The actual type of equipment used may vary.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
ORE TRANSPORT SYSTEM

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schneider	DATE 11/3/65
APPROVED BY	DATE	EXXON D.E. Mac	DATE 11/3/65
DRAWING NO	FIGURE 2-13	SHEET OF	REVISION NO

Typical Representations Refinements May Be Made During Final Engineering

On the haulage level, 26-40 ton trucks will be loaded through chutes. Trucks will dump into coarse feed bins over the crusher with one bin each for ore and waste rock. Mechanical feeders will be used to direct the contents of each bin separately and at a controlled rate to the primary crusher. A discharge feeder will convey the crushed rock from the bin to a wide, slow-speed picking belt from which timber and steel trash can be removed. The main conveyor will move crushed rock horizontally to the main shaft. Crushed rock will be loaded into the shaft skips which then will be hoisted to the surface.

A dust control system will be provided for the rock handling system underground. Dust from the primary crusher discharge will be collected. Collection duct work from the surge bin feeder and picking belt will be manifolded into a dust collector similar to those used for insertable collector installations. Dust collected in this system will be discharged onto the main conveyor. Dust suppression at the skip loading station will be accomplished using water sprays.

2.1.2.11 Underground Primary Crusher

A jaw crusher will be installed below the main haulage level (Figure 2-13). Ore will be fed to this crusher by mechanical feeders. This crusher will be capable of crushing ore or waste rock at an instantaneous rate of approximately 550 tons per hour. Crushed material will discharge to a surge bin immediately below the crusher.

2.1.2.12 Sanitation Facilities

Sanitation facilities consistent with modern U.S. Bureau of Mines approved facilities will be provided at several locations on each level in the mine within walking distance of most work locations. Mine sanitation facilities will be provided in the vicinity of the shop and other permanent installations, and within walking distance of active areas on the mining levels.

2.1.2.13 Water Supply Facilities

Potable water will be distributed throughout the mine via pipes installed in the main shaft and drifts. The source of potable water will be the surface fresh water well used to supply potable water to the entire Project.

2.1.2.14 Fuel Handling and Storage

Diesel fuel oil to supply the needs of surface and underground vehicles, the emergency power generators, and other plant equipment will be delivered to the mine/mill site by tank truck. Fuel will be off-loaded through a pumphouse adjacent to the bulk fuel oil storage tanks. These tanks will be located within dikes sized to contain the fuel oil in the event of a spill, tank leakage, or rupture. The fuel handling and storage system will be designed in accordance with state and federal codes.

Diesel fuel will be distributed from the bulk storage pumphouse by buried pipelines to surface use locations. Fuel for underground use will first be pumped to measuring tanks on the surface adjacent to the underground delivery borehole. These tanks will be

located within dikes with sufficient capacity to contain the contents of the tanks. Valves controlling the filling and emptying of these tanks will be interlocked with the receiving tank in the underground fuel station. Surface tank filling will not be possible unless the borehole delivery valve is closed. Discharge from the measuring tanks will only be possible when the underground receiving tank, of greater capacity, is empty and the valve between the two measuring tanks is closed.

Fuel will be transferred from the measuring tanks to the underground tanks via a steel pipe. This pipe will be in a borehole with a steel casing in the overburden section.

One fuel tank station will be located underground near the mobile equipment shop. Its tank will have a fuel dispensing pump, valving, and level sensors. The tank will be located in a bedrock excavation behind a concrete retaining wall. Any spilled fuel will be collected with a sump pump recessed into a bedrock floor, filtered and recycled to the fuel tank. The diesel fuel station will have a foam generator for fire suppression and fire doors and sensors.

Individual vehicles will either be refueled at the fuel station by pumping directly from the storage tank or fuel will be hauled to remote parts of the mine in a tank truck.

2.1.2.15 Mine Safety Systems

The mine will be constructed to operate in accordance with applicable federal and state mine safety regulations. Fixed safety systems will include the following:

Power - Back-up electrical generators will be maintained on-site to provide essential services such as hoisting, mine water pumping, and ventilation in the event of a power interruption.

Warning System - The emergency warning system used to notify personnel underground will utilize an odor agent which, when released into both the fresh air ventilation stream and the mine compressed air system, will quickly permeate the mine workings.

Fire Prevention and Control - Fire prevention will be a prime consideration that will be incorporated during the design and engineering phase. Appropriate fire suppression systems will be installed where necessary. In addition, ventilation doors of fire resistant materials will be provided at shaft stations, the mobile equipment repair shop, fueling bays, or other locations as necessary. Also, the mine utility water supply system will be designed to be used for fire control.

Portable hand-held dry chemical fire extinguishers will be installed on all mobile equipment, at each power distribution installation, fueling bay, shop, and at other strategic locations throughout the mine. Larger fire fighting units may be stored near the mobile equipment shop for use there or for transport to a remote location.

In addition, each person underground will be provided with a one-hour self rescuer and will be trained in its proper use. These devices will protect miners from carbon monoxide combustion product until evacuated or secured in a refuge chamber according to the mine evacuation plan. Mine rescue apparatus with the necessary ancillary

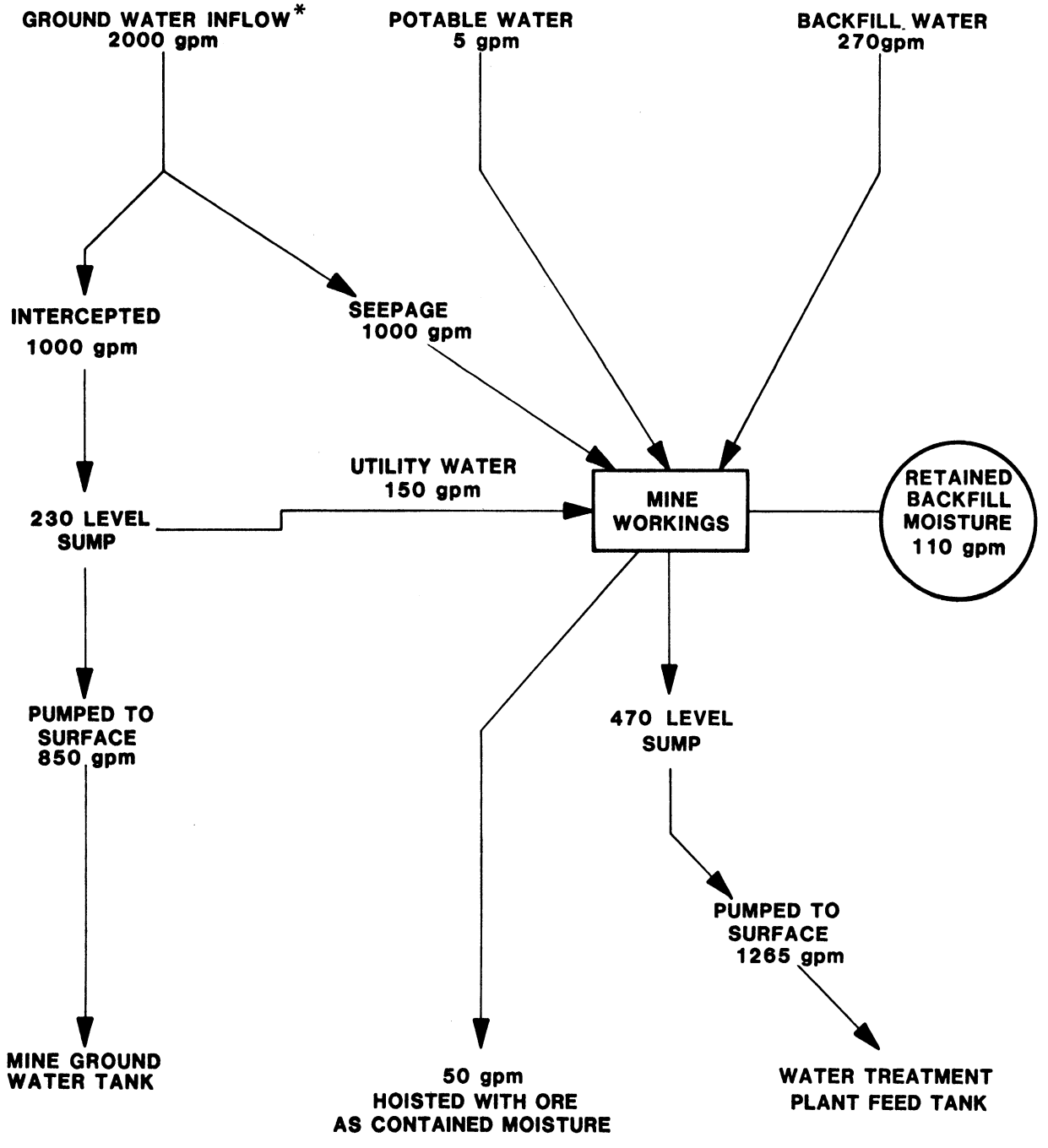
equipment will be located on the surface for use by properly trained mine rescue teams.

First Aid Supplies - First aid supplies will be stored underground in strategic locations and will also be available at the safety office on the surface. All employees will be trained in basic first aid techniques and selected employees may receive additional emergency medical training. An ambulance will be located on-site.

2.1.2.16 Mine Drainage

The predicted steady state rate of ground water inflow to the mine ranges from approximately 935 to 1,590 gallons per minute. This range represents the potential variation from ground water recharge to the main glacial aquifer over the mine site area. The expected mine inflow rate is about 1,270 gallons per minute and is based on the approximate average annual recharge rate. For purposes of designing the underground mine water handling systems, an inflow rate of 2,000 gallons per minute was used based on no control of mine inflow. However, during mine development and operation, all practical efforts will be made to control and reduce the rate of ground water inflow. Therefore, it is unlikely that total inflow to the mine in excess of 2,000 gallons per minute will ever be experienced. The design basis for the mine water inflow is depicted on Figure 2-14.

Ground water inflow to the proposed mine will typically be collected in two separate systems. First, an uncontaminated ground water interceptor system will be installed on the uppermost mine levels. Ground water inflow to the mine will be



*ASSUMED DESIGN RATE;
EXPECTED INFLOW RATE = 1270 gpm

Typical Representation : Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MINE DRAINAGE SCHEMATIC & WATER BALANCE

SCALE	STATE	COUNTY	
NONE	WISCONSIN	FOREST	
DRAWN BY: DR SPRINGBORN	DATE: 9/83	CHECKED BY:	DATE:
APPROVED BY:	DATE:	APPROVED BY: C.C. Schneider	DATE: 11/86
APPROVED BY:	DATE:	EXXON: D S Mac	DATE: 11/86
DRAWING NO: FIGURE 2-14		SHEET ___ OF ___	REVISION NO: 2

localized, occurring predominantly where weathered bedrock courses are in contact with the overburden aquifer at the subcrop. The intensity and lateral extent of the bedrock weathering diminishes with depth. Initial mine production has been planned for the lower mining levels which are below the weathered zones. Therefore, ground water inflows to mine workings during the early years of the mine life are expected to be very limited and localized.

When low inflows are experienced, it will be difficult or impractical to attempt segregation, collection and pumping of uncontaminated ground water. At steady state inflow rates less than about half the 2,000 gallons per minute design maximum, it may be most practical to allow all ground water seepage to be pumped or drained to the mine drainage sumps designed for unintercepted water. For further information refer to the High Capacity Well Approval Applications.

2.1.2.17 Personnel Facilities

Lunch rooms will be strategically located on each mine level within walking distance of most work locations, at the mobile equipment shop, and at the crusher/conveyor installation. Some of these areas will be multi-purpose, serving as first aid stations, communications centers, meeting and training locations, and marshalling points.

2.2 Mill

The mill facilities will include all the equipment for handling and storing the ore hoisted to the surface and the grinding and recovery of the valuable minerals from the ores to produce finished concentrates.

All major process equipment will be housed in the concentrator building. Coarse ore from the mine will be stockpiled in a separate building, east of the concentrator building.

The facilities, which will be discussed in more detail in the following subsections, include:

1) Ore handling facilities;
2) Ore grinding, concentration, dewatering, and concentrate handling areas;
3) Reagent storage and mixing areas;
4) Analytical and testing laboratory;
5) Backfill preparation system and spill control facilities; and
6) Tailings thickening.

A representative list of equipment associated with the mill is presented in Table 2.4.

2.2.1 Ore Handling

After ore is hoisted to the surface, it will be conveyed to the covered coarse ore stockpile. The stockpile will hold approximately 2 days of ore. A concrete tunnel below the stockpiles will house feeders for reclaiming the ore. The feeders will transfer the coarse

TABLE 2.4

MILL FACILITIES - TYPICAL EQUIPMENT LIST

Operation	Equipment Description
Coarse Ore Handling Backfill Preparation	Conveyor to Coarse Ore Stockpile Coarse Ore Feeder Belts Conveyor-Coarse Ore to SAG Mill Insertable Dust Collectors
Waste Rock Handling and Crushing	Fixed Tripper to Waste Rock Bin Feeder Waste Rock Bin to Crusher Primary Crusher - Waste Rock Secondary Crusher - Waste Rock Vibrating Screen-Waste Rock Slurry Tank and Pumps Insertable Dust Collectors
Grinding and Regrinding	Recycle Conveyor SAG Mill Ball Mill Vibrating Screens Slurry Pump Cyclones-Primary Regrind Tower Mill-Zinc Regrind Tower Mill-Copper/Lead Cyclones-Zinc Regrind Cyclones-Copper Head Regrind Regrind Pumps

Operation	Equipment Description
Backfill Preparation	Cyclones, Primary and Secondary Marconaflo High Pressure Pumps Slurry Pumps Feeders
Flotation	Flotation Machines - Copper/Lead Flotation Machines - Lead Flotation Machines - Copper Flotation Machines - Zinc Flotation Blower Pumps, Conditioners, and Overhead Cranes
Concentrate Thickening, Filtering, and Loadout	Thickener - Copper Thickener - Lead Thickener - Zinc Filters Conveyors Thickener Underflow Pump - Copper Thickener Underflow Pump - Lead Thickener Underflow Pump - Zinc Thickener Overflow Pump - Copper Thickener Overflow Pump - Lead Thickener Overflow Pump - Zinc Filter Feed Pumps

Operation	Equipment Description	
Reagent Preparation and Distribution	Starch	- Mixing Tank and Agitator - Transfer Pump - Day Tank - Metering Pump
	Sodium Dichromate	- Bulk Storage Tank - Transfer Pump - Mix Tank and Agitator - Solution Pump - Day Tank - Metering Pumps
	Depressant (Zinc, Sulfate, Lime, and Sodium Cyanide)	- Mix Tank & Agitator - Loop Pump - Metering Pump
	Sulfur Dioxide	- Bulk Storage Tanks - Transfer Pump
	Activated Carbon	- Eductor System - Eductor Circulating Pump - Mix Tank and Agitator - Transfer Pump - Day Tank & Agitator - Metering Pump
	Sodium Cyanide	- Mix Tank & Agitator - Transfer Pump - Day Tank - Metering Pumps

Operation	Equipment Description	
Reagent Preparation and Distribution (continued)	Polypropylene Glycol Methyl Ether (Frother)	- Bulk Storage Tank - Transfer Pump - Mix Tank - Transfer Pump - Day Tank - Metering Pumps
	Sodium Sulfide	- Mix Tank and Agitator - Solution Pump - Day Tank - Metering Pumps
	Zinc Sulfate	- Mix Tank and Agitator - Solution Pump
	Copper Sulfate	- De-lumper - Mix Tank & Agitator - Solution Pump - Day Tank - Metering Pumps
	Sodium Ethyl Xanthate	- Mix Tank - Solution Pump - Day Tank - Metering Pump
	Sodium Ethyl & Potassium Amyl Xanthates	- Mix Tank - Solution Pump - Day Tank - Metering Pumps

Operation	Equipment Description	
Reagent Preparation and Distribution (continued)	Sodium Isopropyl Xanthate	
		- Mix Tank
		- Solution Pump
		- Day Tank
		- Metering Pumps
	MIBC (Frother)	- Delivery Pump
		- Bulk Storage Tank
		- Transfer Pump
		- Transfer Tank
		- Transfer Pump
		- Day Tank
		- Metering Pumps
	Sodium Silicate	- Delivery Pump
		- Bulk Storage
		- Transfer Pump
		- Mix Tank & Agitator
		- Solution Pump
		- Day Tank
		- Metering Pumps
	Flocculant	- Storage Tank
		- Transfer Pump
	Spare	- Mix Tank
		- Transfer Pump
		- Day Tank
		- Metering Pump
	Crane	

Operation	Equipment Description
Milk-of-lime and Soda Ash Preparation	Pneumatic Conveyor System
	Lime - Rotary Air Lock Feeder - Storage Bin - Insertable Dust Collector - Paste Slaker - Lime Slurry Pump - Slurry Tanks & Agitator - Circulation Pump
	Soda Ash - Rotary Air Lock Feeder - Soda Ash Storage Bin - Insertable Dust Collector - Screw Conveyor - Mix Tank and Agitator - Feed Pumps
	Crane
	Vertical Floor Pump
Tailings Thickening	Thickener Thickener Underflow Pumps Thickener Overflow Pumps

Note: While this list is representative, it is only intended to show the types of major process equipment required for the process unit operations described herein. The actual types of process equipment used could change depending on final engineering and product availability.

ore onto a belt conveyor which will transport the material in a tunnel and conveyor gallery to the semi-autogenous grinding (SAG) mill.

Belt scales will be installed on appropriate conveyors to record the quantity of material flowing through the system.

The entire ore handling facility from the mine headframe through coarse ore storage, waste rock crushing, and grinding will be completely covered. There will be no contaminated water runoff from the ore handling facility. Any drainage water collected in the sumps of the coarse ore storage facility will be pumped to the grinding circuits.

Insertable dust collectors will be used for dust control in the ore handling facility.

Preproduction ore and waste rock during initial mine development will be transported by truck from the headframe to a prepared laydown area north of the concentrator (Figure 2-5). Recovery of ore would be managed so that the protective cover on the storage area will remain in place throughout the Project life. While this storage area is planned for preproduction ore, it could be maintained and reactivated as needed for use as an ore surge area, concentrate storage area or equipment staging area.

A small bin to the east of the coarse ore storage facility will be used to contain waste rock. Waste rock delivered to this bin will be crushed to supplement mine backfill. The facilities associated with backfill preparation are described in subsection 2.2.11.

2.2.2 Ore Crushing

Only preproduction or mine development ore will be crushed on the surface. Approximately 350,000 tons of this ore will be coarse crushed from minus 24 inches to minus 8 inches in a temporary mobile crusher. This crusher which will operate during the first 2 years of production will be located near the coarse ore storage building such that the crushed material can be fed to the ore stockpile. An opening will be provided in the building to allow transfer of ore to the stockpile.

The crusher feed dump pocket will be fed by a 35-ton haulage truck which will be loaded at the preproduction ore storage area. An earthen ramp will be constructed to allow the trucks access to the crusher dump pocket.

2.2.3 Concentrator

The recovery of concentrates from the ore will take place in a building located northwest of the mine production shaft (Figure 2-5). The equipment required for extracting the zinc, copper, and lead minerals from the coarse ore will be housed in this building. This equipment will be used for the following: grinding, flotation, thickening and dewatering, concentrate storage and loadout, and reagent preparation and storage.

Electrical power, utilities, heating, and ventilation will be provided in the building, as required. Road and railroad access will be provided into the primary grinding section, reagent storage area, and the concentrate loadout section. Floors will drain to separate sump

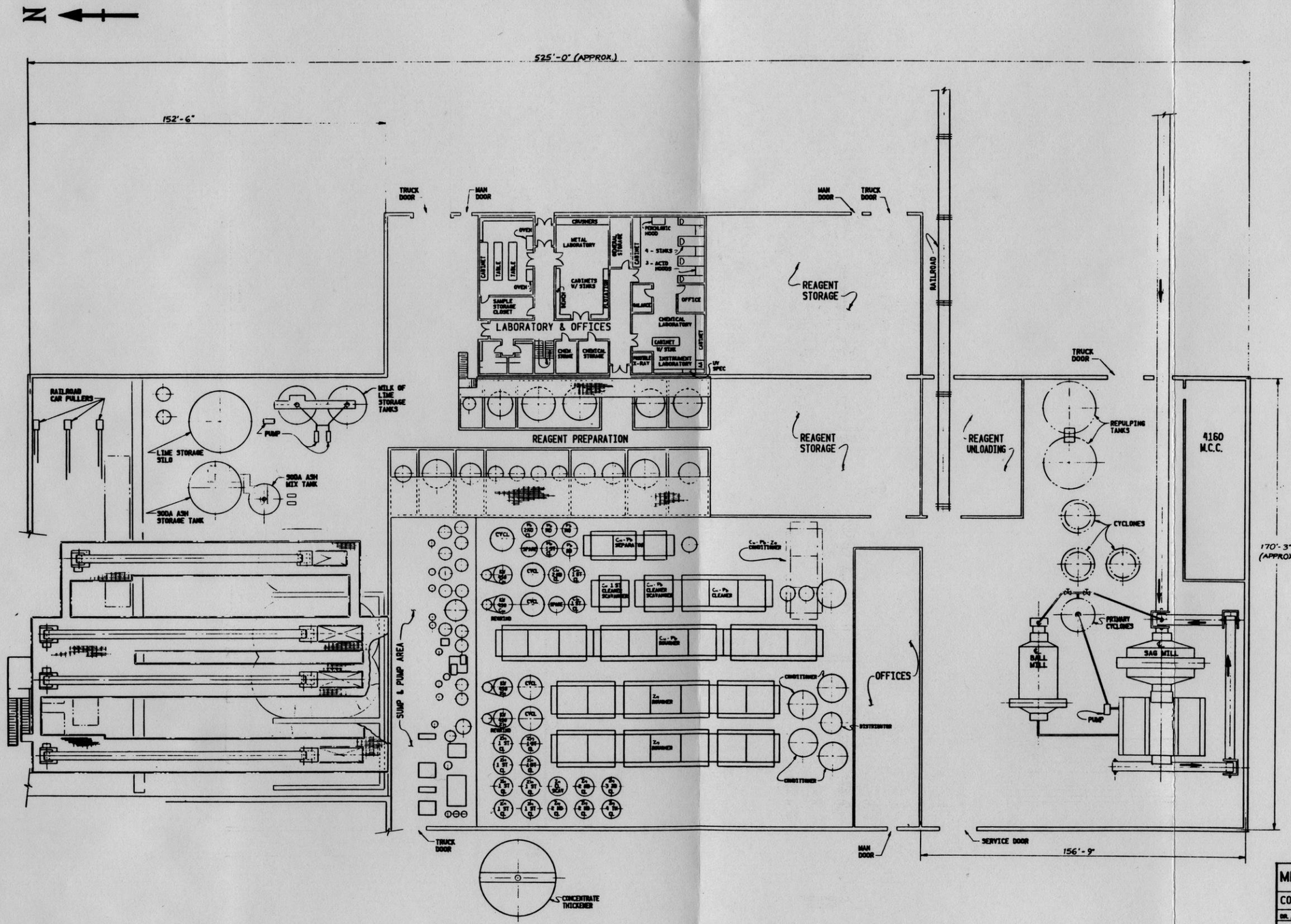
pumps which return the various product spills to appropriate feed points.

2.2.4 Ore Treatment

The facilities for recovering the valuable minerals from the ore will include the grinding and flotation circuits (Figure 2-15). The grinding mills will liberate, through size reduction, valuable mineral particles from the gangue minerals. The flotation circuits will separate and concentrate the zinc, copper, and lead minerals into three concentrate products. This facility will also include thickeners and filters for dewatering the concentrates produced.

Grinding - Coarse ore will be conveyed from coarse ore stockpile directly to a semi-autogenous grinding (SAG) and ball mill grinding circuit. Here the ore will reduced in size by wet grinding. The slurry of fine particles from the grinding circuit will be pumped to aerator/conditioners where the ore will be conditioned by adding air and reagents before it flows to the flotation circuit for concentrate recovery.

Flotation - The conditioned ore slurry will flow from the aerators in the grinding section to the flotation section where the liberated zinc, copper, and lead mineral particles will be selectively recovered as mineral-rich froths. Reagents will be added at various steps in the flotation circuit that will cause selective flotation of the liberated, valuable minerals from the gangue, leaving a tailing for backfill recovery and disposal. The final concentrates of the zinc, copper, and lead minerals will be pumped to separate dewatering and filtering facilities. All slurries will flow by gravity wherever possible. Pumps will be used where gravity flow is not practical.



PLAN VIEW

Typical Representations: Refinements May Be Made During Final Engineering

MPSI	MINERAL PROCESSING SYSTEMS, INC 240 ARCH ST. P.O. BOX 15-512 YORK, PA. 17405		
CONCENTRATOR BUILDING			
DR. JCM	DT. 8-8-85	S05-004729	
CK.	BY.		
APP.	SC. 1:200		
EXXON MINERALS COMPANY CRANDON PROJECT			
TITLE: CONCENTRATOR BUILDING			

FIGURE 2-15

Regrinding - To ensure maximum liberation of the copper, zinc, and lead minerals, the rougher and scavenger flotation concentrates will be reground as part of the flotation process. The regrind mills will be used in a closed circuit with classifiers which will separate the fine and coarse particles, advancing the fine particles to the flotation system for mineral concentration and the coarse particles back to the regrind mills for further grinding.

Dewatering, Handling and Shipping - The final flotation concentrates produced in the concentration process will contain 25 to 35 percent solids by weight with the balance being water. These slurries will be pumped to respective concentrate thickeners as the first step in the dewatering process. The thickened underflows from each concentrate thickener will contain 55 to 60 percent solids by weight and will be further dewatered using semi-continuous pressure filters. These filters can produce concentrate filter cakes with residual moisture levels of 8 to 12 percent by weight. Drying of concentrates using gas-fired kilns is not anticipated.

The cake discharge from the filters is friable, can be transported on a conveyor, and is non-dusting in nature. The filter cake will be loaded directly into railcars or stored beneath the filters, if required.

2.2.5 Reagent Storage and Mixing

This facility will be designed for preparation of reagents required in the concentration process and will store enough prepared reagents to ensure continuous operation of the concentrator. The types,

approximate quantities, and typical storage containers of reagents to be stored and used in the mill are shown in Table 2.5. Lime, sodium carbonate (soda ash), and sodium sulfide required in the water treatment plant will also be supplied from this area.

2.2.6 Concentrator Control Room

The main control room will be located such that grinding and flotation operations can be observed visually by the control room operator. All process equipment will be tied into the control room which will include start-up warning alarms. electrical and mechanical interlocks, emergency stop switches, and various process alarms. Necessary equipment will be installed to monitor all aspects of the grinding, flotation, and dewatering processes. Computer control devices and graphic displays of the process with equipment running condition will be in this area.

Other environmental monitoring equipment will be located in the environmental laboratory in the concentrator building.

2.2.7 Heating Equipment

The heating system for the concentrator building will consist primarily of self-contained natural gas heaters that will be installed throughout the buildings' production area. Ventilation will be provided by exhaust fans.

Other buildings on the surface will also have self-contained heating units where required.

2.2.8 Tailings Thickening

The tailings thickener will be about 200 feet in diameter, uncovered and installed at grade level. The fine tailings from the backfill preparation facility (described in subsection 2.2.11) will be pumped to the thickener. The solids content in the feed slurry will be about 7 percent by weight. After settling, the thickener underflow will contain 55 percent solids by weight at a flow rate of approximately 550 gallons per minute. The thickener underflow will be collected in a sump and transported by pipeline to the Mine Waste Disposal Facility (MWDF).

The thickener overflow at approximately 6,250 gallons per minute will contain a small amount of solids. A portion of this water will be recycled directly to the backfill cyclone process as make-up water and the remainder will be recycled to the mill via the reclaim pond.

2.2.9 Concentrate Handling and Loadout

The concentrate handling and loadout facilities will be enclosed and are located at the north end of the mill building (Figure 2-15). The concentrates will normally be loaded directly into railcars. Trucks will not normally be used; however, if they are required, they probably would be 20-ton semi-trailer type dump trucks.

Temporary storage areas for concentrate will be located beneath the concentrate filters. Separate areas for zinc, copper, and lead concentrates will be provided.

TABLE 2.5

TYPICAL REAGENT STORAGE DATA

Reagent	Physical Form	Received By	Storage Capacity	Storage Containers
Sulfur Dioxide (SO_2)	Liquid	Truck (Tanker)	150,000 lb	Bulk Tank
Copper Sulfate ($CuSO_4 \cdot 5H_2O$)	Granular	Railcar	300,000 lb	Drums, Bags
Sodium Cyanide (NaCN)	Briquette	Truck	36,000 lb	Returnable Containers
Polypropylene Glycol Methyl Ether	Liquid	Truck	50,000 lb	Bulk Tank, Drums
Sodium Sulfide ($Na_2S \cdot 9H_2O$)	Flake	Rail	80,000 lb	Drums, Bags
Xanthates	Granular	Truck	63,000 lb	Drums
Zinc Sulfate ($ZnSO_4 \cdot 7H_2O$)	Granular	Truck	54,000 lb	Bags
Starch	Powder	Truck	30,000 lb	Bags
Sodium Dichromate ($Na_2Cr_2O_7$)	Liquid 69% Solution	Truck (Tanker)	12,000 gal.	Bulk Tank
Sodium Silicate (Na_2SiO_3)	Liquid	Tank Car	15,000 gal. (175,500 lb)	Bulk Tank
Activated Carbon	Powder	Railcar	75,000 lb	Bags
Methyl Isobutyl Carbinol	Liquid	Tank Car	12,000 gal.	Bulk Tank
Lime (CaO)	Pebble	Rail	660 Tons.	Bulk Silo
Flocculant	Liquid or Powder	Truck	45,000 lb	Drums, Bags
Caustic Soda (NaOH)	Pellet	Truck	600 lb	Drums
Soda Ash (Na_2CO_3)	Granular	Railcar	375 Tons.	Bulk Silo
Ferric Sulfate ($Fe_2(SO_4)_3$)	Granular	Truck	75,000 lb	Bags
Sulfuric Acid (H_2SO_4)	Liquid	Tanker	67,500 lb	Bulk Tank

Note: Typical representation of reagent storage data: refinements may be made during final engineering or operations.

2.2.10 Spill Control Facilities

Provisions to contain slurry spills will be available throughout the mill building. Process spills will be restricted to confined areas, collected in floor sumps, and pumped back into the appropriate process equipment so that valuable minerals can be recovered; this will also eliminate the potential for contaminating any surface waters.

Spills in corridors containing process piping will be channeled into drainage trenches, collected in sumps, and returned to the process.

The concentrator building will contain an overflow system to handle major spills that cannot be contained by floor sumps and containment berms. Spills reaching the overflow systems will exit the northwest side of the building and flow through a ditch and culvert system to surface drainage basin No. 2 (Figure 2-5). This basin will be lined with two 4-inch lifts of bentonite modified soil protected by an 18-inch till cushion. The basin will be equipped with a pump for transferring decanted water from spill material to the reclaim pond. Thus, this water will become part of the process water system.

Recovered reagents will be collected in such a manner to assure that they can still be used as intended. Reagent storage and preparation facilities are designed with the criteria that any spills are to be contained for recovery and use. At the end of operations, unused reagents will either be returned to the vendor or sold to another user.

2.2.11 Backfill Preparation Facility

The underground mining method requires backfill to stabilize the peripheral in-place rock after the ore is mined. The mine backfill will use the coarse fraction of the mill tailings, excess waste rock, and may require sand from an off-site source.

The coarse fraction from the cycloned tailings will be pumped from the backfill cyclones in the concentrator building to the waste rock crusher/backfill mixing plant located east of the coarse ore stockpile (Figure 2-5). Here the cycloned tailings will be mixed with crushed waste rock and pumped to bore holes connected to the underground handling facilities. Facilities will also be provided near the waste rock crusher to meter and mix cement when required into the backfill. The cement storage bins will be located north of the backfill crusher near the railroad tracks.

2.2.12 Backfill Storage and Transport

Storage capacity of backfill sands will be provided in Marconaflo storage tanks located near the waste rock crusher/backfill mixing plant. A pump will transfer the sand-slurry to the backfill mixing tank for addition of crushed rock and cement as needed before transfer to the mine. The Marconaflo system can repulp at about 70 percent solids and provides a close control of density.

2.2.13 Concentrator Laboratories

Three separate laboratory facilities will be located in the concentrator building. A metallurgical laboratory will be provided to

prepare samples for chemical analyses and to perform both routine and non-routine metallurgical testing for process performance evaluation and ore amenability studies.

An analytical laboratory will provide chemical analyses to support process evaluation and control work, analyze drill samples from underground, and provide analyses for concentrate shipments.

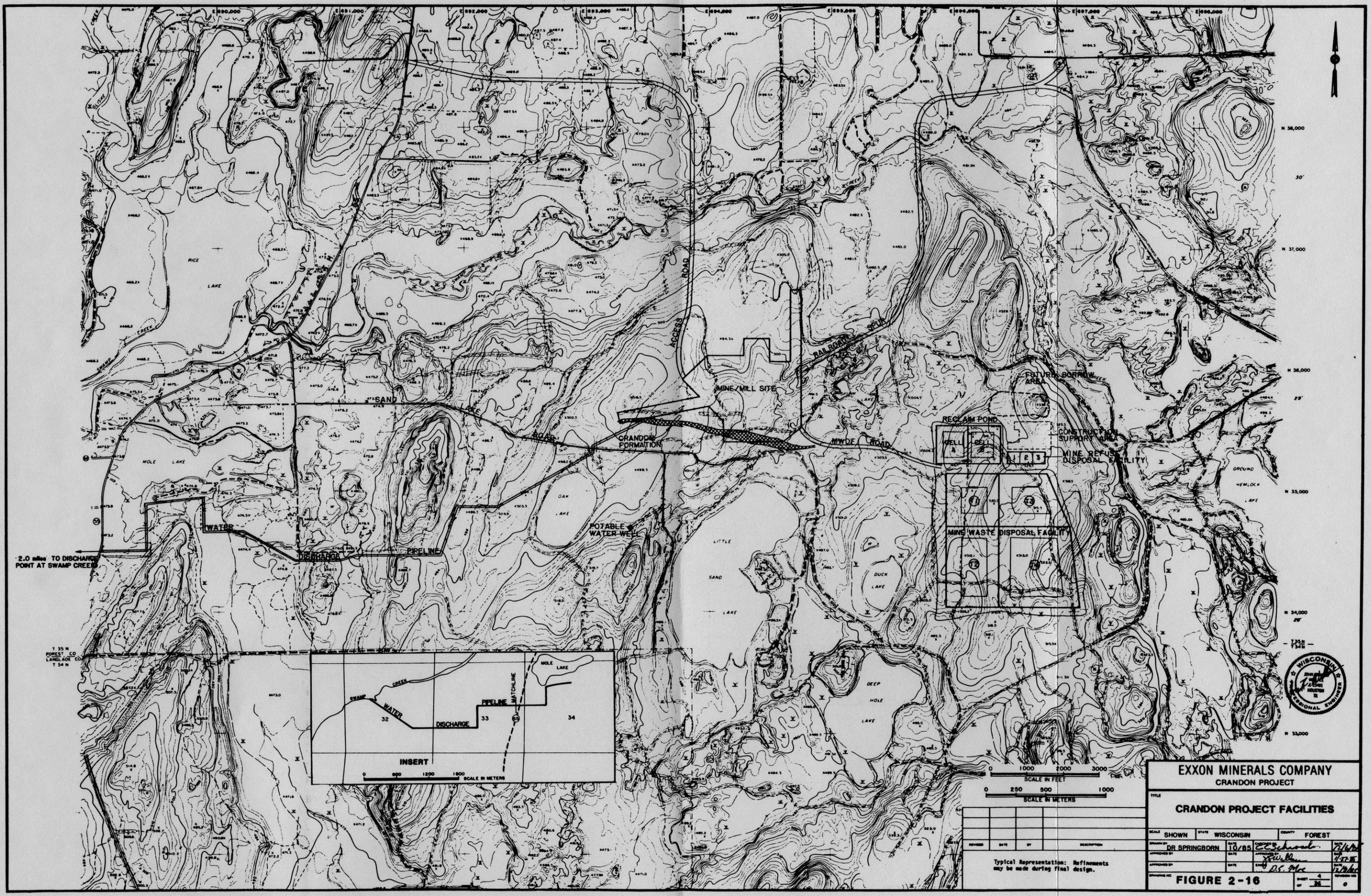
An environmental laboratory will provide monitoring capability including analyses of water discharge samples, samples from monitoring wells, and analysis of dust samples. Required biological studies may be done by outside contractors.

2.3 Mine Waste Disposal Facility

The primary function of the mine waste disposal facility (MWDF or facility) will be to provide for environmentally compatible surface disposal of the waste generated from the mining and processing of the ore. The layout, structure, performance and operations of the MWDF are described herein. Additional design details are available in the MWDF Feasibility Report which conforms to the requirements of NR 182. Nearly all of the waste will be ground rock produced during the milling of the ore. The MWDF will consist of earthen ponds constructed primarily from site area soil materials. The ponds will be lined with a bentonite modified soil mixture with an underdrain placed over the liner. The facility will be sized to provide storage capacity for the fine tailings, reclaim pond sludge, and water treatment plant sludges.

Figure 2-16 shows the MWDF in relation to the mine/mill site, the access road, the railroad spur, and the adjacent water reclaim pond. Four ponds with a total surface area of approximately 270 acres inside the pond crests will be used over the productive life of the mine. The total area of the ponds to the outside toe of the embankments is approximately 365 acres. The four ponds will range in plan area between 60 and 140 acres and will be sequenced in construction, operation, and reclamation to accommodate the production of tailings from the mill. A construction support area will be required to contain the liner and drain processing facilities. This support area will be approximately 25 acres in size as shown on Figure 2-16.

The facility has been designed to have an approximate earthwork balance during construction, operation, and closure; that is,



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CRANDON PROJECT FACILITIES

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY [signature]	DATE 12/6/85
APPROVED BY	DATE	APPROVED BY [signature]	DATE 12-7-85
APPROVED BY	DATE	APPROVED BY [signature]	DATE 12/9/85
DRAWING NO. FIGURE 2-16		SHEET 4 OF 36	REVISION NO. 0

most soils required for facility construction can be obtained from excavations within the tailing pond areas. Some limited quantities of fill required for final reclamation contouring will require the development of a 40 acre borrow area north of the MWDF. Temporary storage of soil and other materials will also occur during the MWDF construction and operations. Detailed discussions of these facilities can be found in the MWDF Feasibility Report.

2.3.1 Waste Rock Transport and Storage

During the course of mine development and during production, a substantial quantity of waste rock will be produced from excavations in and around the orebody (Table 2.6). Waste rock will be of variable composition and will consist predominantly of quartz and other silicate minerals (chlorite, sericite, plagioclase) and varying amounts of pyrite.

During initial mine development most of the waste rock will be brought to the surface and stockpiled on the preproduction ore storage pad. During production, however, a much lesser volume of waste rock will be generated on an annual basis, and it will be utilized as underground road material, mine backfill, and as riprap in the MWDF area. Separately located waste rock surge piles will not be required at the MWDF. Waste rock will be delivered to the preproduction ore storage pad and reclaimed as needed for mine backfill or for riprap. About 5 percent of the mine waste will be used as riprap.

During early mine development, which occurs before the underground crusher is available, rock size will be about 24 inches or

TABLE 2.6

ESTIMATED YEARLY GENERATION OF WASTE ROCK VOLUMES

YEAR	ESTIMATED ROCK x10^3 Tons	Volume (yd^3)[a]	APPROXIMATE Size of Rock
Construction			
1	2	1	All minus 24-inch rock
2	130	87	
3	528	352	
Operations[b]			
Years 1-16 (16 Years at 230,000 tons/yr)	3,680	2,453	All minus 8-inch rock
Years 17-27 (11 years at 245,000 tons/yr)	2,695	1,797	
Total	7,035	4,690[c]	

[a]Volume based on estimated density of 1.5 tons per cubic yard.

[b]During operation Years 28 and 29, previously developed stopes will be mined and minimal waste rock will be produced.

[c]Approximately 5 percent of this volume will be used as slope protection inside the MWDF area.

less in diameter. After the underground crusher is installed late in the construction period, waste rock hoisted to the surface will be crushed to approximately 8 inches or less in diameter. All transport of waste rock to the temporary stockpile or the MWDF will be by truck.

Haul roads at the dump sites will be constructed from crushed rock product obtained from an off-site supplier and will not contain sulfides.

2.3.2 Waste Rock Disposal

Waste rock volumes and approximate production schedule are presented in Table 2.6. Current projections indicate that about 50 percent of this material will be hoisted to the surface over the life of the mine. Of the material hoisted to surface, approximately 400,000 tons will be used as riprap in the MWDF area. The remaining waste rock hoisted to the surface will be crushed and returned underground as backfill for mined out stopes.

If a surplus of backfill should develop late in the mine life, any waste rock not needed for backfill would be disposed in one of the tailing ponds.

2.3.3 Tailings Transport and Reclaim Water Transfer

The tailings transport system will transfer the fine tailings by buried pipeline from the mill to the MWDF as a slurry. Pipes at the MWDF will be routed along the embankment crests. The haul road from the mine/mill area to the MWDF will share a common corridor with the pipeline system.

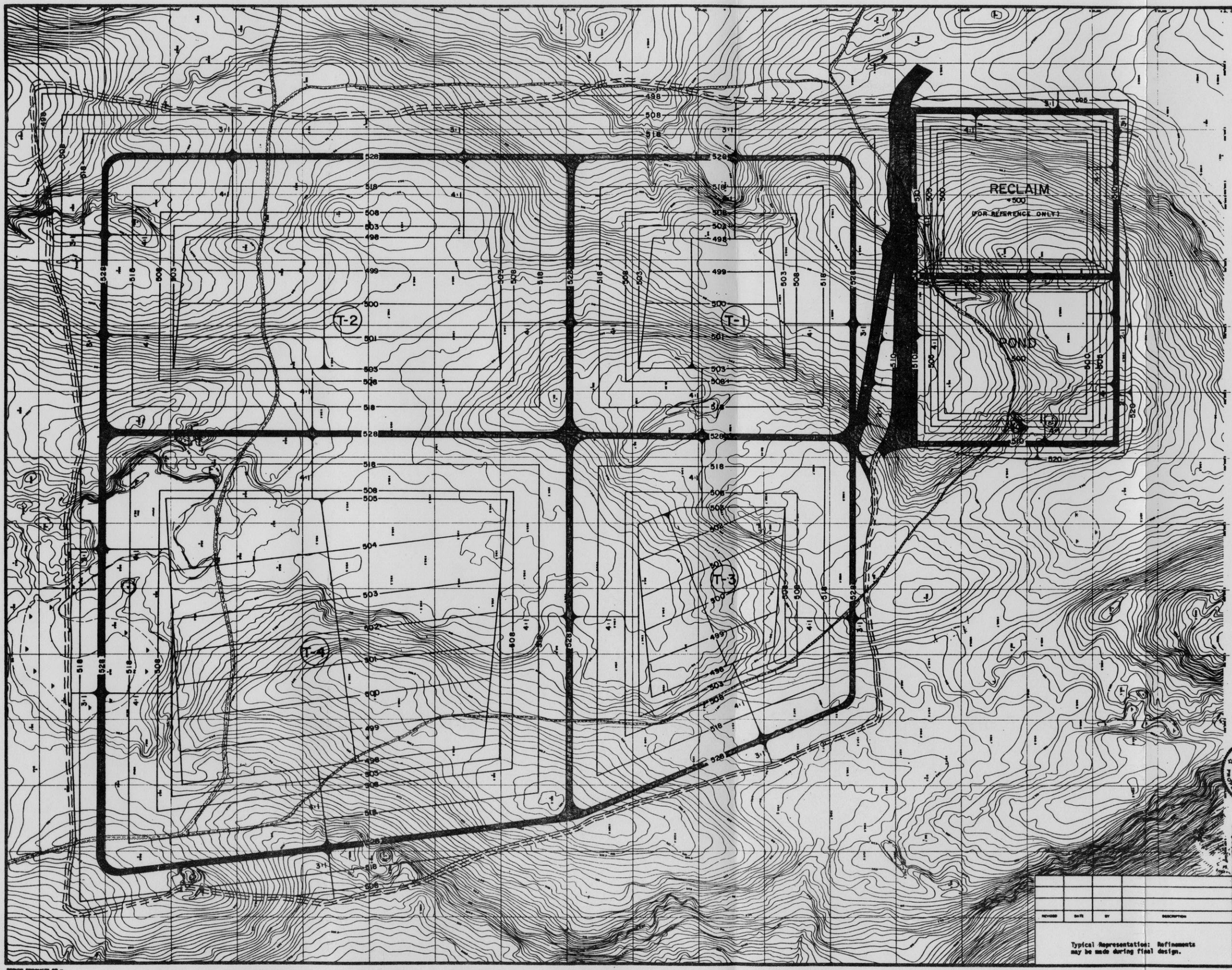
Access roads will be provided on the crest of the embankments and along the toe of the exterior embankments for inspection and to facilitate periodic maintenance of the facility if required (Figure 2-17). The access roads will be surfaced with crushed rock or granular materials to provide an all-weather surface. The embankment crests are designed to accommodate a minimum 16-foot wide access road with safety berms or guard rails. In some sections of the ponds, the embankment crest is wider because the tailings and water recycle pipelines are parallel to the access road. The perimeter access road at the toe of the embankments is designed to be 20 feet wide for two-way traffic. The haul road to the MWDF will be about 28 feet wide to permit two-way traffic; additional width will be provided where necessary for pipelines.

From the mill to the MWDF, the pipeline system will be installed underground. There will be no need for emergency dumping of the tailings in the event of power interruption; the pumping system will be located at the mill site; there is no need for interim pumping along the pipeline. Pumps for returning reclaim water to the mill site will be located at the reclaim pond.

Three pump and pipeline systems will be included in the system from the mine/mill site to the MWDF. They are:

1) 6.5 inches inside diameter high density polyethylene (HDPE) tailings slurry pipeline.

2) 15.0 inches inside diameter HDPE reclaim water return pipeline.



LEGEND

- ACCESS ROAD
- (T-1) POND NUMBER
- EMBANKMENT SLOPE

NOTES:

1) BASE GRADE ELEVATIONS SHOWN ARE TO TOP OF FINAL CONSTRUCTED SURFACE. SUBTRACT ROCK, FILTER, DRAIN, AND LINER THICKNESS TO DETERMINE SUBGRADE ELEVATIONS.

GENERAL NOTES:

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.
4. CONTOURS SHOWN WITHIN THE POND CONFINES ARE FINISHED GRADE/TOP OF FILTER LAYER UNLESS OTHERWISE INDICATED.

0 100 200 400 600 800
SCALE IN FEET
0 50 100 150 200 250
SCALE IN METERS

WISCONSIN JOHN FRANCIS [illegible] PROFESSIONAL ENGINEER

REVISED	DATE	BY	DESCRIPTION

Typical Representation: Refinements may be made during final design.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MWDF HAUL ROADS

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY J.J.T	DATE 5-25-84	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
DRAWING NO		SHEET NO	REVISION NO 0

FIGURE 2-17

3) 15.0 inches inside diameter HDPE thickener overflow pipeline.

To safeguard and protect the system, the tailings pipelines and other pipes handling process water will be buried 6 feet below ground to avoid damage by freezing or external hazards.

Monitoring of the tailings pipeline will enable early detection and repair of pipeline faults and defects. Flow meters located on the ends of the pipeline (one near the mill and one near the MWDF) will enable the operator to detect significant leaks or ruptures in the pipeline and shut the system down should such an event occur. Test spools of pipe flanged into the tailings pipeline will be checked periodically for pipeline wear. These test spools will be accessed through manholes for inspection. Additionally, the pipeline route will be inspected daily to detect any unusual conditions that may affect the pipeline operation.

2.3.4 Tailings Disposal

Waste Volume - The size of the MWDF is based on the amount of tailings that cannot be returned to the mine. The orebody is estimated at 67.4 million tons. This reserve estimate was used in sizing the MWDF. Of this mass about 40 percent will require surface disposal in the form of fine tailings. Based on an estimated final average in place density of 108 pounds per cubic feet, a storage volume of about 11,470 acre-feet has been calculated.

In addition to the fine tailings, the design has allowed for an additional 200 acre-feet for the sludges produced from the water

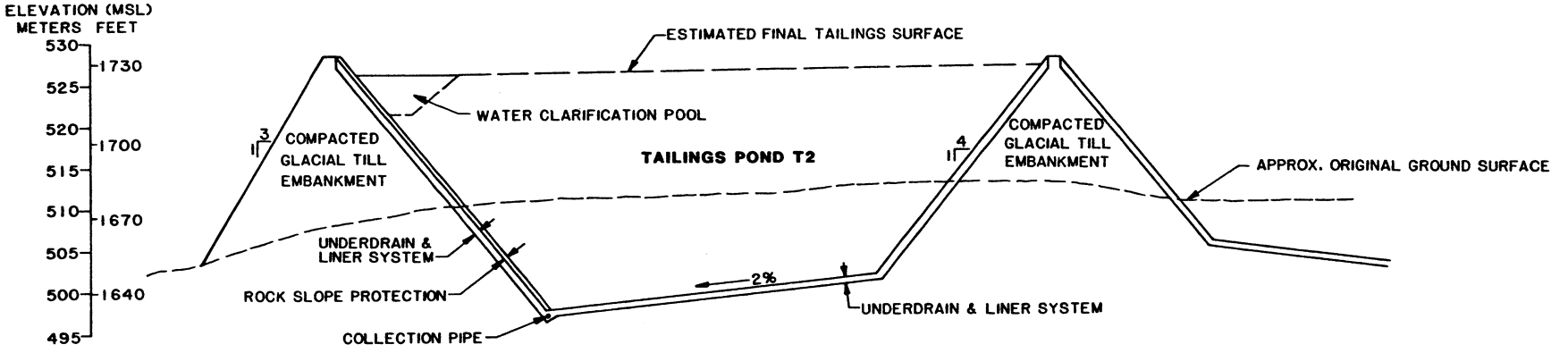
treatment process. Allowing for this 200 acre-feet of sludge, a total waste storage volume of about 11,670 acre-feet will be provided.

As the tailings are deposited in the ponds, they will form sloping beaches that result in unused pond storage volume of approximately 13 percent. Applying the 13 percent storage volume loss to the estimated waste volume will result in a total estimated waste disposal storage volume design requirement of approximately 13,400 acre-feet.

Freeboard above the normal water level when the pond is full has been designed to meet the requirements of NR 182. According to the requirements of NR 182.11(1)(q), a 3-foot freeboard is sufficient to prevent overtopping of waves for the 100-year, 24-hour rainfall event and accompanying high winds. However, based on the expected final tailings surface slopes and the pond water pools, actual pond freeboard will range from 8 to 12 feet above the normal maximum tailing pond water levels. A section through a typical tailing disposal pond is shown on Figure 2-18.

Mine Waste Disposal Facility Location and Design - An area southeast of the mine/mill site will be used for the MWDF. This area primarily lies in Section 32, T35N, R13E in Forest County.

The major characteristics of this area are: (1) an extensive upper soil layer of relatively low permeability till; (2) low ground water gradients; (3) the depth from the existing ground level to the main ground water table averages approximately 100 feet; and (4) no domestic use of ground water within the compliance boundary area of the

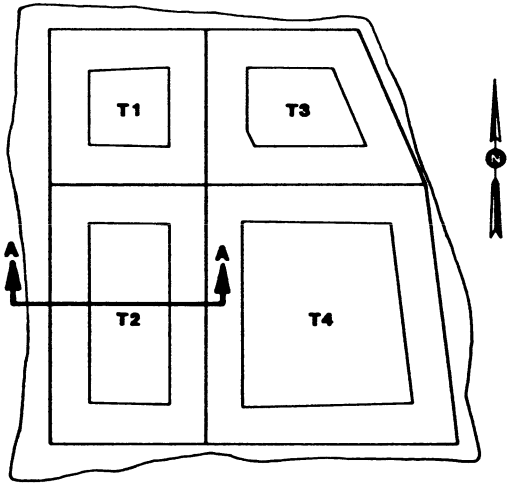


SECTION A-A

0 50 100 150
SCALE IN METERS

0 250 500
SCALE IN FEET

VERTICAL SCALE EXAGGERATED 5x



PLAN VIEW
(NOT TO SCALE)

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY
PLAN & SECTION

SCALE: SHOWN	STATE: WISCONSIN		COUNTY: FOREST		
DRAWN BY: DR SPRINGBORN	DATE: 10/85	CHECKED BY:	DATE		
APPROVED BY	DATE	APPROVED BY: C.C. Schroeder	DATE: 11/13/85		
APPROVED BY	DATE	EXXON: D.F. Mc	DATE: 11/3/85		
DRAWING NO: **FIGURE 2-18**	SHEET ___ OF ___	REVISION NO			

MWDF. With the distance from tailing pond bottom to ground water of approximately 50 feet.

The design layout for the MWDF is shown on Figure 2-18. The facility will consist of four ponds that are constructed, operated, and reclaimed sequentially.

The inside slopes of the pond embankments will be 4 horizontal to 1 vertical (4H:1V) to accommodate placement of the pond lining system. The outside slopes will be 3 horizontal to 1 vertical (3H:1V). The 3H:1V outside slopes of the MWDF are conservatively flat for stability and maintainability. During the plan of operation consideration will be given to the possible inclusion of benches on the exterior slope to further aid in erosion control. The glacial till soils to be used in the embankments are excellent construction soils and could be placed at steeper slopes if desired. The 3H:1V outside slopes were chosen with aesthetic consideration for the reclaimed facility. The 4H:1V inside slopes have been chosen primarily for construction considerations of the bentonite-modified soil liner and other seepage control system layers. With these flat slopes, conventional equipment can be used to construct the seepage control system readily and meet required quality control objectives.

Specific individual pond design data are included below:

MWDF INDIVIDUAL POND DATA

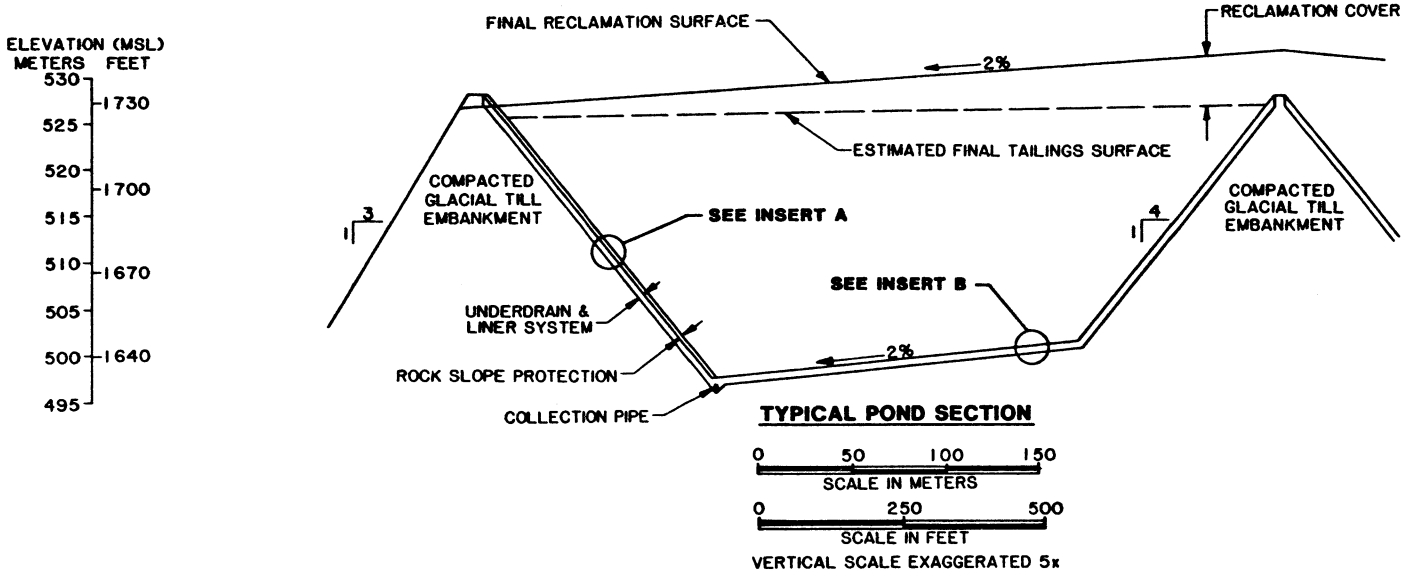
Pond Data/Pond Number	Tailing Ponds T1	T2	T3	T4	Total
Area Inside Toe (acres)*	60	95	70	140	365
Area Inside Crest (acres)	43	71	50	107	271
Maximum Interior Depth (feet)	100	100	100	100	--
Maximum Exterior Fill Height (feet)	118	105	88	44	--
Crest Elevation (feet)	1,732	1,732	1,732	1,732	--
Lowest Bottom Elevation (feet)	1,633	1,633	1,633	1,633	--
Struck Storage Volume (acre-feet)	2,010	4,090	2,640	6,480	15,220
Tailings Storage Volume (acre-feet)	1,920	3,560	2,270	5,640	13,390

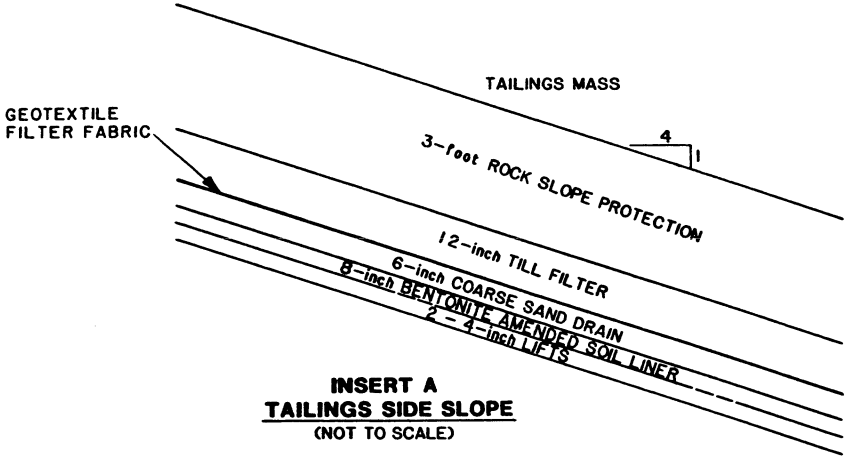
*Construction limits

Seepage Control System - All of the ponds will utilize an underdrain system below the tailings to collect and remove seepage water. The underdrain system will be underlain by a bentonite modified soil liner. Figure 2-19 shows a configuration of the underdrain system with a filter layer, a drain layer, and the bentonite modified soil liner.

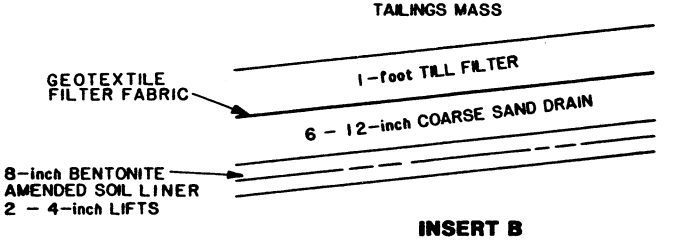
The seepage control system will be continuous over the pond bottom and inside slopes of the embankments. Slopes on the pond bottom will allow water movement in the underdrain layer to a collection pipeline.

The base of the tailing disposal ponds and the bentonite modified soil liner has been designed to slope at a 2 percent grade from the common internal embankment toward the upstream toe of the external embankment. The underdrain collection pipelines located along the upstream toe of the outside tailing pond embankments facilitate collection of drainage from the embankment drain layer. The perforated collection pipes





INSERT A
TAILINGS SIDE SLOPE
(NOT TO SCALE)



INSERT B
TAILINGS POND BOTTOM
(NOT TO SCALE)

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY SEEPAGE CONTROL SYSTEM

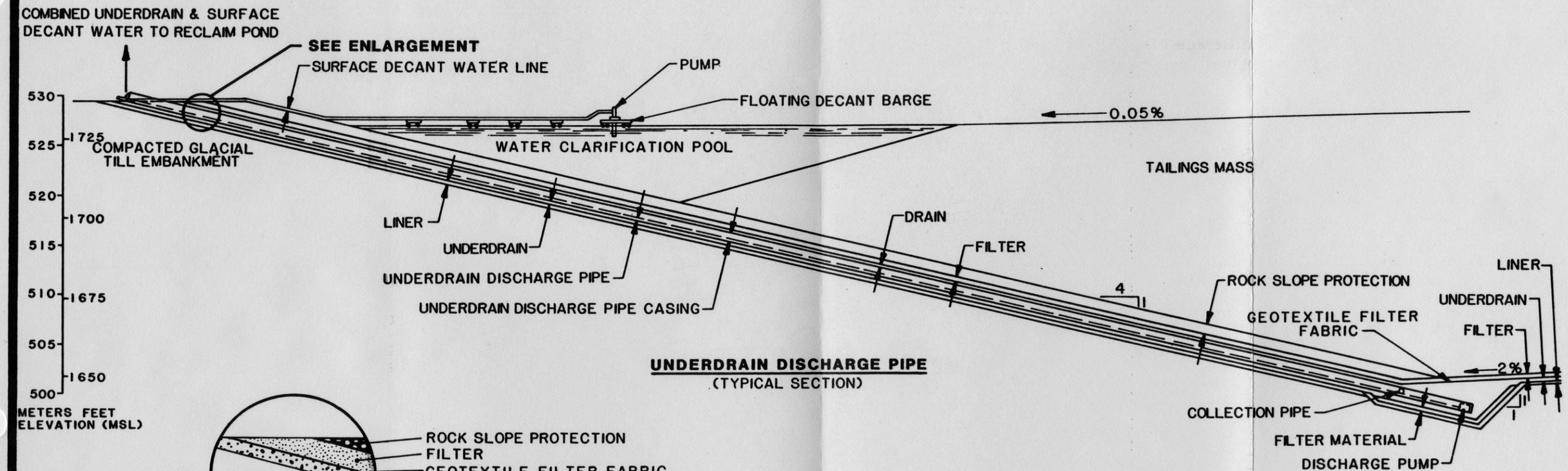
SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY		DATE	
APPROVED BY	DATE	APPROVED BY C.C. Schroeder		DATE 11/13/85	
APPROVED BY	DATE	EXXON D.S. Mc		DATE 11-15-85	
DRAWING NO **FIGURE 2-19**		SHEET ___ OF ___		REVISION NO	

provide greater hydraulic capacity than required based on the estimated leachate collection rate for each tailing pond.

Leachate will be removed from each of the four tailing ponds by pumping from one of the two underdrain discharge pipelines constructed along the exterior embankments. This will allow continuous pumping of the underdrain even during periods of scheduled maintenance or in the event portions of the system become inoperative. Liquids in the pipe system will be routed to the nearest underdrain discharge pipeline for removal by pumping.

The thicknesses shown for the filter and drain layers, 12 inches and 6 to 12 inches, respectively, have been conservatively chosen to satisfy all design requirements and to provide an adequate protective cover thickness for the liner. The bentonite modified soil liner thickness has been selected to assure a minimum 8-inch thickness and to afford a measure of redundancy to the liner performance. At the tailings surface, at the low end of the tailing beaches, water will be allowed to pond to a convenient operating depth before transfer to the reclaim pond system. The details of this transfer or decant system are shown on Figure 2-20. Discharge pipes will be placed in each pond and used to pump water from the underdrain perimeter collection pipeline to the top of the embankment crest. At the pond crest, it will be combined with the decant water for transfer to the reclaim pond system.

The surge capacity in each of the tailing ponds, above highest normal water levels, is in all cases greater than required from a storm and wave run-up standpoint. In an emergency, if the surge capacity in



UNDERDRAIN DISCHARGE PIPE
(TYPICAL SECTION)

ENLARGEMENT

UNDERDRAIN POND PERIMETER PIPE
(TYPICAL SECTION)

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY TYPICAL TAILINGS POND UNDERDRAIN & SURFACE DECANT WATER SYSTEMS

SCALE	STATE	COUNTY	
NONE	WISCONSIN	FOREST	
DRAWN BY: DR SPRINGBORN	DATE: 10/85	CHECKED BY:	DATE
APPROVED BY	DATE	APPROVED BY: C.C. Schroeder	DATE: 11/85
APPROVED BY	DATE	EXXON: E 21	DATE: 11/13/85
DRAWING NO: FIGURE 2-20		SHEET ____ OF ____	REVISION NO

the reclaim ponds was not sufficient, the tailing ponds could be used to temporarily store water.

2.3.5 Water Treatment Waste Disposal

The water treatment process will produce two waste products. The first, a sludge resulting from lime and sulfide precipitation processes and the lime/soda ash softening process, will be mostly calcium carbonate. This sludge will be added to the tailings and pumped to the MWDF for disposal during normal operations.

The other solid product will consist primarily of crystalline sodium sulfate. The production of crystallized sodium sulfate from the water treatment plant will range from 0 to 11 tons per day depending on the percentage of water being treated by the reverse osmosis/vapor compression evaporation (RO/VCE) units.

Prior to sodium sulfate crystallization, the nearly saturated sulfate solution exiting the VCE unit will be lime neutralized and then clarified to remove insoluble impurities. This post treatment of the VCE brine ensures a marketable salt cake or a non-hazardous secure landfill disposal option. A detailed description of the sodium sulfate disposal is given in the MWDF Feasibility Report.

2.3.6 Reclaim Pond Sludge

Throughout operation, sludge will accumulate in the water reclaim ponds. This sludge will consist of fine sediments and particulate precipitates that settle during retention of the water.

During final Project reclamation the sludge will be collected and disposed of in the MWDF.

A conservative projection of 140,000 cubic yards of reclaim pond sludge has been made for the life of the Project. This estimate is based on the water flow rate passing through the two celled pond system, the suspended solids in the water, the total Project time, and a sludge density. This volume of sludge can be held in the system with no effect on the reclaim pond. Overall, it will occupy approximately 16 percent of the total operating volume. Divided evenly between the two cells, it would amount to approximately 3.2 feet of sediment on the pond bottom.

Some difference will exist in the sludges between the two cells of the reclaim pond. Cell B, the first to receive the tailings pond decant and underdrain water, will have sludge consisting predominately of tailings and calcium carbonate precipitates, while cell A will have a predominance of gypsum precipitates from the pH adjustment step between the two cells. Some metal hydroxide precipitates may be present in cell A from pH adjustment.

If required, suitable sludge removal methods are available that would not damage the pond liner while still allowing continued pond operation. A small floating suction dredge with depth control on the suction head could be used. In practice, a small depth of sludge (1.0 foot) would not be removed to maintain an additional layer over the liner. If the estimated 140,000 cubic yards of sludge were distributed evenly over the final tailings surface of pond T4, the depth of sludge would be approximately 1 foot. Since there are no crucial timing constraints on reclamation of pond T4, ample time will be available for

proper management of the sludge through drying or blending with tailings or cover soil. The sludge could also be incorporated into the thick till grading layer planned as the first step in reclamation of the tailing pond.

2.4 Ancillary Facilities

Ancillary facilities include access to the site, the services building, fuel storage handling, water treatment and water distribution systems, sanitary waste treatment facility, explosives magazines, and transportation and power distribution facilities required to support the operation of the mine/mill complex. These facilities are all shown on Figure 2-5. The design objectives for these facilities were to unify as many of them as practical and to locate them as close to the major facilities as possible to reduce travel time for personnel and to prevent duplication of facilities.

2.4.1 Rail Spur

A railroad system will be required to service the mine/mill site. The rail spur will be routed from the main Soo trunk line northeast of the mine/mill site. The spur will consist of a single track approximately 2.7 miles long and will include three 3,280-foot long sidings located near the connection to the trunk line. A single span bridge to carry the track over Swamp Creek will be constructed of prestressed concrete girders supported on concrete abutments.

Track will be provided in the mine/mill complex for concentrate loading and handling of bulk materials and supplies. A locomotive will be used to move railcars within the mine/mill site and between the site and sidings.

The design of the railroad allows normal railroad maintenance practices to be followed for the railroad spur line. Because the spur line will be new and will receive relatively little use, maintenance

will primarily relate to erosion control and control of vegetation in the right-of-way. These activities are described in subsection 3.5.2.2.

2.4.2 Access Road

A new access road will be provided for traffic generated by the mine/mill construction and operation. The road will consist of two 12-foot wide lanes and 8-foot wide shoulders. A single span bridge constructed of prestressed concrete girders supported by concrete abutments will carry the road across Swamp Creek.

The road will connect with State Highway 55 and proceed in a southeasterly direction for 3.0 miles to the mine/mill site. The road will be contained in a 100-foot wide corridor. The main electrical power line to the mine/mill site will be located adjacent to the road and will require a similar corridor width. Clear cutting of the powerline corridor is not expected to be required.

A 3-inch bituminous concrete pavement with an underlying 1-foot crushed aggregate base course is planned for the roadway section. The access road will be posted as a private road leading to the Crandon mine; however, no gates or guards are planned at the State Highway 55 intersection.

2.4.3 Parking and Gate House

The employee and visitor parking area will be located south of the services building. The parking area will have a Class C asphalt paving with concrete curbs and gutters. The parking area will drain to surface drainage basin No. 1 located near the southeast corner of the parking area.

A gate house will be on the north side of the parking area to control access into the Project site.

2.4.4 Services Building

The services building will house major shops, garage, warehouse, worker change and shower facilities, and managerial and administrative offices. The shops and warehouse will provide service support and maintenance for the mine/mill process equipment and mobile equipment. A fire truck and an ambulance will be housed in the garage area. The warehouse will stock maintenance and replacement parts and tools used for maintenance of mine/mill equipment.

2.4.5 Storage Areas

Lubricant storage and cold storage buildings will be located east of the mill. Lubricants, paints, and cleaning materials for both the mine and mill will be stored in the lubricant storage building; the building will not be heated. The building floor will be concrete without floor drains. There will be no long-term storage of large quantities of these materials. The building and contents will be inspected daily and any spills will be cleaned manually as required. The design, construction, and use of this building will be in accordance with applicable federal, state and local requirements.

A cold storage building will be used to store miscellaneous mechanical parts such as pump impellers and casings, some larger motors, and mechanisms for flotation cells. The building will be used to store those parts that are too large and cumbersome to keep in the warehouse area of the service building.

A covered storage area will be located on the east side of the Project site. This structure will be an open shed type facility for storing specialty pipe, pipe couplings and fittings, and other parts that need to be kept in a covered facility for easy retrieval at any time of the year.

Timber and steel storage - The area south of the covered storage facility and west of the rail line will be used for storage of timber, steel, pipe, and other bulk materials that can be stored outside. These materials will be used in the mine and mill operations. The storage area will have a graveled surface.

Topsoil and mulch resulting from the clearing and grubbing activities will be stored on the east side of the mine/mill site area. This will provide easy access to these materials for landscaping and reclamation activities.

2.4.6 Sanitary Waste Facilities

The sanitary treatment system will be designed to handle sanitary wastes from the surface facilities and underground mine. The wastes from the surface facilities will be transported to the sanitary treatment system via a buried pipe system. Containerized waste from the mine will be transported to the surface in the mine cage for disposal in the system. The total average daily flow rate of sanitary waste water has been estimated to be 16 gallons per minute with a peak hourly flow rate of approximately 110 gallons per minute.

The system will consist of a small factory manufactured treatment plant utilizing an activated sludge process with extended aeration. The plant design will be tailored to the specific hydraulic

and BOD/TSS loadings for the Project. The plant will include zones for flow equalization, aeration, clarification, sludge storage, and chlorine contact. A separate sludge holding tank to reduce the frequency of sludge removal will also be included. The plant size will be in the 25,000 to 30,000 gallon per day flow range. To prevent any wintertime operating problems from splashing and freezeup, the plant will be enclosed.

The treatment plant effluent will be added to the Project excess water discharge system for eventual discharge to Swamp Creek downstream from Rice Lake. The location of the sanitary waste facility, on the east side of the mine/mill site, is shown on Figure 2-5.

Sludge generated in the treatment plant will be transferred frequently from the sludge zone in the plant to the separate sludge holding tank. Sludge removal and disposal from the separate, larger tank will be handled by a licensed private contractor. The tank will be sized to allow 1 to 2 months accumulation of sludge.

Additional information on the proposed sanitary waste facilities is included with the facilities plans for the sewage treatment system prepared for the Project following NR 110.09. The facilities plan was filed as part of the WPDES permit application.

2.4.7 Power Supply Facilities

Electrical Power - Electrical power for the Crandon Project will be delivered at 115 kV from the Wisconsin Public Service Corporation (WPSC) power grid serving the area to a main substation located within the mine/mill site (Figure 2-5). The main substation will include terminating structures, switching structures, power circuit

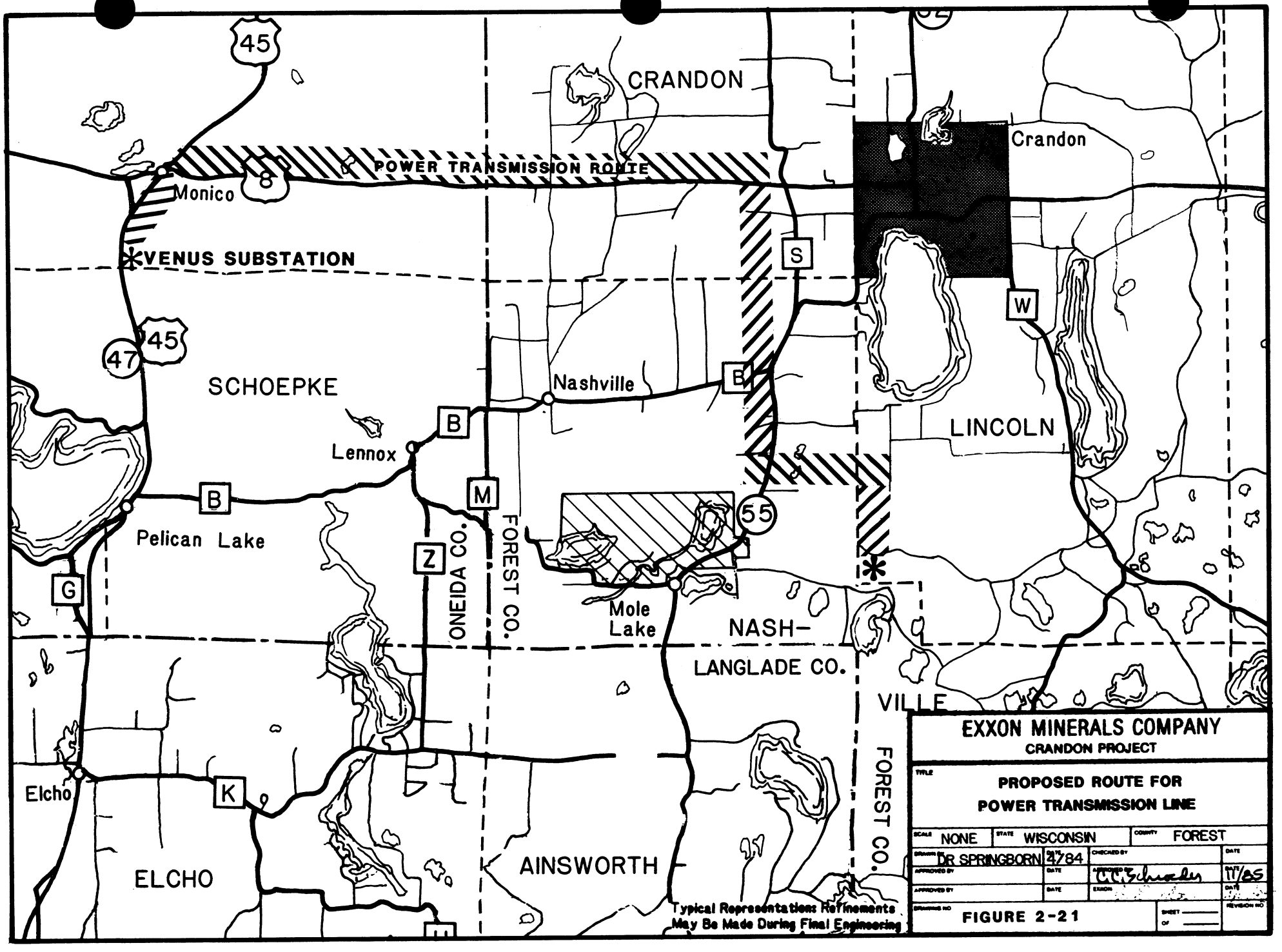
breakers, and transformers for reducing the 115 kV to 13.8 kV. The required medium voltage switch gear will be located in a concrete block building within the substation.

The 115-kV powerline from WPSC will originate from the Venus substation approximately 18 miles from the Project site. The transmission line will follow a route from the Venus substation along U.S. Highway 8 toward Crandon and then south across private right-of-way to the main access road for the Project. The proposed route for the transmission line is shown on Figure 2-21. WPSC will be responsible for construction of the transmission line to the terminal structure of the main substation. This powerline will be installed during the first 7 months of Project construction and will provide power during the remainder of the construction and operation phases.

All transformers are manufactured in compliance with NEMA standards and will comply with the 77 dB(A) at 3.3 feet OA/FA operation maximum of the NEMA standard.

The 13.8-kV power will be distributed to major points of use within the mine/mill site through an underground distribution system. At the major points of use, distribution substations will be installed where the 13.8 kV will be reduced to 4.16 kV or 480 V for powering motors and other equipment.

The MWDF will be supplied at 13.8 kV from the main distribution system. This power circuit will be underground within the mine/mill site and overhead on wooden poles from the east boundary of the mine/mill site to the MWDF.


45
CRANDON
Crandon
POWER TRANSMISSION ROUTE
8
Monico
VENUS SUBSTATION
S
W
47
45
SCHOEPKE
Nashville
B
LINCOLN
Lennox
B
M
B
Pelican Lake
ONEIDA CO.
FOREST CO.
55
Z
G
Mole
Lake
NASH-
LANGLADE CO.
VILLE
FOREST CO.
Elcho
K
ELCHO
AINSWORTH
Typical Representation: Refinements
May Be Made During Final Engineering
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
PROPOSED ROUTE FOR
POWER TRANSMISSION LINE
SCALE NONE
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
DATE 4784
CHECKED BY
DATE
APPROVED BY
DATE
APPROVED BY
EXXON
DATE 11/85
APPROVED BY
DATE
DRAWING NO
FIGURE 2-21
SHEET
OF
REVISION NO

During loss of power from the 115-kV system, it will be necessary to supply emergency power to certain underground mine equipment for safety reasons. Diesel emergency generators will be available to supply emergency power. These will be located in the main switch gear building at the main substation.

The generators will be housed in the main switch gear building which is a concrete block building and, after the permanent power is installed, will operate only in an emergency or for routine maintenance.

The outdoor substations consist of a high voltage switch, mineral oil filled power transformers, and secondary main circuit breakers. The secondary circuit breakers in turn feed the appropriate motor control centers located in the process areas. The outdoor substations will be mounted on concrete pads. The areas will be fenced as required by code.

Power will be supplied from the main substation through an underground electrical duct system buried within 4 feet of the ground surface with manholes at points required for pulling cables.

A communications duct system will provide telecommunication, data, and intercom routes throughout the Project surface facilities.

Natural Gas - Natural gas will be used for surface heating of the underground mine ventilation air, for general heating of buildings and facilities, and in the water treatment plant. Natural gas will be supplied by WPSC from an existing pipeline running generally east-west approximately 8 miles north of the mine/mill site. A 6-inch pipeline extension will be constructed from the existing pipeline to a metering

station located within the mine/mill site. The gas will be distributed by underground pipeline from the metering station to the points of use in the mine/mill site.

2.4.8 Fuel Storage and Distribution

Fuel oil will be used to supply the needs of the underground mining equipment, surface mobile equipment, emergency power generators, and small portable or miscellaneous heating equipment. Bulk storage tanks will be located above grade on the eastern edge of the mine/mill parking lot for storage of fuel oil. These tanks will be located in accordance with Wisconsin Administrative Code.

Truck access will be provided to the fuel oil storage tank area. Pumps will be provided to permit unloading of the trucks. Pumps and pipelines will be provided to offload and distribute fuel to points of use within the mine/mill site.

Fuel for use underground will be transferred from the bulk fuel tanks to two measuring tanks located next to the fuel delivery borehole. Pumps for this purpose are located next to the bulk storage tanks.

In the event of minor contamination of the water within the dike, the oily water will be pumped to a tanker truck and transported to the industrial sewer system, which is equipped with an oil/water separator, for disposal.

The transfer pumps are located in a small pump house outside of the dike for fire safety reasons. The pumps also will be surrounded by a concrete wall to contain any spills which might occur in the pump house.

In the unlikely event of a tank rupture, the spilled fuel would be totally contained within the dike. If such an event should occur, the spilled fuel will be pumped to a tanker truck for disposal at an approved disposal location off-site or to a reprocessor if appropriate. Similarly, any major spills less than a tank rupture could be handled in the same way.

A fueling station will be provided for dispensing fuel to surface mobile equipment. This station will be located east of the tailing thickener. The fueling station will have one diesel fuel tank and one gasoline tank, both of which will be buried. The fueling station will be designed in accordance with applicable state and federal codes.

2.4.9 Explosives Storage Magazine

An explosives magazine and storage area will be located approximately 1,800 feet north of the point where the railroad tracks enter the Project site (Figure 2-5). An area for parking and storing loaded trailers will be included within a fenced security area. Separate areas will be provided for storage of explosives and blasting caps. An earthen barricade will be constructed between the area containing explosives and caps and the area for parking trailers with other blasting agents.

The construction and arrangement of this facility will be in accordance with all applicable codes.

2.4.10 Potable Water Facilities

Potable water will be taken from a new well to be located approximately 0.5 mile southwest of the mine/mill site (Figure 2-22). From the supply well and pumphouse, underground piping will carry the water to the fresh water tank at the water tank plant area. A separate system of pumps and pipelines will distribute the potable water to points of use within the mine/mill facilities. It is not anticipated that treatment of this water will be required; however, a chlorinator treatment system will be provided and available for use if necessary.

The potable water well and distribution piping will be designed in compliance with NR 112 and H62, respectively. The potable water distribution system and well will be periodically tested for bacteriological quality.

Additional information on the proposed potable water facilities for the Project is presented in the High Capacity Well Approval Applications.

2.4.11 Water Treatment Plant and Excess Water Discharge

The water treatment plant will be located on the east side of the concentrator (Figure 2-5) and will consist of three separate treatment systems. One system will treat approximately 80 percent of the contaminated water pumped from the mine for discharge. This same system, however, will be designed with sufficient capacity to treat all the contaminated mine water if necessary. The second system will be designed to treat the ground water intercepted in the mine if treatment proves to be necessary prior to discharge. The third system will be

0.15m (6")Ø POTABLE WATER TRANSMISSION LINE (TOTAL LENGTH APPROX. 2000m (6562)

POTABLE WATER WELL (WS-1) LOCATION N 34,694m (N 113,825feet) E 893,352m (E 2,929,772feet)

MINE/MILL SITE

FRESH WATER TANK

SAND LAKE ROAD

OAK LAKE

LITTLE SAND LAKE

SKUNK LAKE

DUCK LAKE

25 26 29 30 31 32 35 36

0 500 1000 1500 SCALE IN FEET

0 100 200 300 400 500 SCALE IN METERS

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

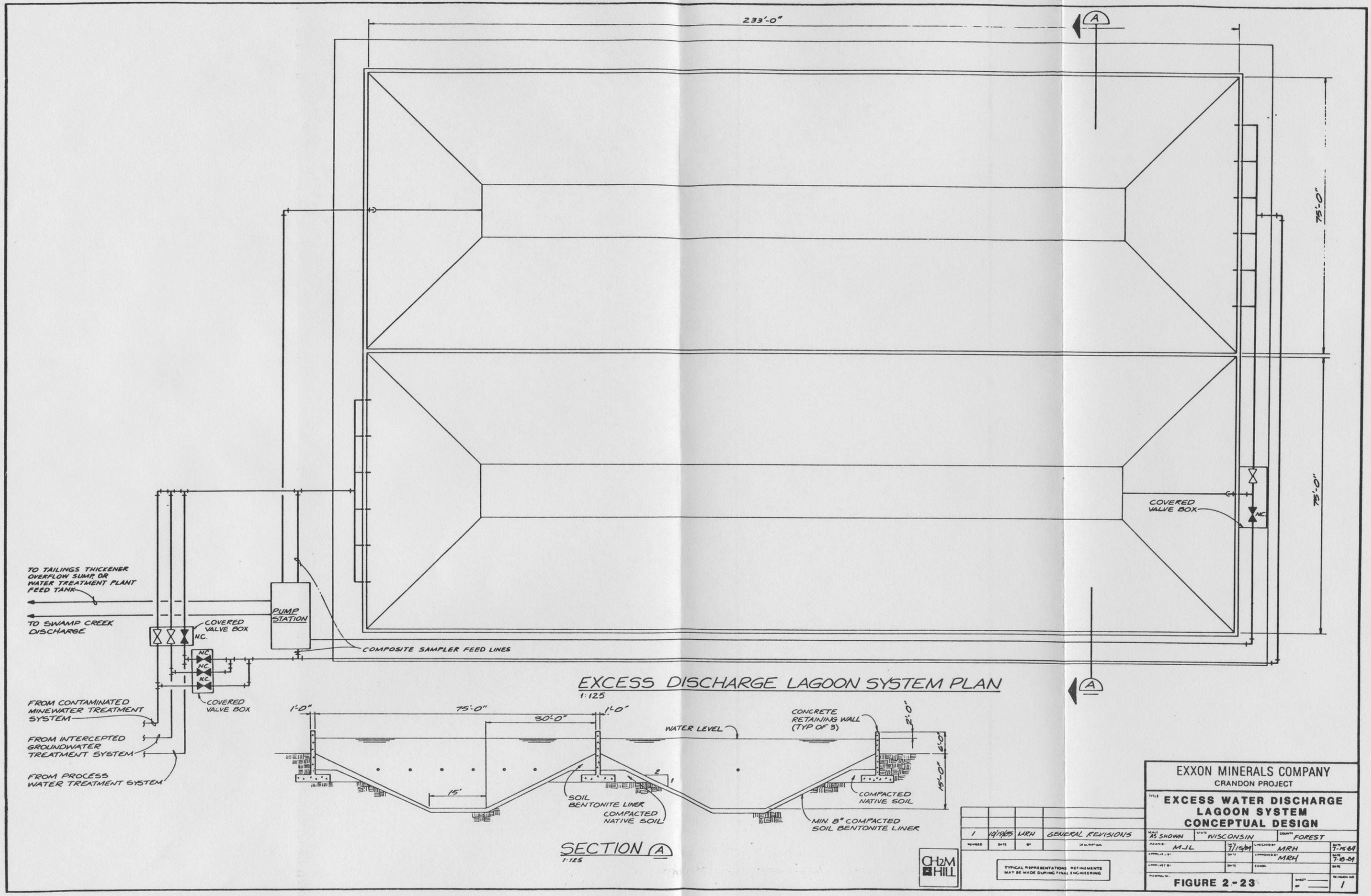
TITLE
LOCATION OF POTABLE WATER WELL FACILITIES

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 2/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON	DATE
DRAWING NO **FIGURE 2-22**		SHEET OF	REVISION NO

designed to treat the remaining 20 percent of the contaminated mine water and a sufficient volume of water from the reclaim pond for use as process water. Facilities will also be provided to monitor the quality of the various treated waters to ensure that the treatment systems are functioning properly and producing effluent of necessary quality. Excess water that has been processed through the water treatment plant will be pumped to discharge lagoons located in the northeast area of the mine/mill site. These lagoons (Figure 2-23) are designed to retain water for approximately 48 hours prior to pumping to Swamp Creek. This will enable sampling of the process water and allow for corrective action should the water treatment plant encounter an upset condition. For additional information on the water treatment plant, discharge lagoons, or water quality refer to the Water Treatment Facility Engineering Report prepared by CH2M-Hill, 1985.

2.4.12 Reclaim Water Pond

The location and orientation of the two-celled reclaim pond at the north side of the waste disposal system are shown on Figure 2-16. The pond will be located close to the wastewater sources and facilities to reduce operating cost and land disturbance. The pond serves mainly to hold and transfer water between the MWDF and the mill and a location between the two facilities minimizes the water handling system. The ponds will settle out fine particulates from the water decanted from the tailings pond for recycle to the concentrator. Organic compounds (collectors and frothers) will be reduced to concentrations that will allow successful recycle of water to the concentrator by aging for a sufficient time (approximately 30 days).



EXCESS DISCHARGE LAGOON SYSTEM PLAN

1:125

SECTION A

1:125

NO.	DATE	BY	REVISED
1	10/19/83	MRH	GENERAL REVISIONS

TYPICAL REPRESENTATIONS. REFINEMENTS MAY BE MADE DURING FINAL ENGINEERING

CH2M HILL

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **EXCESS WATER DISCHARGE LAGOON SYSTEM CONCEPTUAL DESIGN**

SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN: MJL	7/15/84	CHECKED: MRH	7-15-84
APPROVED:	DATE	APPROVED: MRH	7-18-84
APPROVED:	DATE	EXXON	DATE
PROJECT NO.		SHEET NO.	REVISION NO. 1

FIGURE 2-23

The retention volume in the reclaim pond as well as the tailings ponds will provide surge capacity for the water management system. They are designed to ensure that temporary interruptions of service of any of the components of the system do not cause a complete shutdown of the mine or concentrator. When the water level in the reclaim ponds is at the maximum normal operating level, there is potential water surge (storage) capacity in the pond provided by ample freeboard. The reclaim pond has a design freeboard in excess of 10 feet above maximum operating water level. This freeboard can provide temporary storage for about 26 days of water flow at a rate of 1,385 gallons per minute while still maintaining a minimum 3-foot freeboard below the pond's crest. The reclaim pond's freeboard is designed to contain the volume of the probable maximum precipitation (PMP) event including the water from the largest tailing pond (T4). The preferred operating practice will be to keep the water level in the pond below the maximum level so that surge capacity is available without infringing on the minimum freeboard allowance.

The two-celled system will be utilized to assure adequate retention time in the ponds and to prevent short circuiting of water through the pond system.

Retention of the recycle water in the reclaim pond promotes the natural oxidation of thiosulfate and other polythionates to sulfate. To neutralize the acid generated as a result of the thiosulfate oxidation, lime will be added to the water where it flows from cell B to cell A.

On the basis of fine particulate sedimentation and surge capacity, any reclaim pond retention time in excess of a week should be

adequate. Organic and thiosalt removal requires more time and is affected by seasonal temperature changes. If one reclaim pond cell is temporarily removed from service, reducing the retention time from approximately 30 to 15 days, no long-term detrimental effect should occur.

The reclaim pond dimensions will be:

	Estimated Dimensions		
	Cell A	Cell B	Total
Area Inside Toe (acres)*	25	25	50
Area Inside Crest (acres)	18	18	36
Bottom Area (acres)	10	10	20
Lined Slope Area (acres)	6.5	6.5	13
Maximum Depth (feet)	33	33	--
Max. Exterior Fill Height (feet)	33	--	--
Crest Elevation (feet MSL)	1,673	1,673	--
Storage Volume (acre-feet)	267	267	534

*Construction limits

All embankment materials, with the exception of lining and rock slope facing materials, will consist of the soil excavated from the pond interiors. The reclaim pond inside embankment slopes will be 4 horizontal to 1 vertical (4H:1V) to facilitate installing the pond lining system. The outside slopes will be 3H:1V. In accordance with NR 132.18, the 100-year flood elevation is approximately 1580 feet (482 meters) elevation.

The reclaim pond will utilize a two-part lining system which will consist of a bottom 8-inch bentonite modified compacted soil liner and a 36-mil thick Hypalon or HDPE (high density polyethylene) synthetic membrane upper liner. The membrane will be protected by placing an underdrain/vent layer over the bentonite modified soil liner to serve as the membrane base; then the membrane will be covered by 1.5 feet of sand. The lining system will be continuous across the pond bottom and sides. Riprap will be provided along the upper areas of the inside embankments to further protect the lining system.

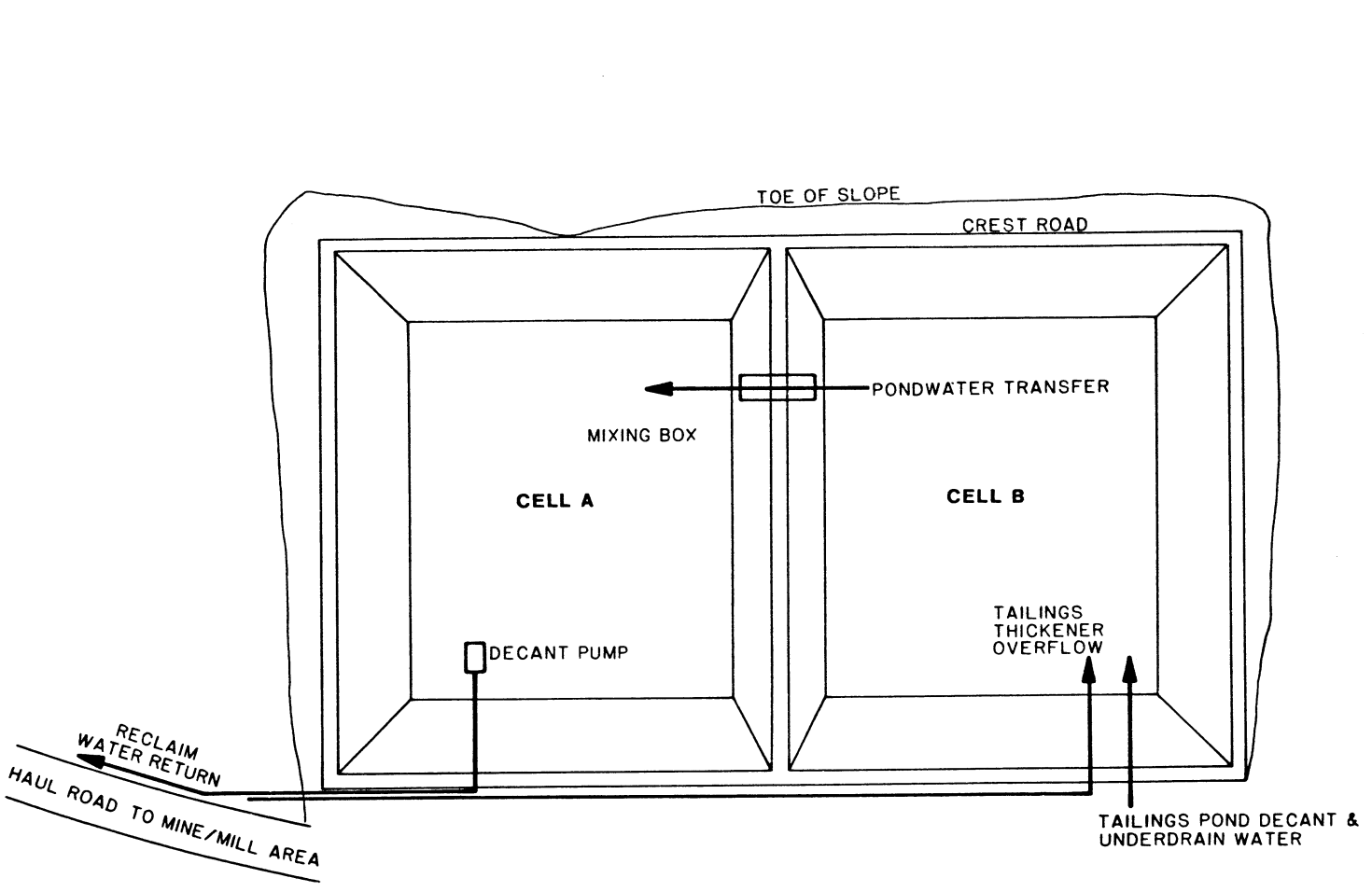
The underdrain system of each reclaim pond cell will slope slightly from a high point in the center to the inside toe of the pond embankment. There, any water entering the underdrain will be collected in a perforated perimeter pipe. Two standpipes in each cell running up to the pond embankment crest will allow periodic checks to see if any seepage has entered the underdrain system. The standpipes will be sized to allow insertion of a submersible pump in the event any seepage has to be removed from the underdrain.

The drain layer also will serve as the venting mechanism for any gases that might build up under the synthetic liner. Additional perforated pipe running through the center area of the pond, and connected to the perimeter collection pipe, will assure complete venting of the entire pond area. Final venting is achieved through the standpipes connected to the perimeter collection pipe.

2.4.13 Reclaim Water Pumping System

Location of the main features of the water handling systems at the reclaim pond is shown on Figure 2-24. Thickener overflow and the secondary stream from the tailings pond underdrain and decant systems will provide primary flow to the reclaim pond. Discharge points to the reclaim pond and the water transfer location between the two cells in the pond are also shown on Figure 2-24. The locations were chosen to provide maximum retention time in the system.

A floating barge connected with an access bridge will be used to mount the pumps to return the reclaim water to the mine/mill site.



0 250 500
SCALE IN FEET
0 50 100 150
SCALE IN METERS

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
RECLAIM WATER POND WATER HANDLING SYSTEM

SCALE	STATE	COUNTY
SHOWN	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	9/85		
APPROVED BY	DATE	APPROVED BY	DATE
		CR Schroeder	1/13/86
APPROVED BY	DATE	EXXON	DATE
			1/15/86

DRAWING NO. **FIGURE 2-24** SHEET ___ OF ___ REVISION NO.

2.4.14 Other Water Facilities

Mill Site Runoff - Runoff from the bulk reagent storage area and the area from the services building extending NNW to the mill area will have potential for contamination. Runoff from this area will flow to a swale immediately north of the conveyor gallery leading to the concentrator. The outlet from the swale has an oil/water separator and discharge will be controlled with a manually operated sluice gate. Water collected from this area will be pumped to the thickener overflow sump in the tailing thickener pump chamber. This water will be pumped to the reclaim pond and become part of the process water system.

Equipment Laydown Area - An area located near of the mine air heater will be used as an equipment laydown area; runoff from this area will have potential for oil contamination. Runoff will be directed to an oil/water separator in the southwest corner of the laydown area. Water that has been through the separator will be pumped to the tailing thickener overflow sump and then to the reclaim pond.

These areas cover a total of about 3 acres. Assuming average annual precipitation and no allowance for evaporation, runoff from these areas will add 6 gallons per minute to the reclaim pond.

Waste oil from oil/water separators and other waste lubricants will be collected and stored in drums until transported off-site by a contractor to a reprocessing facility. An estimate of the volume of waste oil is not available and, therefore, frequency of shipment to reprocessing facilities is unknown.

Surface Water Drainage - Figure 2-5 shows the current mine/mill site layout, including the locations of the two water drainage basins used for collection, retention, and release of all uncontaminated

surface waters in the mine/mill area. Discharge from the drainage basin is regulated under the WPDES Permit.

2.4.15 Preproduction Ore Storage

A storage area will be located at the north edge of the mine/mill site to store rock hoisted to the surface during mine development and prior to the start of mill operations. Prior to starting the underground crusher, approximately 875,000 tons of uncrushed rock with 24-inch top size will be placed on the storage area. This includes 350,000 tons of ore and about 525,000 tons of waste.

The preproduction storage area has been designed to accommodate about 875,000 tons and will occupy an area of 8 acres (Figure 2-5). A central ridge divides the area on a north-south axis. Each side of the pad slopes away from this ridge at a 2 percent grade. The east, south, and west sides of the area are bounded by berms with runoff collection ditches which route water to surface drainage basin No. 3 located on the north side of the area. Also, there is a high point on the road to the storage area; runoff collected on the road west of the high point is also collected and will flow to surface drainage basin No. 3. This assures that no contaminated runoff will discharge to the surrounding area. The base of the storage area will consist of a compacted pad of existing soil. Two 4-inch bentonite-modified soil liners will be placed over the pad. A 18-inch till cushion will be placed over the liner for protection.

All runoff from the area will be collected in surface drainage basin No. 3. Water from this basin will be pumped to the reclaim ponds via the tailings thickener overflow. This drainage basin is sized to

hold the volume of water from a 25-year, 24-hour storm event collected on a 8-acre area.

2.4.16 Core Processing and Storage

A pre-engineered building will be constructed east of the coarse ore storage building (Figure 2-5). This building will be used for processing and storage of drill cores.

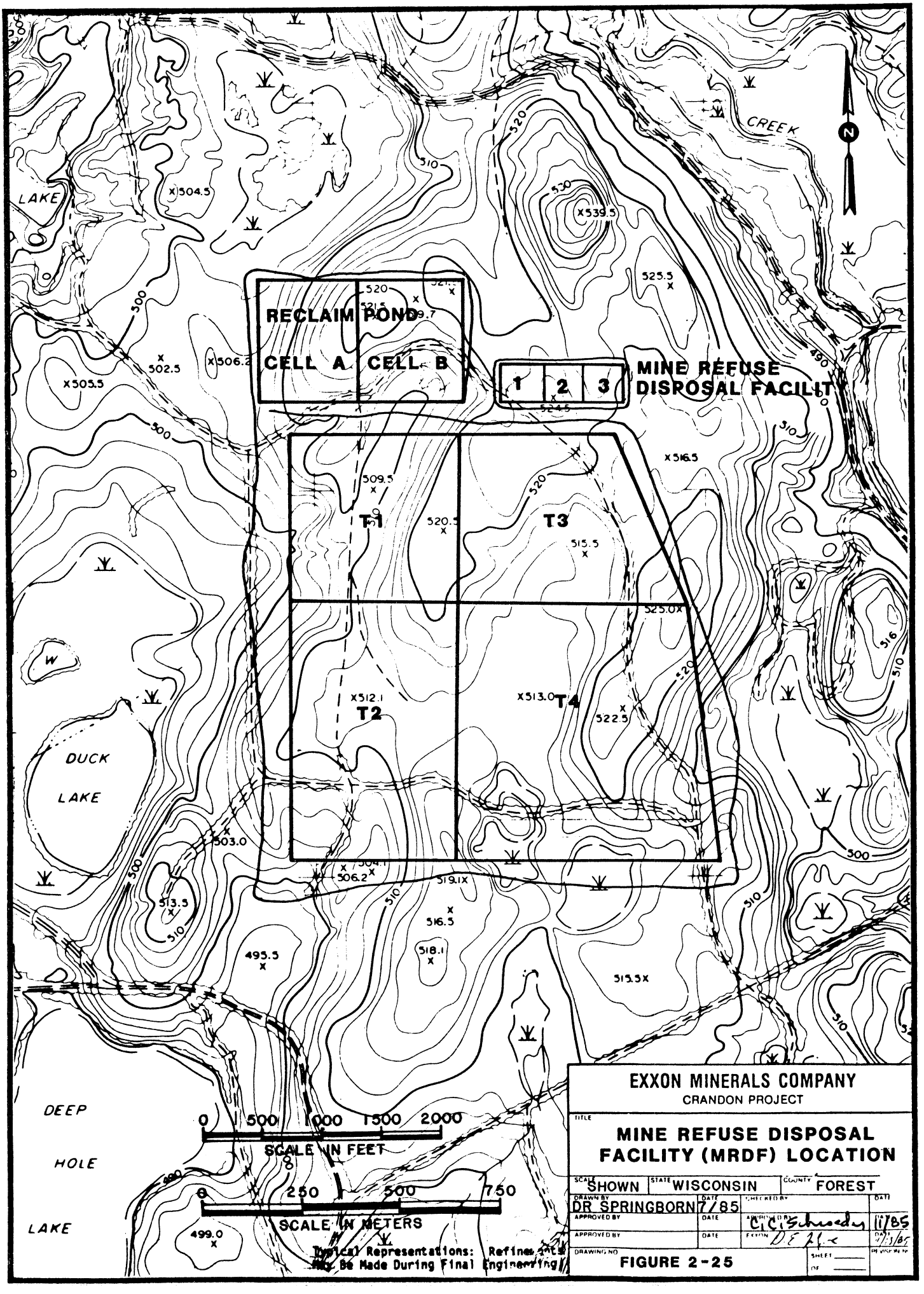
2.4.17 Truck and Railroad Scales

A truck scale will be located on the main access road at the approach to the gate house. The purpose of this scale will be to weigh shipments of bulk materials such as grinding balls, fuel oil, and reagents.

The railroad scale will be located on the spur track east of the concentrate loadout area. The purpose of this scale will be to weigh carloads of concentrate prior to shipment and to weigh incoming bulk materials.

2.4.18 Mine Refuse Disposal Facility

A facility located on the Project site will be used for disposal of mine refuse. The facility will be located east of the water reclaim pond, separated from the MWDF and the reclaim pond by at least 100 feet. The location of the mine refuse disposal facility (MRDF) is presented on Figure 2-25. Based on quantity projections of refuse for disposal over the life of the Project, the facility would require approximately 9 acres. The MRDF would be developed one cell at a time with each cell covering approximately 3 acres. Phased development will allow resizing of the later cells if necessary.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MINE REFUSE DISPOSAL FACILITY (MRDF) LOCATION

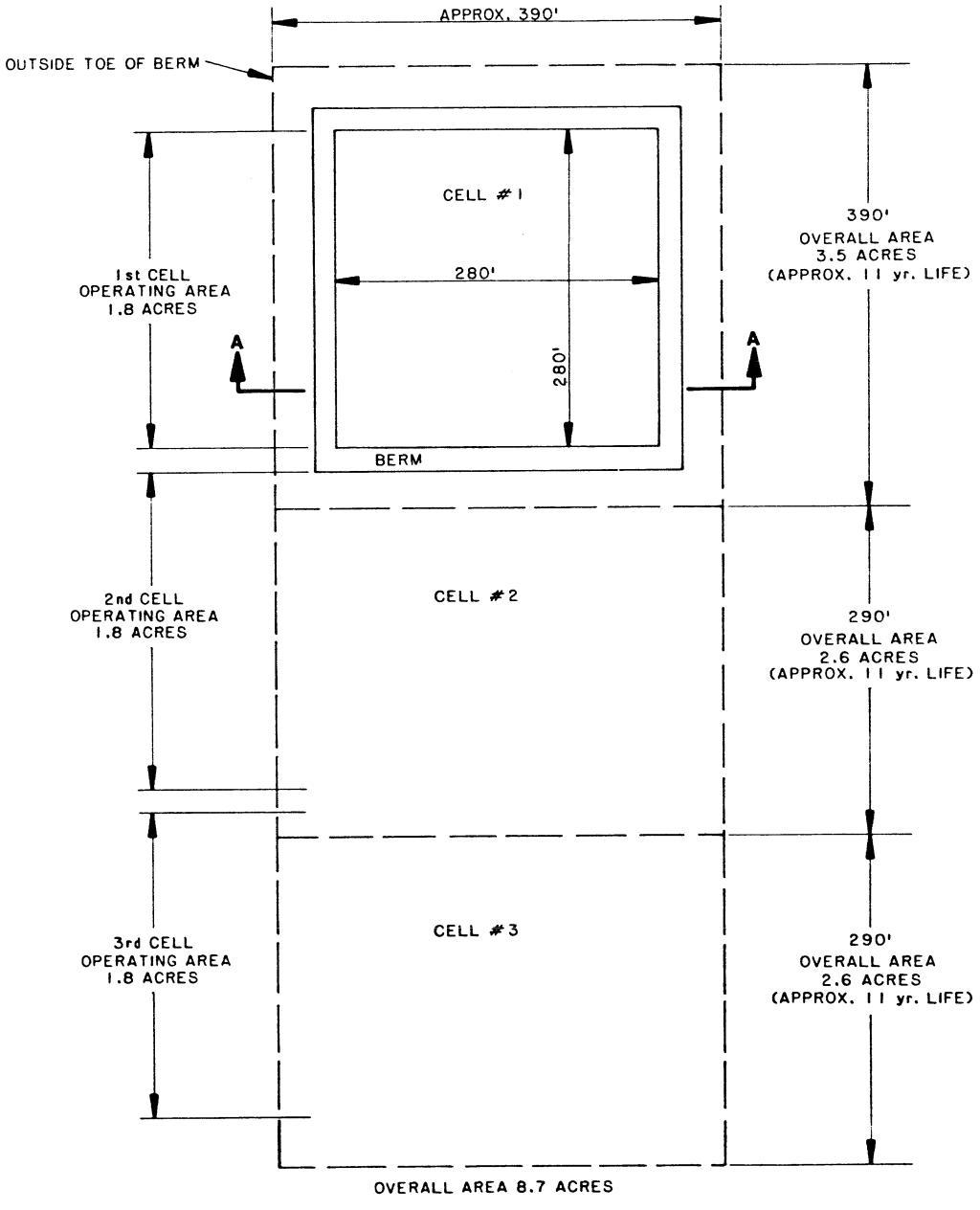
SCALE	STATE	COUNTY
SHOWN	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	7/85		
APPROVED BY	DATE	APPROVED BY	DATE
		C.C. Schneider	11/85
APPROVED BY	DATE	EXXON	DATE
		DE 2.x	11/13/85
DRAWING NO		SHEET	REVISION NO
FIGURE 2-25		OF	

Seepage of leachate from the refuse material in each cell will be controlled by the construction of a liner in the bottom and along the sides of each cell. The liner consists of two 4-inch lifts of a bentonite modified soil similar to the proposed MWDF liner. The same thickness (8 inches) will be used on the bottom and the sides of each cell. The bentonite modified soil will be manufactured using on-site glacial till materials and sufficient bentonite to achieve a design permeability of 5×10^{-8}cm/sec. The liner collection system is designed to control the head on the liner and to minimize seepage through the liner.

A two layer blanket underdrain of prepared local soil material will be placed above the liner in each of the three cells. The upper layer will serve as a filter which will transmit leachate to the drain layer below and also inhibit migration of fines into the drain layer. The filter layer will be separated from the drain layer by a geotextile filter fabric which will prevent the finer material of the filter layer from entering the drain layer below. The drain layer has been included to provide sufficient hydraulic capacity to accommodate any leachate volumes that are transmitted to the filter layer.

The generalized configuration and cross section of the MRDF is shown on Figure 2-26. The inside slopes of the cells will be 4 horizontal to 1 vertical (4H:1V) to facilitate placement of the lining system. These relatively flat slopes will allow the use of conventional construction equipment and will allow required quality control objectives to be met.



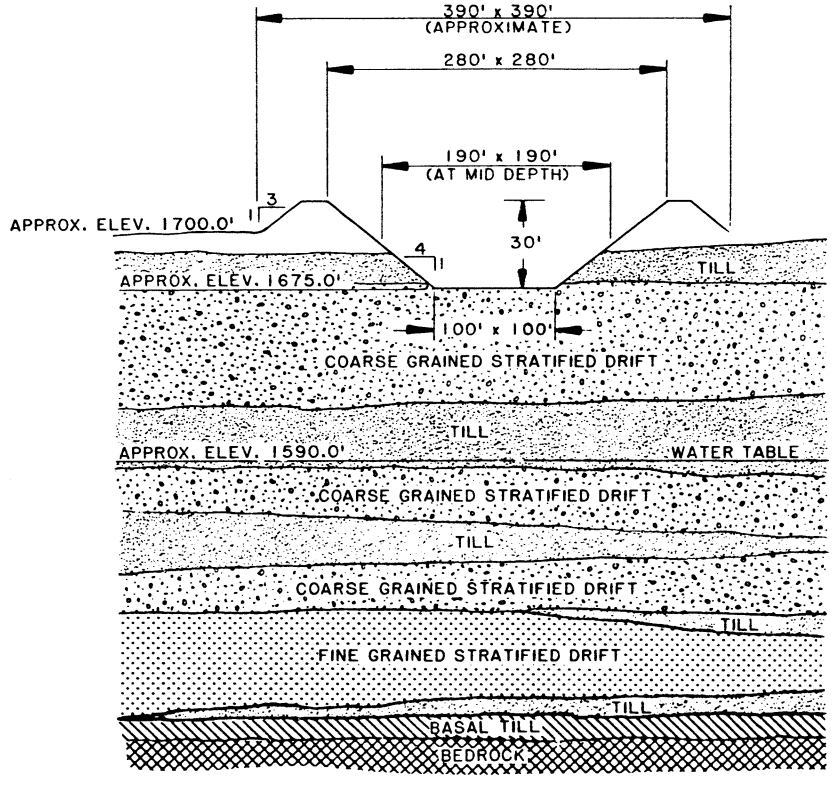
GENERALIZED CONFIGURATION

(CONFIGURATION NOT ADJUSTED FOR SPECIFIC TOPOGRAPHY)

0 100 200 300

SCALE IN FEET

SECTION A-A
GENERALIZED CROSS SECTION
(ELEVATIONS NOT ADJUSTED FOR SPECIFIC TOPOGRAPHY)
(NOT TO SCALE)



Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
GENERALIZED MRDF CONFIGURATION & CROSS SECTION

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 7/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schweder	DATE 7/15/85
APPROVED BY	DATE	EXXON	DATE
DRAWING NO		SHEET ___ OF ___	REVISION NO

FIGURE 2-26

Table 2.7 shows the summary of the design capacity for the MRDF. Specific details for this facility are included in the MRDF Feasibility Report.

TABLE 2.7

SUMMARY OF THE MINE REFUSE DISPOSAL FACILITY DESIGN CAPACITY

	Cubic Yards
1) Refuse Volume for Each Cell, as estimated	34,000
2) Daily Cover for Estimated Refuse for Each Cell	7,000
3) Cell Capacity as Designed	41,000

3.0 CONSTRUCTION AND OPERATION PROCEDURES

3.1 Construction

3.1.1 Construction Schedule

The duration of the construction phase is controlled by the time required to develop the main shaft and headframe, the east exhaust shaft, and to perform the requisite underground mine development. The sequence of critical activities for mine development consists of the main and east exhaust shafts sites preparation, freezing and sinking the shaft collars to bedrock, the establishment of permanent electric power on-site, placing the main shaft headframe concrete, erecting the east exhaust shaft temporary headframe, installation of sinking hoists, sinking the shafts to their appropriate levels, hoist equipping the main production/service shaft, and development of the mine haulage ways, initial stopes, and underground ore handling facilities.

Approximately 30 months will be required to sink the shafts and perform the underground development required to commence mine production. The time required for construction of the surface facilities is less. Therefore, the sequence of surface facilities construction will be initially governed by the requirement to provide the support facilities for the mine development operations. Thus, the installation of environmental protection systems, such as surface drainage basins to hold surface runoff from the disturbed areas of the site, sewage treatment facilities, and mine waste water treatment facilities, as well as the installation of permanent power, a concrete batch plant, and access roads are first priorities. Construction of the general facilities buildings and the concentrator, coarse ore storage,

and miscellaneous tanks and thickeners will be scheduled for completion when the mine can produce ore in sufficient quantities to make operation of the concentrator feasible.

The planned sequence and estimated duration of the principal construction activities during the construction period are shown on Figure 3-1.

Many factors have potential for extending the construction schedule. Some of these factors include: inclement weather, labor problems, delays in equipment/material deliveries, and design modifications.

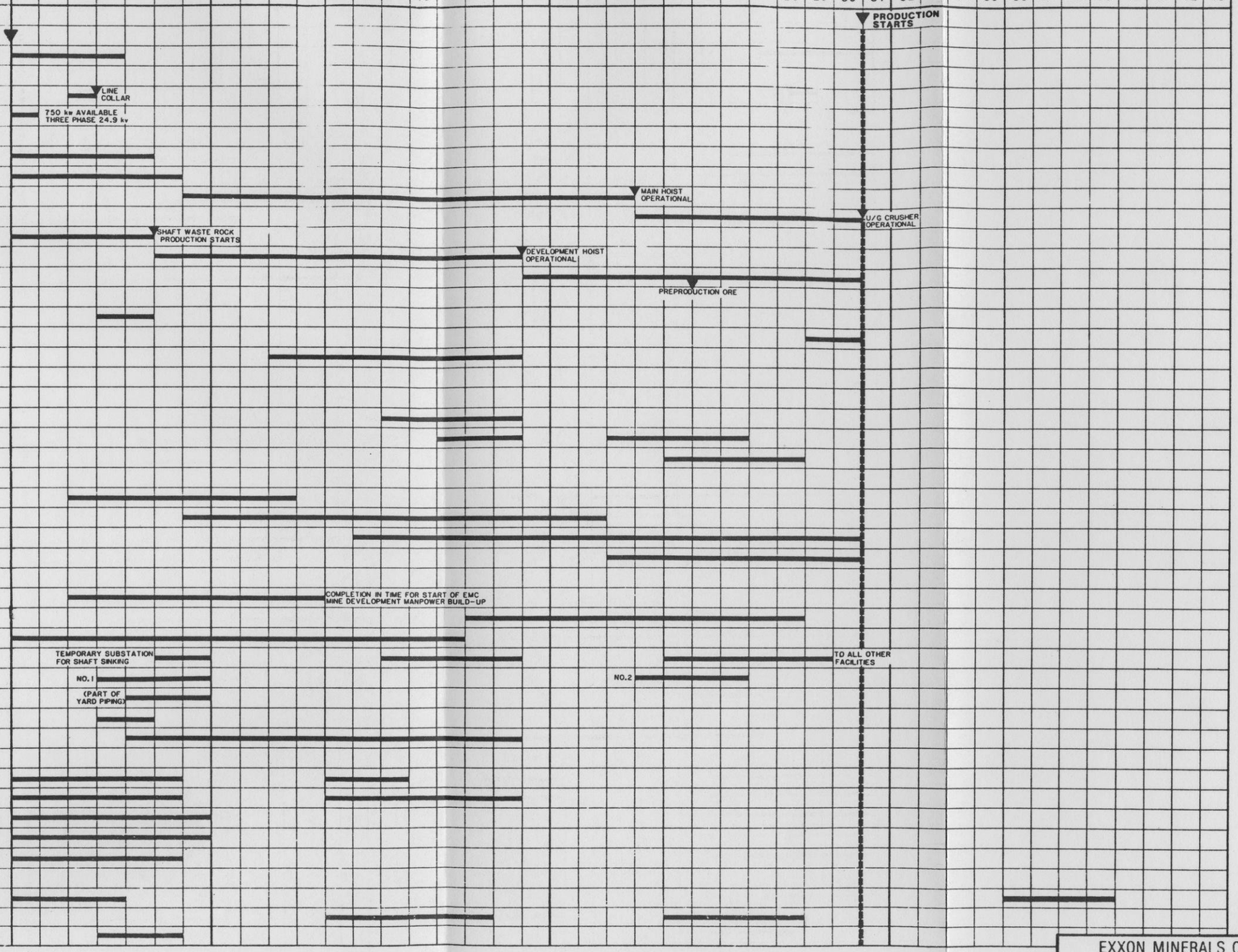
3.1.2 Mine/Mill Site Preparation

Mine/mill site preparation will be performed in two stages. Initially, the site will be cleared of trees and shrubs and then rough-graded. Immediately following this, those areas not required in the early phases of construction development will be reseeded to control erosion and runoff. Final grading of the reseeded areas will be performed as dictated by the requirements of the construction schedule.

Prior to clearing and grubbing, marketable trees will be cut and removed from the site. Tree stumps and brush will be mulched and stockpiled for use in land restoration. Any stumps or other grubbing materials that cannot be chipped for mulch will be disposed by burning in an approved air curtain destructor.

The storage area for the salvaged topsoil and mulch will be located on the east side of the mine/mill site.

ITEM NO.	ACTIVITY	YEAR / MONTHS FROM ACTUAL FIELD START
1		
2	ACTUAL FIELD START	
3	MINE/MILL SITE PREPARATION	
	TEMPORARY FACILITIES	
4	TEMPORARY BATCH PLANT	
5	TEMPORARY POWER EX UTILITY TO TEMP. SITE BLDGS	
	MINE CONSTRUCTION/DEVELOPMENT	
6	MAIN SHAFT COLLAR	
7	MAIN SHAFT HEADFRAME	
8	MAIN SHAFT SINK & EQUIP	
9	ORE BINS/CRUSHER	
10	EAST EXHAUST SHAFT	
11	SINK & EQUIP TO 572 LEVEL	
12	EMC MINE DEVELOPMENT	
13		
14	PREPRODUCTION ORE STORAGE	
15	R.O.M. PRODUCTION	
16	COMPRESSOR STATION	
	SURFACE FACILITIES	
	COARSE ORE STORAGE SYSTEM	
17	EXCAV, FOUNDATIONS, WALLS, SLABS (INC. TRANSFER TOWER)	
18	STRUCTURAL STEEL & FINISH BLDG	
19	EQUIPMENT INSTALLATION	
	CONCENTRATOR	
20	EXCAVATING, FOUNDATIONS, WALLS & SLABS	
21	STRUCTURAL STEEL & FINISH BLDG	
22	EQUIPMENT INSTALLATION	
23	MINE BACKFILL PREPARATION SYSTEM	
	GENERAL FACILITIES	
24	SERVICES BUILDING	
25	PROCESS WATER SYSTEM (PUMPS, PIPING, TANKAGE)	
26	WATER TREATMENT PLANT	
27	PLANT POWER DISTRIBUTION	
28	STANDBY GENERATOR	
29	NATURAL GAS PLANT DISTRIBUTION SYSTEM	
30	SANITARY WASTE TREATMENT PLANT	
31	YARD PIPING	
	OFF - SITES	
32	ACCESS ROAD	
33	RAILROAD	
34	115 kv POWERLINE (UTILITY)	
35	PRIMARY SUBSTATION (EMC)	
36	INCOMING NATURAL GAS LINE & METER STATION	
	MWDF	
37	RECLAIM POND	
38	TAILINGS POND T1	
39	MINE REFUSE DISPOSAL FACILITY	



NOTE: Schedule May Vary Depending Upon The Season Of Year When Construction Is Initiated.
Schedule Delays May Occur Because Of Inclement Weather, Labor Problems, Other Force Majeure Items.

Typical Representations Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CRANDON PROJECT CONSTRUCTION SCHEDULE

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	4/84		
APPROVED BY	DATE	APPROVED BY	DATE
		C.C. Schweda	11/13/85
APPROVED BY	DATE	EXXON D.F. Moe	DATE 11/12/85

DRAWING NO. **FIGURE 3-1** SHEET — OF — REVISION NO. 6

GDS 6/1001

Any large boulders encountered during the site preparation activity will be moved to the edge of the site area. These boulders, which are contained in the glacial overburden will be crushed, used as riprap in the MWDF area, or used in the mine operation. If any boulders are unusually large, they will be reduced in size by blasting or by use of a drop ball.

Erosion control at the site will be developed as necessary with the rough grading. To the extent possible, the permanent surface drainage systems will be used for runoff control. Further discussion of erosion control is contained in subsection 3.5.

3.1.3 Construction Materials (Nonmetallic)

The primary nonmetallic materials needed for construction of the Project along with approximate quantities are summarized below:

Item	Quantity
Concrete (includes surface and undergound)	51,000 yd^3
Base Course (includes access road and in-plant roads)	32,000 yd^3
Subbase (includes access road and in-plant roads)	37,700 yd^3
Asphalt Pavement	9,700 yd^3
Railroad Ballast (includes spur and siding)	41,700 tons
Railroad Subbase	13,700 tons
Bentonite	6,000 tons

Sand and aggregate for the above items could be supplied from local sand and gravel contractors. The bentonite, to be used primarily

for the MWDF, will be obtained from out-of-state and will be delivered by truck or rail.

Two separate batch plants will be used on the Project construction site. The first, a temporary concrete batch plant, will be located southeast of the main shaft. This facility will provide most of the concrete for the surface buildings and for underground mine construction.

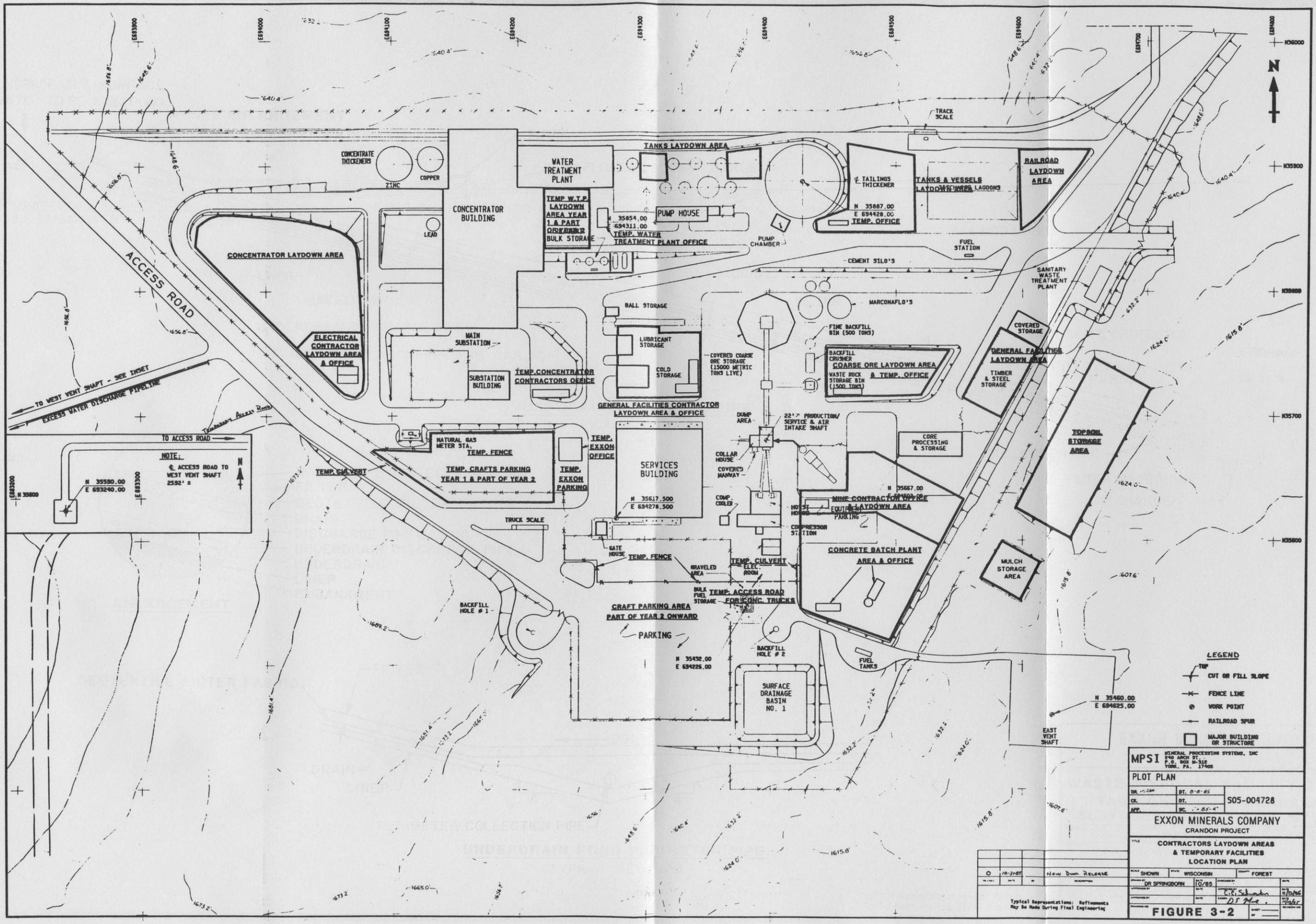
A second processing plant will be located in the tailing ponds construction area. This plant will be used to mix bentonite with native soils to provide liner material for the tailing ponds, reclaim water pond, refuse facility, surface water drainage basins, and the preproduction ore storage pad.

Discussion of the plants estimated air emissions have been included in the Air Permit Application.

3.1.4 Temporary Facilities

The need for temporary facilities for construction use will be minimized by making use of permanent facilities wherever possible. However, some temporary structures will be required.

Temporary facilities such as construction offices for Exxon and the contractors, storage and workshop buildings for contractors, a concrete batch plant, potable water, electric power, and sanitary facilities will be required at the site until permanent buildings are completed. The location and type of temporary buildings and facilities will be controlled by Exxon to ensure appropriate siting and quality of structures (Figure 3-2).


ACCESS ROAD
TO WEST VENT SHAFT - SEE INSET
EXCESS WATER DISCHARGE PIPELINE
TEMPORARY ACCESS ROAD
TO ACCESS ROAD
NOTE:
℄ ACCESS ROAD TO WEST VENT SHAFT 2592' ±
N 35580.00
E 693240.00
CONCENTRATE THICKENERS
ZINC
COPPER
LEAD
CONCENTRATOR BUILDING
WATER TREATMENT PLANT
TEMP. W.T.P. LAYDOWN AREA YEAR 1 & PART OF YEAR 2 BULK STORAGE
TANKS LAYDOWN AREA
PUMP HOUSE
N 35854.00
E 694311.00
TEMP. WATER TREATMENT PLANT OFFICE
PUMP CHAMBER
TAILINGS THICKENER
N 35887.00
E 694428.00
TEMP. OFFICE
TANKS & VESSELS LAYDOWN AREA
LAGOONS
RAILROAD LAYDOWN AREA
TRACK SCALE
FUEL STATION
CEMENT SILO'S
SANITARY WASTE TREATMENT PLANT
MARCONAFLO'S
CONCENTRATOR LAYDOWN AREA
ELECTRICAL CONTRACTOR LAYDOWN AREA & OFFICE
MAIN SUBSTATION
SUBSTATION BUILDING
TEMP. CONCENTRATOR CONTRACTORS OFFICE
BALL STORAGE
LUBRICANT STORAGE
COLD STORAGE
GENERAL FACILITIES CONTRACTOR LAYDOWN AREA & OFFICE
COVERED COARSE ORE STORAGE (15000 METRIC TONS LIVE)
FINE BACKFILL BIN (500 TONS)
BACKFILL CRUSHER
COARSE ORE LAYDOWN AREA & TEMP. OFFICE
WASTE ROCK STORAGE BIN (1500 TONS)
COVERED STORAGE
GENERAL FACILITIES LAYDOWN AREA
TIMBER & STEEL STORAGE
TOPSOIL STORAGE AREA
DUMP AREA
22'-7" PRODUCTION/ SERVICE & AIR INTAKE SHAFT
COLLAR HOUSE
COVERED MANWAY
CORE PROCESSING & STORAGE
NATURAL GAS METER STA.
TEMP. FENCE
TEMP. CRAFTS PARKING YEAR 1 & PART OF YEAR 2
TEMP. CULVERT
TEMP. EXXON OFFICE
TEMP. EXXON PARKING
SERVICES BUILDING
N 35617.500
E 694278.500
COMP. COOLER
HOIST HOUSE
COMPRESSOR STATION
N 35667.00
E 694604.00
MINE CONTRACTOR OFFICE & LAYDOWN AREA
EQUIPMENT PARKING
TRUCK SCALE
GATE HOUSE
TEMP. FENCE
GRAVELED AREA
TEMP. CULVERT
ELEC. ROOM
BULK FUEL STORAGE
TEMP. ACCESS ROAD FOR CONC. TRUCKS
CONCRETE BATCH PLANT AREA & OFFICE
MULCH STORAGE AREA
CRAFT PARKING AREA PART OF YEAR 2 ONWARD
PARKING
BACKFILL HOLE # 1
BACKFILL HOLE # 2
N 35432.00
E 694226.00
SURFACE DRAINAGE BASIN NO. 1
FUEL TANKS
N 35460.00
E 694625.00
EAST VENT SHAFT
N
LEGEND
CUT OR FILL SLOPE
FENCE LINE
WORK POINT
RAILROAD SPUR
MAJOR BUILDING OR STRUCTORE
Typical Representations: Refinements May Be Made During Final Engineering
0 10-21-85 New Dwn Release
MPSI MINERAL PROCESSING SYSTEMS, INC 940 ARCH ST. P.O. BOX M-312 YORK, PA. 17405
PLOT PLAN
DR. DT. 8-8-85
CK. DT.
APP. SC. 1" = 83'-4"
S05-004728
EXXON MINERALS COMPANY
CRANDON PROJECT
CONTRACTORS LAYDOWN AREAS & TEMPORARY FACILITIES LOCATION PLAN
SCALE SHOWN STATE WISCONSIN COUNTY FOREST
DRAWN BY DR SPRINGBORN DATE 10/85 CHECKED BY DATE
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO.
FIGURE 3-2

Sand Lake Road will be used for access during construction until the permanent access road is constructed and then as secondary access until the mine/mill construction activities are completed.

A temporary parking area for automobiles used by commuting workers will be provided on the mine/mill site until the permanent parking area is completed during the second construction year.

Temporary laydown areas for the storage of building materials and equipment will be provided on the site adjacent to structures under construction.

The temporary concrete batch plant and aggregate stockpile area will be established in the first year of construction to provide the necessary concrete supply. This batch plant will be removed during the third year of construction when all concrete has been placed.

Fire protection for all temporary construction buildings will be provided by a fire truck stationed on-site. In addition, hand-operated fire extinguishers will be provided by the various contractors. The permanent fire water loop will be completed during the second year of construction and will increase the effectiveness of the fire truck by providing the availability of fire hydrants throughout the site.

Potable and construction water will be provided by on-site wells now in existence and new wells to be installed during the first year of construction. A High Capacity Well Approval Application has been submitted to the DNR to cover two wells that will supply potable and construction water for the Project. One of the wells will be a new well located southwest of the mine/mill site which will be the primary

potable water supply well during the mine operating period. The other well will be a new non-potable well located northeast of the MWDF. This well will provide construction water for general use in the area of the MWDF but will primarily be used for water supply for material processing to produce the underdrain and liner materials for construction of the MWDF.

Both of these wells will be built as soon as possible during initial site development. They will then be available to meet all potable and construction water requirements throughout the construction period. For the short time before the potable well could be ready for use, two existing site wells (WW#1 and WW#2), although not approved for potable water, would be used for construction water and Exxon would arrange to haul in and distribute (through water dispensers) required potable water. After construction, site wells (WW#1 and WW#2) would be either abandoned or used as monitoring wells.

During the first 6 months of construction and until the mine/mill substation is completed, temporary on-site power will be furnished from an existing utility company line with a capacity of 500 kW and by use of on-site generators. By month 7 the main 115 kV powerline will have been installed and the first 13.8-kV/4.16-kV transformer energized.

In accordance with applicable regulations and good practice, chemical toilets for construction personnel will be provided on-site. Wastes will be collected and disposed off-site by an approved contractor. When the sanitary disposal system is completed, early in the construction period, sanitary wastes will be disposed at this

facility. The use of chemical toilets will continue throughout the construction period because some work locations will not be conveniently located near permanent toilet facilities.

A security fence enclosing the mine/mill site will be installed by the end of construction year one. A clear area on each side of this fence will be maintained. Temporary fences within the construction site may be installed by Exxon or the contractors. All fences will be approved by Exxon with respect to location and type prior to erection and will be removed when no longer needed.

3.1.5 Access Road Construction

The right-of-way corridor for the new access road will be cleared and grubbed of trees and shrubs prior to rough grading. During clearing and grubbing, marketable trees will be cut and hauled off-site. Tree stumps and brush will be burned or mulched with chippers and stockpiled for use in land restoration.

Existing topsoil will be stripped and saved from all cleared and grubbed areas along the access road right-of-way. Based on preliminary engineering for the access road, approximately 35 acres of right-of-way will be cleared and grubbed. Assuming a depth of suitable topsoil of 9 inches throughout the cleared area, a total volume of approximately 29,000 cubic yards of topsoil would be available for stockpile and reuse. Suitable areas along the right-of-way will be chosen to temporarily stockpile the topsoil. If temporary protection (control of surface water runoff) is required, it will also be provided.

Construction of the access road includes topsoiling, fertilizing and seeding of all disturbed areas along the right-of-way. Most salvaged topsoil will be applied to the road side slopes prior to seeding. However, at the completion of access road construction, any unused topsoil will be hauled to the permanent topsoil stockpile at the mine/mill site.

The total estimated amount of wetland soil materials removed along the access road during construction is approximately 6,300 cubic yards. No separate estimate of peat materials within this volume has been made. These soil materials will be used as a top dressing on the roadway side slopes outside the edges of the aggregate base course.

Implementation of runoff and erosion control methods are discussed in subsection 3.5.2.3.

Roadways will be built up using selected cut materials from within the road alignment. A base of well-graded material will then be placed and compacted. It is anticipated that this base material will be acquired from an established commercial source.

Construction processes for the pavement will follow normal practice used in the area. A central plant will batch and mix the pavement materials followed by truck transfer to the site where paving machines would be used for pavement placement.

3.1.6 Mine Construction

3.1.6.1 Mine Surface Facilities

The mine surface facilities are described in section 2.1.1. These facilities will be constructed using typical construction

techniques of any surface facility. Typical construction equipment is presented in subsection 3.1.17.

In addition to the above items a temporary steel headframe will be erected at the east exhaust/development shaft along with a small hoist house to contain the shaft sinking and development hoist. After mine construction is complete, this shaft and headframe will be converted to handle exhaust ventilation fans and the emergency escape hoist.

3.1.6.2 Shafts and Collars

The plan for development of the mine includes construction of three vertical shafts.

Each shaft will have a concrete lined collar through the glacial overburden and weathered subcrop rock. Collar construction will include stabilization and hydraulic control by ground freezing, followed by excavation and concrete lining within the protective frozen soil cylinder.

The stabilized ice wall will be formed by closed circuit circulation of a cooling fluid (typically calcium chloride brine) through a circular pattern of vertical pressure-tested steel cased boreholes containing inner down-flow tubes. Monitor boreholes will also be provided to measure ground water levels, ground temperatures, and for detection of brine leakage. With this temporary ground stabilization method no foreign materials are introduced to the ground water regime or surrounding soils.

Excavation will commence using a crane and clam shell for removal of loose material, followed by pavement breakers or rock drills and explosives to break up larger boulders, and chipping hammers to trim the walls of the excavation to the proper diameter. Upon completion of the excavation, a reinforced concrete collar will be poured in place. This collar will be approximately 2 feet thick and will reach from finished surface elevation to a depth into competent bedrock sufficient to assure a firm foundation. At the interface of the collar, the bedrock, and the overburden, inert grout will be pumped under pressure through holes in the collar and into the rock and glacial formations to provide a watertight seal.

Once excavation and lining of a shaft collar are complete, the protective ice wall and the surrounding soils will be allowed to thaw. Abandonment of the freeze pipes will include:

1) Removal of brine for off-site disposal by the freezing contractor;

2) Clean water flushing of freeze pipes;

3) Mechanical perforation of freeze pipe casings at the soil-rock interface at the hole bottom; and

4) Displacement of freeze pipe flushing water with neat cement grout delivered from the surface.

When the collar sections of the main shaft and east exhaust shaft are completed, a headframe structure will be erected over each shaft. For the main production shaft, this will be the permanent concrete tower headframe, whereas a temporary steel development hoisting headframe will be installed on the east exhaust shaft. Conventional

sinking through rock will then commence at the main shaft and at the east exhaust shaft concurrently.

Once the east exhaust shaft sinking is complete and mine level development begins, shaft drainage water will constitute only a part of the estimated total mine inflow. Until that time, approximately 18 months after the start of construction, all shaft water will be pumped to the surface wastewater lagoons and/or the reclaim pond. During this 18-month period, an estimated 6,500,000 gallons of water will be pumped from the shaft excavations. The wastewater lagoons will be available to receive the shaft construction water when sinking in bedrock begins. One cell of the reclaim pond will also be available within 1 to 2 months after the start of shaft sinking. Only about 8 percent of one cell of the reclaim pond 87,000,000 gallons normal operating capacity would be required to store all the estimated 6,500,000 gallons of shaft excavation drainage.

3.1.6.3 Underground Development

Upon completion of the east exhaust shaft horizontal level development will commence. A longitudinal section of the mine is shown in Section 2.0 on Figure 2-11. Horizontal drifts will be driven westward to intersect the main shaft already completed from the collar section. A mobile equipment ramp decline will be developed toward main haulage level. Drift mining on the main haulage level will begin upon completion of the main shaft sinking and hoist installations. Preproduction mining on the lower mine levels and the sublevel between them will prepare the initial stope blocks for production. The ramp

will provide for interlevel equipment movement and access to the maintenance shop.

The underground ore handling facilities will be constructed upon completion of the main production shaft. These facilities will consist of coarse ore and waste bins, crusher facilities, belt conveyors, and a loading pocket installation. Ore and waste passes will connect these facilities to the upper mine levels.

3.1.6.4 Waste Rock Storage Area

Waste rock generated during shaft sinking operations and preproduction mine development will be stockpiled on the preproduction ore and waste storage pad on the north side of the mine/mill site. A portion of the stored waste rock will be used for MWDF slope protection. The remainder will ultimately be crushed and returned to the mine as backfill.

3.1.7 Mill Construction

The mill facilities have been categorized as follows:

1) Buildings with concrete foundations, structural steel frame and insulated structural walls and roof;

2) Buildings with concrete foundations, concrete block walls and insulated metal roof; and

3) Process structures such as thickeners, tanks, conveyors, and pipe racks supported on concrete foundations.

The typical construction equipment required is presented in subsection 3.1.17.

3.1.8 Mine Waste Disposal Facility and Reclaim Pond Site Preparation

Site preparation for the MWDF and reclaim pond will be completed in phases so that only the area actually required for construction in a particular phase will be cleared and grubbed. Only a portion of the total area will be under development at any one time. The maximum disturbed area at any given time will be 285 acres, which is about 50 percent of the ultimate total of 480 acres including the construction borrow area.

Additional information on the MWDF is presented in the revised NR 182.08 Feasibility Report.

The site preparation procedures for the waste disposal and reclaim pond area will include clearing and grubbing, separation of marketable timber, and burning or mulching of tree stumps and brush. Suitable topsoil will be stockpiled for future use. Large boulders will be handled in a similar manner as described for the mine/mill surface area.

All wetland deposits (peats, mucks, and other organics) will be removed from the MWDF area during pond excavation and used as top dressing or mulch on the embankments. Most of the deposits are in the pond bottom areas and are 16 to 33 feet higher in elevation than the bottom grade of the pond. Those wetlands in the embankment areas will also be removed completely, down to firm subsoils prior to any embankment construction.

Based on estimated wetland material depths and areas, an approximate volume of 275,000 cubic yards of material will be removed. Of the total estimated excavation for the MWDF (11,195,000 cubic yards), the wetland material represents about 3 percent. The excavated organic materials will be temporarily stored adjacent to the excavation area to allow drainage and then used as top dressing on embankments and other areas where vegetation is to be established.

The outside faces of the containment berms of the tailings and reclaim ponds will be graded at 3H:1V and stabilized by application of topsoil, hydro-mulching and revegetation.

3.1.9 Mine Waste Disposal Facility and Reclaim Pond Construction

Construction of the MWDF has been scheduled in such a way that completion of each of the tailing ponds occurs at the time at which it is required for disposal of tailings. The limited construction season in the area requires the concentration of construction efforts during the May through November period to meet the schedule in each work phase.

Scrapers will excavate and haul material directly to the embankment for placement and compaction or to a stockpile area located adjacent to the construction support area for later use. Portions of the stockpiled soil will be used for preparing liner and underdrain material. The remainder will be placed in a long-term stockpile for future use. The height of the stockpile will be limited to approximately 50 feet. The storage area required is approximately 25 acres.

Upon completion of the excavation in a particular area, the subgrade will be brought to grade and proof rolled to be followed by placement of the bentonite modified soil liner. The liner material will be hauled by dump trucks to paving machines for placement followed by compaction.

The liner will be developed from processed till (material larger than 0.75 inches removed) and mixed with bentonite. This mixture will be blended and moisture conditioned to a uniform consistency using a continuous feed horizontal paddle auger mixing system specially designed for this type of construction.

Water requirements at the construction support area for preparation of the underdrain material are primarily related to the volume rate of material handled and its fines content. The necessary rate of material handled depends on the scheduled need for facilities. The total water requirement will range from 4,000 to 6,000 gallons per minute. Actual make-up water will range from 400 to 600 gallons per minute to account for water loss with the materials removed from the process. There will be a settling pond associated with the process; however, small high capacity clarifiers will be used first to keep the pond size to a minimum. The clarifiers and settling pond will remove the finest material, with the clarifier underflow pumped to the pond. After completion of a construction phase the fines will be removed from the pond and placed in the MWDF as construction waste or, if suitable, used as site grading fill during reclamation. During the first phase of construction, much of the system sizing requirements will be determined because there will be less opportunity to spread out the material

processing during that phase. Based on these needs, the settling pond to contain the fines removed during the first phase of construction will range in size from 2 to 4 acres with a depth of 10 to 15 feet.

The till soil will be mixed with the bentonite at its natural moisture content. Additional water will be added during mixing as required to bring the mixture to the required moisture content before placement and compaction.

Precautions to protect the surrounding environment will include routing of potential surface water drainage and installation of siltation ponds. Any damage to the previously constructed segments as a result of erosion or other causes will be repaired or reconstructed. In most cases, any damage probably will be restricted to the top filter and repairs will be no different than any other construction that might require some interim regrading.

Bentonite modified soil will be placed and compacted on the 4H:1V pond interior side slopes using the same paving techniques as described for the bottom areas of the ponds. The liner material will be placed to a uniform thickness in two separate lifts in order to achieve the design thickness of 8 inches. The relatively flat 4H:1V side slopes have been selected to assure there are no construction difficulties in working on the slopes.

Techniques for spreading the processed till in constructing the underdrain layer will be similar to those used in highway construction with special considerations developed to protect the underlying liner. Grade control and soil material quality assurance

methods are well established for roadway construction and final project specifications will be patterned similarly.

Following placement of the bentonite modified soil liner, the underdrain and filter material will be placed to protect the liner from adverse environmental conditions. A geotextile will also be used between the drain and filter layers to prevent migration of filter material into the underdrain. Installation of the underdrain pipe system will be performed during the same time period as placement of the liner, drain, and filter.

Quality assurance and quality control procedures will be implemented by Exxon during construction of the liner and underdrain system to ensure the system will be installed in accordance with the material and performance specifications presented in the revised MWDF Feasibility Report.

For the reclaim pond, the installation of the bentonite modified soil liner and the drain/venting layer will be mechanical operations. Placement of the synthetic membrane will be manual. Once the synthetic liner is in place, the sand cushion and protective cover will be placed by dumping and spreading ahead of the construction equipment such that the liner is protected by a sand cushion. An additional layer of transition material will be placed on the upper portions of the reclaim pond slopes where riprap is required. The sand cushion and transition material will provide protection against damage to the synthetic liner.

During the early stages of construction a support area will be developed immediately north of the site for tailing pond T3. This

support area will be used as a base of operations during the construction of the waste disposal facilities. The pad will be sloped to drain, with the runoff diverted into a retention pond. The surface of the support area will consist of natural glacial till. Dust will be controlled by sprinkling with water as needed.

Additional information on the construction of the tailings facility is presented in the MWDF Feasibility Report.

3.1.10 Pipeline and Water Discharge Structure Construction

Pipelines are required to transport tailings slurry to the tailing ponds, thickener overflow water to the reclaim pond, and water from the reclaim pond to the mill and treated water to the Swamp Creek discharge. Pipelines will be buried below the frost line to avoid frost damage and for improved visual effect.

Excavation will be by either trenching machine or backhoe; and after installation of the pipeline, backfilling will be sequenced to keep open excavations to a minimum during construction. Trench depths will confine excavation to be within glacial till, blasting will not be required, and all excavation can be by backhoe or similar equipment. All pipelines will be pressure tested prior to placement in the trench. The trench will be backfilled with till.

Instrument cable will be buried with the pipe. The cable will be used as a metal source for pipeline locating instruments. Erosion control procedures during construction will be followed as described in subsection 3.5.2.5.

The water discharge pipeline to Swamp Creek will be buried as discussed above within a 50-foot right-of-way. The discharge structure at Swamp Creek will be constructed using a backhoe for excavation, minor grading, and placement of riprap.

A similar technique will be used to install the reclaim water and thickener overflow water pipelines associated with the reclaim pond, and the decant/underdrain water pipelines from the tailing ponds.

The pipeline area width, approximately 8 feet, will be reseeded but will be kept clear of trees and brush to permit vehicular passage for periodic inspection. Pump stations will be located close to the tailings thickener and at the reclaim pond.

3.1.11 Railroad Construction

Construction of the railroad spur will be completed in Years 1 and 2 of the Project. Activities during construction will consist of the following: (1) clearing and grubbing, (2) installation of 5 miles of railroad spur track and siding track, including culverts, grading, bridge structure, and crushed aggregate ballast; and (3) application of topsoil, fertilizer, seed, and mulch. In the preliminary engineering work for the railroad spur, an estimated 45 acres will be cleared and grubbed within the right-of-way. Assuming 6 inches of suitable topsoil throughout the cleared area, approximately 35,300 cubic yards of topsoil will be stripped and saved. An estimated 14,400 cubic yards of topsoil will be used during railroad spur construction for reclaiming disturbed

areas and embankment or cut slopes. Any excess topsoil will be relocated to the topsoil stockpile at the mine/mill site.

Construction will start on the single span bridge across Swamp Creek when the access corridor has been cleared sufficiently to allow men and equipment into the area. Erosion control and stream protection procedures as described in subsection 3.5.2.2 will be followed.

Wetland soil materials excavated for construction of the railroad spur will be used as top dressing along the railroad spur embankments or cut side slopes. For the railroad spur, the volume of wetland excavation was estimated to be 16,600 cubic yards.

The earthwork balance determined during preliminary engineering design of the railroad indicated approximately 28,800 cubic yards of select borrow material would be required to construct the railroad. This material will be provided by excess borrow available from development of the mine/mill site or alternatively it could be obtained from the MWDF area during its initial development.

3.1.12 Powerline Construction

Electrical power for the mine/mill facility will be supplied at 115 kV by the WPSC. The 115-kV transmission line to the mine/mill site will be constructed by WPSC from the Venus substation, about 18 miles west of the mine/mill site, to the mine/mill main substation.

Because of the permitting process, right-of-way acquisition, and transmission line construction time, permanent power may not be

available at the mine/mill site for the first 7 months of construction. During this interim period, power will be supplied by on-site diesel powered generators.

3.1.13 Sanitary Facilities

The sanitary treatment plant will be installed as soon as possible and should be available within 6 months after start of Project construction. When the excess water discharge system is complete, the sanitary treatment plant effluent will discharge directly to that system. Prior to completion of the discharge system, the surface wastewater lagoons or reclaim water pond will be used to contain the sanitary treatment plant effluent discharge. If Exxon or a contractor utilizes a restroom/shower trailer, a temporary sewage holding tank will be used for that facility.

A licensed septic tank pumping contractor will be used to service the portable toilets and the holding tank (if required) as necessary. Prior to installation of the permanent sanitary treatment plant the licensed contractor will haul the sewage off-site for disposal. After installation, the sewage will be transferred to the permanent facilities.

Assurances have been received from licensed septic tank pumping contractors that this type of arrangement and their service would be satisfactory. It is assumed that they have sewage disposal capabilities.

3.1.14 Haul Road Construction

A gravel surface haulage road will be constructed from the mine/mill site to the waste disposal area. The alignment for this road will also accommodate the tailings transport and reclaim water pipelines. Construction methods employed in building the haulage road will be similar to those used in construction of the mine/mill site access road.

3.1.15 Mine Refuse Disposal Facility

The first cell of the mine refuse disposal facility (MRDF) will be built at the inception of construction activities and should be available within 6 months after start of Project construction. This early construction of the MRDF will allow most construction waste to be disposed in the MRDF.

Like the MWDF and reclaim water pond, the MRDF will be developed in stages so that only the area actually required for construction will be cleared and grubbed. During site preparation marketable timber will be recovered followed by burning or mulching of stumps and brush. Suitable topsoil will be stockpiled for future use.

For additional information refer to the MRDF Feasibility Study dated November 1985.

The MRDF has many similarities with the MWDF and water reclaim pond in the design and construction of the lining and leachate collection systems. Construction of this facility will occur during the same time frame as the reclaim pond. Most of the description presented for construction of the MWDF and reclaim pond is applicable for the MRDF, although on a much reduced scale. The operations and materials

requirements will be small in comparison to those for the MWDF and reclaim pond.

3.1.16 Equipment

The types of equipment which will be used for the construction of the surface facilities are shown on Table 3.1. The heaviest concentration of construction equipment will occur during the summer of the first 2 years of construction. During the winter months there will be a marked reduction in the intensity of equipment operation.

TABLE 3.1

CONSTRUCTION EQUIPMENT-SURFACE FACILITIES*

Chain Saws
Feller Buncher
Hydro Mower
Clipper
Front End Loader
Bull Dozer
Backhoe
Motor Grader
Compactor
Wacker
Motor Scraper
Crane
Forklift
Dump Trucks
Concrete Pumper Truck Mounted
Sedans
Pickups
Flatbed
Mobile Lubrication Units
Vacuum Trucks
Water Truck
Fuel Truck
Transit Mix Trucks
Generator
Diesel Compressor
Off-Road Truck
Hydroseeder
LoBoy Truck & Trailer
Processing Plant
Batch Plant
Paver
Conveyor
Pumps
Power Auger

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*All equipment listed is typical for performing the tasks required. Actual equipment used by the contractor may vary according to needs and resources.

3.2 OPERATIONS

3.2.1 Schedule

The operating schedule for the Project will be three shifts per day, 365 days per year. This schedule was the basis for determining the quantity and sizes of mining equipment, ore hoisting requirements, sizes of all process related equipment, water requirements, tailings disposal requirements, and manpower requirements. Mine production commences when installation of the underground crusher is complete and crushed ore is hoisted from the mine. Concentrator production will start when construction of the concentrator and all process equipment is completed and turned over to Exxon by the construction contractor. Backfilling in the mine with coarse tailings will start when concentrate production starts. Table 3.2 presents the estimated storage requirements for ore and concentrates. The schedule and storage capacities shown in these tables are based on an operational life of 29 years for the Project.

The operational life of the Project could be affected by certain factors that would require temporary shutdown of production operations. Temporary mine/mill shutdowns are defined as those periods during which actual mine and/or surface plant operations cease, but all facilities are maintained in start-up readiness. During such periods mine water pumping, water treatment, MWDF underdrain pumping and reclamation, and similar activities would continue. The mine life would simply be extended in real time by an amount approximately equal to the length of the temporary shutdown.

TABLE 3.2

ESTIMATED STORAGE REQUIREMENTS

FACILITY	MATERIAL	LIVE TONNAGE	DAY'S SUPPLY
Coarse Ore Storage	Massive ore	16,000	2
Concentrate Storage	Copper concentrate	1,050	6.5
	Lead concentrate	1,000	19
	Zinc concentrate	2,500	2.5

A variety of events and situations could cause temporary suspension of operations for durations varying from one day to several years. Short shutdowns (i.e., one month or less) might be caused by weather extremes, equipment failure, or planned facilities maintenance or modification. Manpower requirements would not be reduced for these kinds of shutdowns. A cessation of up to 3 to 6 months might result from a labor dispute, either local or by an essential supplier or carrier. Suspension of operations for periods greater than 6 months would most likely be caused by economic conditions such as severely depressed metal prices. Necessary pollution control and monitoring equipment would be operated during these periods to assure compliance with all applicable permit conditions. The ultimate ramification of such events is the extension in real time of mine and facility operations and reclamation.

Cessation of mining, not set forth in the Mining Plan, will be conducted in a lawful manner under Wisconsin Statute 144.875, which requires that the operator notify the DNR and commence stabilization of the mining site.

3.2.2 Mine Operations

3.2.2.1 Mining Method and Equipment

The primary mining method will be mechanized sublevel blasthole open stoping with delayed backfilling; however, other mechanized variations of sublevel stoping and cut-and-fill stoping methods may also be used.

Production blasting will be done at intervals during the week and normally at the end of a shift. Broken ore will be removed from the drawpoints by LHD vehicles and hauled to dump points at steeply dipping ore passes. At rated capacity, three to six stopes will be operating in the mine simultaneously to produce 7,800 tons of ore per day. This will require approximately six LHDs in operation at one time.

Ventilating air will be provided to dilute the exhaust and control emissions as specified by applicable codes. Points where dust may be produced by handling of ore will also receive ventilation to dilute and remove dust and, in certain cases, water sprays or foggers may be used to suppress dust before it reaches the air stream.

Once a stoping block has been completely emptied, it will be backfilled to provide support for the wall rock before the adjacent blocks are mined. This will allow maximum recovery of the economic resource and ensure stability of the rock mass during operation and after abandonment. Further, it will minimize surface storage of process wastes.

The stoping operation does not require personnel to enter the large open stopes at any time. All operations will be conducted in drifts with easily accessible roofs. There, frequent inspections can detect any loose rock. Rock bolts and other means will be used, where required, to improve the strength of mine workings.

On the uppermost mine levels where the ore and country rocks have been somewhat weakened by surficial weathering, mechanized cut-and-fill mining methods will be employed. These methods will involve

removal of horizontal lifts of ore approximately 13-16 feet thick. The void created by each horizontal mining pass will then be backfilled prior to mining the next lift. This approach will limit the span of unsupported stope walls, and thereby will ensure safe working conditions. Less than 10 percent of the orebody will require use of this secondary, but conventional, mining method.

3.2.2.2 Waste Rock

Much of the primary mine development will be done outside the ore zone, thus producing waste rock. The amount of waste rock produced at any given time will vary depending upon the number of headings being advanced in waste versus ore. It is estimated that over the life of the mine 7.1 million tons of waste rock will be produced. Some uncrushed waste rock will be retained in the mine and used as coarse, stope backfill. However, because of the position of the waste-producing headings relative to stopes prepared to take waste rock, about one-half of the waste rock may be crushed and hoisted to surface rather than used directly in the mine as coarse backfill.

Handling of waste rock from the development faces will be similar to that for ore; however, it will pass through separate vertical waste passes to a storage area above the main crusher. A crushing schedule for waste rock will be developed to accommodate the need during a particular period. Waste rock to be hoisted to the surface will be handled in the same manner as ore.

Waste rock that is hoisted to the surface will be diverted to the mine backfill waste rock crushing plant. Here the minus 8-inch rock

will be reduced to approximately 3/4-inch size for regular addition to the mine backfill.

3.2.2.3 Backfill Handling Underground

Mine backfilling will begin with the start of milling operations. The backfill will consist primarily of the coarse fraction of the mill tailings, but will be supplemented with coarse waste rock retained underground, crushed waste rock added on surface, and possibly glacial sands. Backfill slurry containing approximately 70 percent solids will be pumped in two buried high-density polyethylene pipelines from the surface backfill preparation facilities to two mine delivery boreholes located on the south side of the plant area. These boreholes will be cased through the overburden and fitted with 4 to 6-inch diameter distribution pipes. The backfilling operations will normally be conducted 3 shifts per day, 7 days per week.

Fill will be poured into a stope through openings near the top and will be retained at the bottom by bulkheads constructed of either reinforced concrete or timber. Necessary drainage facilities will be placed in the stope before filling commences to collect and carry backfill drainage water from the stope. To enhance ore recovery from secondary stopes, backfill in primary stopes may be strengthened by adding cement.

When the tailings have been classified to remove the fine fraction, a projected deficit of backfill may exist. This deficit will, in part, be made up from coarse waste rock coming from development drifts in the mine, thus eliminating the need to crush then hoist this

fraction of the waste to the surface. Waste hoisted to the surface will be fine crushed and returned to the mine as backfill. Glacial sands may also be periodically required as make-up backfill.

Waste rock from development headings will be within a size range from sand grains to 24 inches. Most will probably be in the range of 6 to 18 inches. When this material is used as stope backfill, it will be placed before or during the placement of hydraulic tailings fill. The hydraulically placed fill will flow into and fill the interstices between the rock fragments.

Cement will be added to the backfill when needed to provide stability so that the column of fill will stand unsupported and enable complete removal of the ore in the adjacent stope. On average, the ratio of cement to backfill material will be about 1:15. Ratios as cement rich as 1:5 may be used in specific situations where higher structural strength is desired, such as in the formation of a floor of fill upon which mobile equipment will subsequently operate. About one-third to one-half of the total fill placed in the mine will contain cement.

As an alternative to making the backfill in a stope self-supporting by adding cement, uncemented fill may be retained by leaving a rib pillar of rock between the fill and the adjacent stope. This pillar would have a minimum thickness of 10 percent of the hanging wall to footwall width of the stope, or 10 feet, whichever is greater. The decision to add cement or to leave a pillar of rock will be based on economics, considering the value of the ore and the cost of cement.

3.2.3 Mill Operations

The concentrator will initially process massive ore to recover the valuable minerals as concentrates of zinc, copper, and lead. The stringer ore will be processed after the depletion of massive ore reserves.

The following subsections provide descriptions of the grinding, classification, flotation, and dewatering processes that will be used to recover the valuable minerals from the ore and to produce backfill for the mine. The mill will be designed to process massive ore. Since stringer ore is easier to process than massive ore, some of the equipment may be removed from the massive circuit when the concentrator is modified to process stringer ore.

In the process of liberation and separation of minerals from the ore, the concentrator will include the following activities:

1) Grinding and classification;
2) Flotation and regrinding;
3) Concentrate handling;
4) Mine backfill preparation;
5) Tailings disposal;
6) Reagent preparation; and
7) Process control.

Varying ore grades will cause the amount of material recovered as concentrates and tailings to vary. The design capacities are expressed only in terms of daily throughput; these quantities were used as the basis for sizing process equipment and operating requirements. The production objective is the average ore throughput expressed on an

annual basis of 2,655,000 tons per year of massive ore or 2,060,000 tons per year of stringer ore which is equivalent to 7,400 tons per day of massive ore or 5,700 tons per day of stringer ore. The concentrator will operate approximately 90 percent of the time with 10 percent downtime for maintenance and thus the average is about 90 percent of the design rate.

3.2.3.1 Ore Transport and Grinding

The ore will be crushed in the primary crusher in the mine to minus 8 inches. Crushed rock will be hoisted from underground and conveyed to the covered coarse ore stockpile. The function of the coarse ore stockpile is to provide surge capacity between the mine and concentrator and to provide a supply of ore to operate the concentrator for those times when the mine is not in production. The live storage capacities of the stockpile will be 16,000 tons for massive ore or about 13,000 tons for stringer ore.

Coarse ore will be reclaimed from the stockpile using feeder belts beneath the piles. These belt feeders will discharge to the main conveyor which will transport ore directly to the semi-autogenous grinding (SAG) mill. A SAG mill is a large horizontal cylinder with heavy steel liners that grinds ore by the tumbling action of both steel grinding balls and the ore.

Fine grinding of the ore will be done in a conventional ball mill. As the mill rotates and the slurry passes through the mill, the impact and abrasion of the balls will reduce the ore size and liberate the minerals.

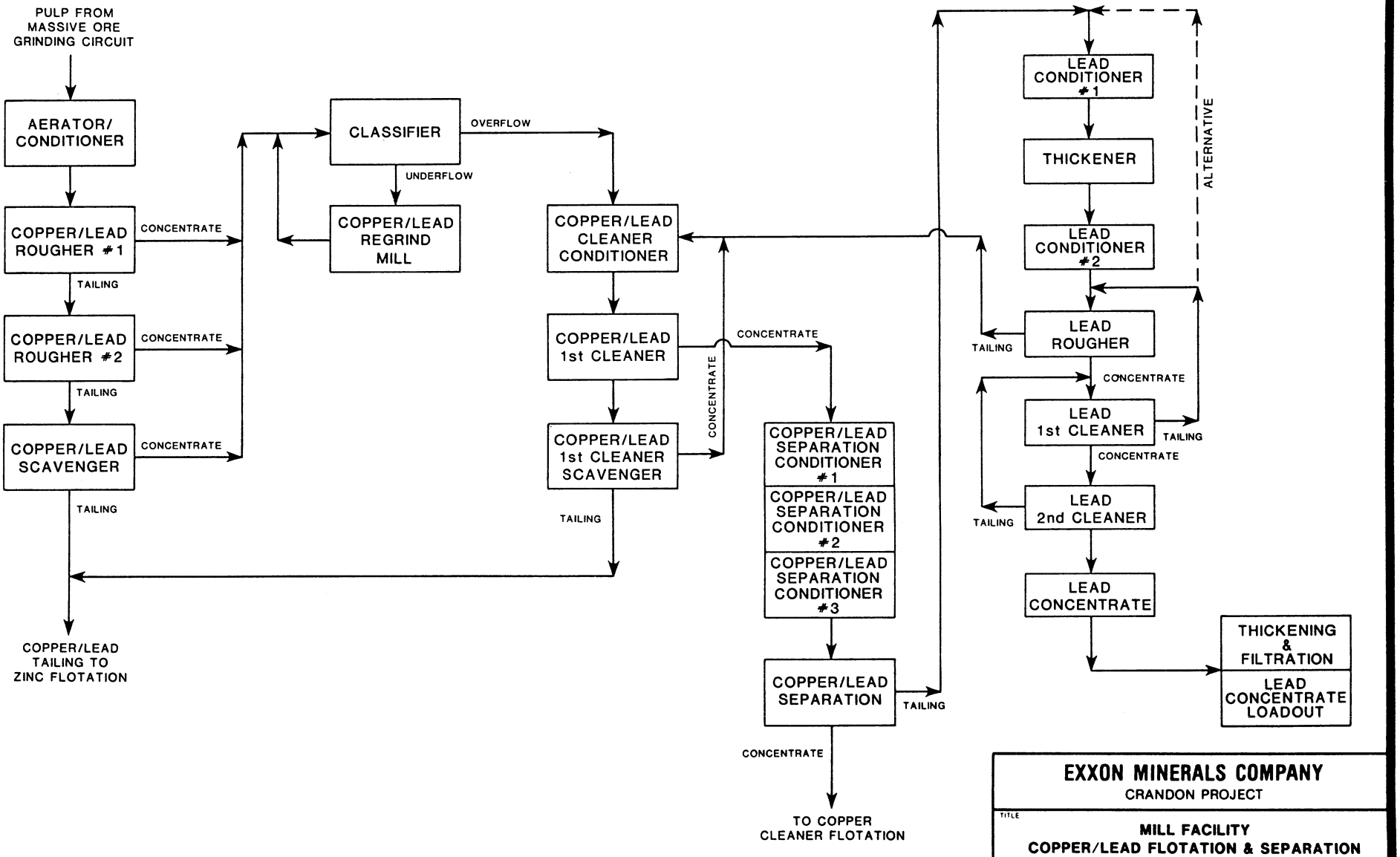
3.2.3.2 Flotation

The sulfide mineral particles will be separated from the ore slurry using a selective flotation process. Selective flotation is the process in which specific sulfide mineral particles adhere to air bubbles, float to the surface of the ore slurry and form a froth which collects on the top of the slurry. The froth is then removed from the slurry.

By the use of various reagents, the mineral may be made to either adhere to an air bubble or to remain in the slurry. The use of these chemical reagents permits the separation and recovery of the zinc, copper, and lead sulfides as separate concentrates from the gangue minerals.

Copper-Lead and Lead Flotation Circuits (Massive Ore) - A schematic flowsheet for copper-lead and lead flotation is shown on Figure 3-3. After grinding, aeration, and conditioning with reagents, the massive ore slurry will be fed into the distributor feeding several banks of flotation machines. This flotation step will produce copper-lead rougher concentrate which requires further processing. The tailings from the copper-lead rougher flotation will pass to a scavenger flotation step in which additional copper and lead minerals will be recovered by flotation. The tailings from the copper-lead scavenger circuit will contain zinc from the massive ore and will be pumped to the zinc circuit.

The copper-lead rougher and scavenger concentrate will be pumped to a regrind circuit containing a tower mill and cyclone classifier. Upon regrinding of the concentrate, the copper minerals



Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
COPPER/LEAD FLOTATION & SEPARATION AND LEAD FLOTATION FLOWSHEET

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
C. ADAMS	8/85		
APPROVED BY	DATE	APPROVED BY	DATE
			12-23-86
APPROVED BY	DATE	EXXON	DATE
			12-23-86

DRAWING NO
FIGURE 3-3
SHEET 1 OF 1
REVISION NO

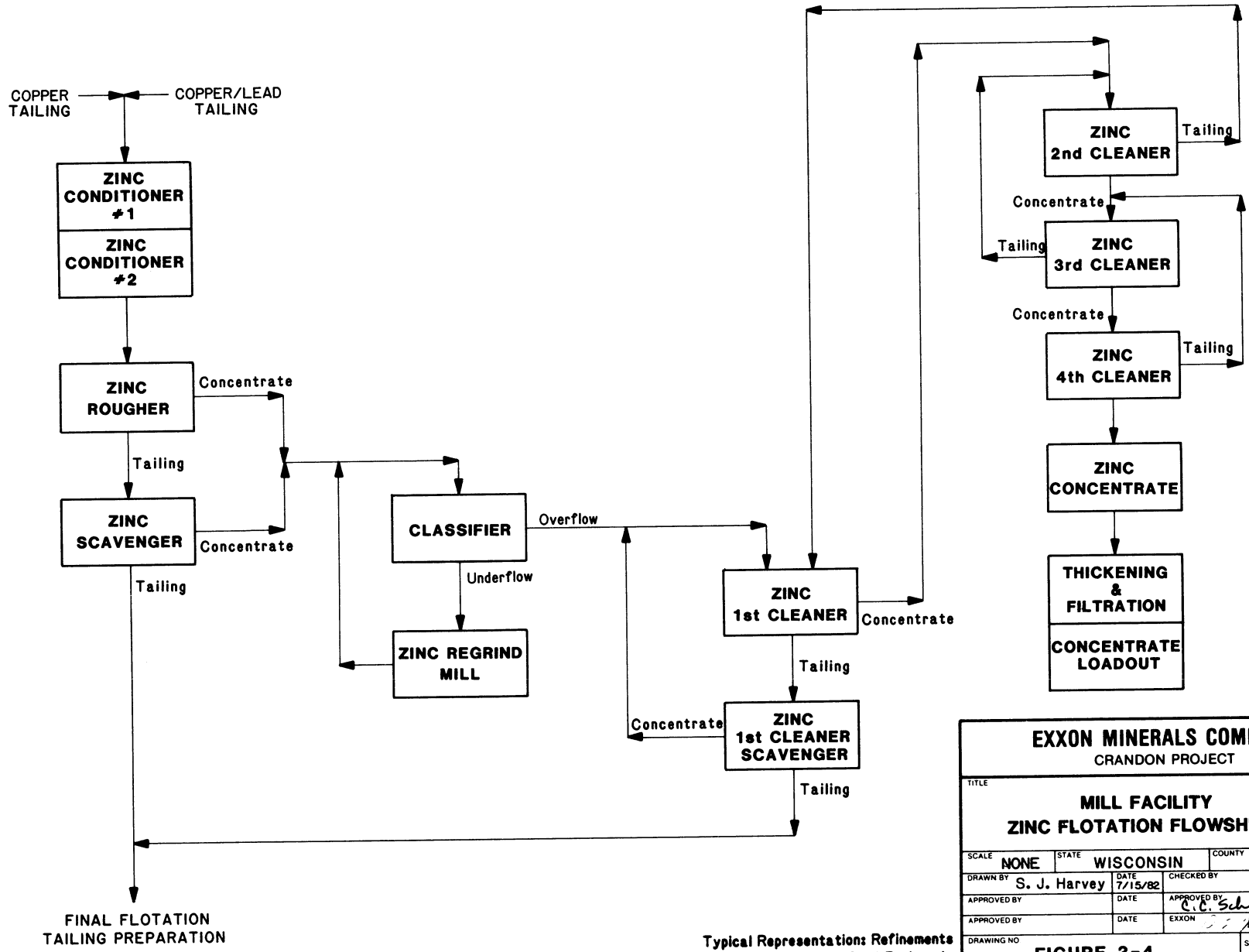
will be separated from the lead minerals by another step of flotation. The copper concentrate will then be pumped to the copper cleaning circuit for two stages of copper cleaning. The lead tailing will then be pumped to a lead circuit to produce a lead concentrate. Stringer ore processing will not produce lead concentrates.

Zinc Flotation - A schematic flowsheet for the zinc circuit is shown on Figure 3-4. The zinc flotation flowsheet will be the same for massive and stringer ores.

3.2.3.3 Concentrate Handling and Transportation

The filtered concentrate will normally be loaded directly into railcars using covered conveyor belts located beneath the filters. When railcars are not available, the conveyor belts beneath the filters can reverse direction and place the concentrate in a temporary storage area beneath the filter area. The temporary storage space will be able to hold about 2 days production of zinc concentrate, 6 days production of copper concentrate, and 19 days production of lead concentrate. These facilities are described in more detail in subsection 2.2.5.

Concentrate will normally be shipped from the Project site in 70 to 100-ton railcars at an estimated rate of 15-20 cars per day. Delivery requirements, empty car availability, and weather will cause variances from normal shipping frequency and in the number of cars per shipment. Loaded railcars will be shipped to North American refining facilities or to port facilities for shipment to overseas destinations.



Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
ZINC FLOTATION FLOWSHEET

SCALE NONE	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY S. J. Harvey	DATE 7/15/82	CHECKED BY		DATE
APPROVED BY	DATE	APPROVED BY C. C. Schroeder		DATE 11/13/85
APPROVED BY	DATE	EXXON		DATE
DRAWING NO. FIGURE 3-4		SHEET OF		REVISION NO. 0

3.2.3.4 Surface Backfill System

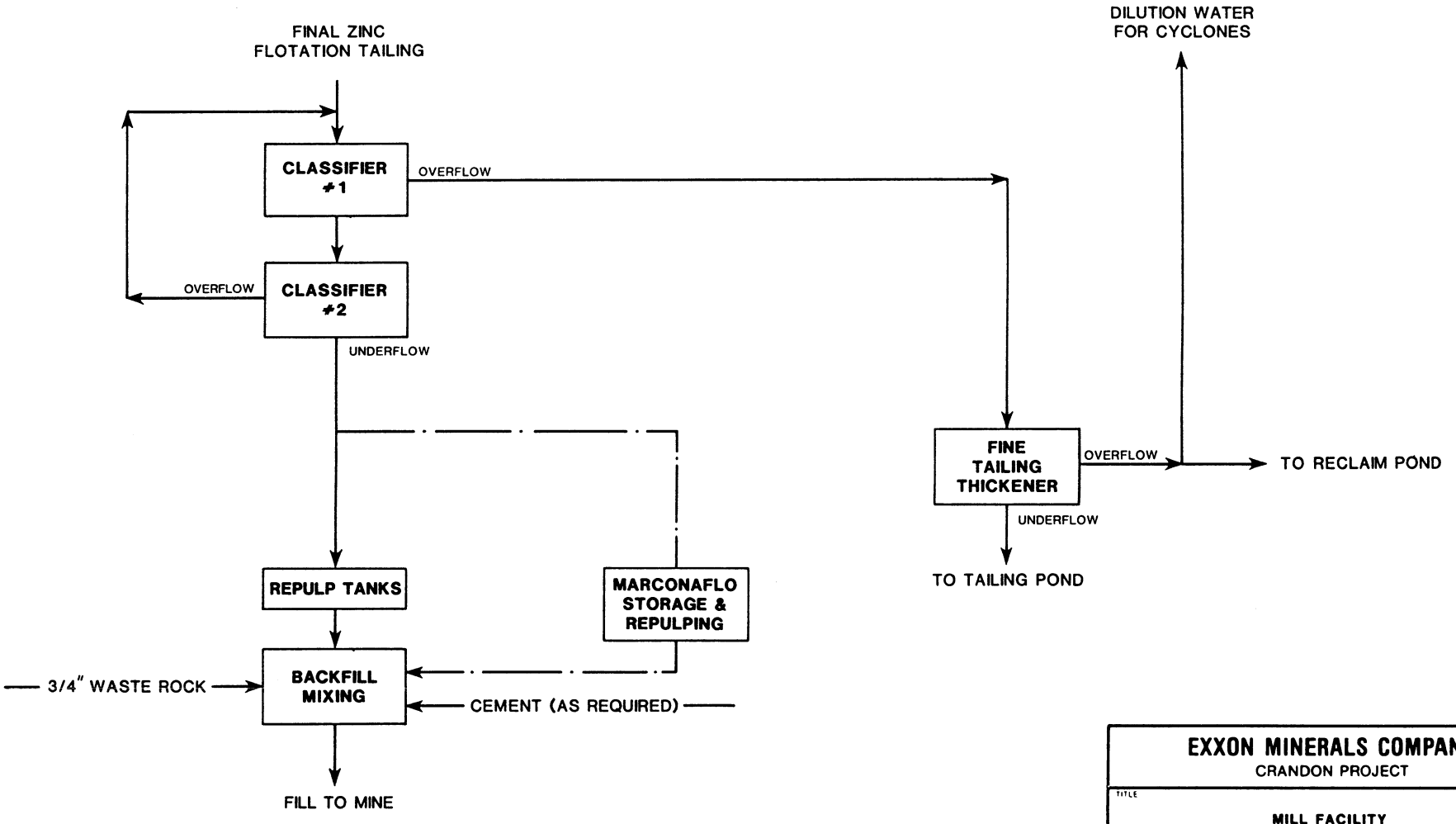
The backfill material to be used is primarily the coarse fraction of the mill tailing. A cyclone classification process will be used to recover the coarse fraction of the mill tailing. The process used for recovering backfill sands from the flotation tailings and the method for storing and handling the sands are shown on Figure 3-5.

The surface backfill system will be in two general locations. The backfill cyclone system will be located in the concentrator building. The cement storage tanks, waste rock crusher, Marconaflo storage tanks, batch mixing tank, and the backfill delivery pumps will be located east of the coarse ore stockpile.

The mine backfill will use all the coarse fractions of the mill tailing. The coarse tailing will be mixed with crushed waste rock and cement, when required, and pumped to the mine as backfill. The fine fraction of the mill tailing may be too fine for general use as mine backfill and if so, will be pumped to the tailing ponds as waste.

The backfill preparation plant will include two sets of pumps and three cyclone clusters to recover the coarse fraction from the mill tailing, storage tanks for the coarse tailings, a cement storage tank with feeder, a waste rock crushing plant, a batch mixing tank, and pumps to deliver the prepared backfill mix to the mine. The backfill preparation area will also include Marconaflo tanks for temporary backfill storage when the mine cannot accept backfill.

Limited surge storage of cycloned tailings sands will be provided in the Marconaflo storage and reclaim system. Two tanks will provide sufficient capacity for the storage of approximately 5 days of mill cycloned tailings sands production. These tanks will be located



Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
BACKFILL FLOWSHEET

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
C. ADAMS	8/85		
APPROVED BY	DATE	APPROVED BY	DATE
			1-23-86
APPROVED BY	DATE	EXXON	DATE

DRAWING NO **FIGURE 3-5** SHEET 1 OF 1 REVISION NO

adjacent to the coarse ore storage pile. The cycloned sands will be pumped from the desliming cyclones directly to a mixing tank or to the Marconaflo storage tanks.

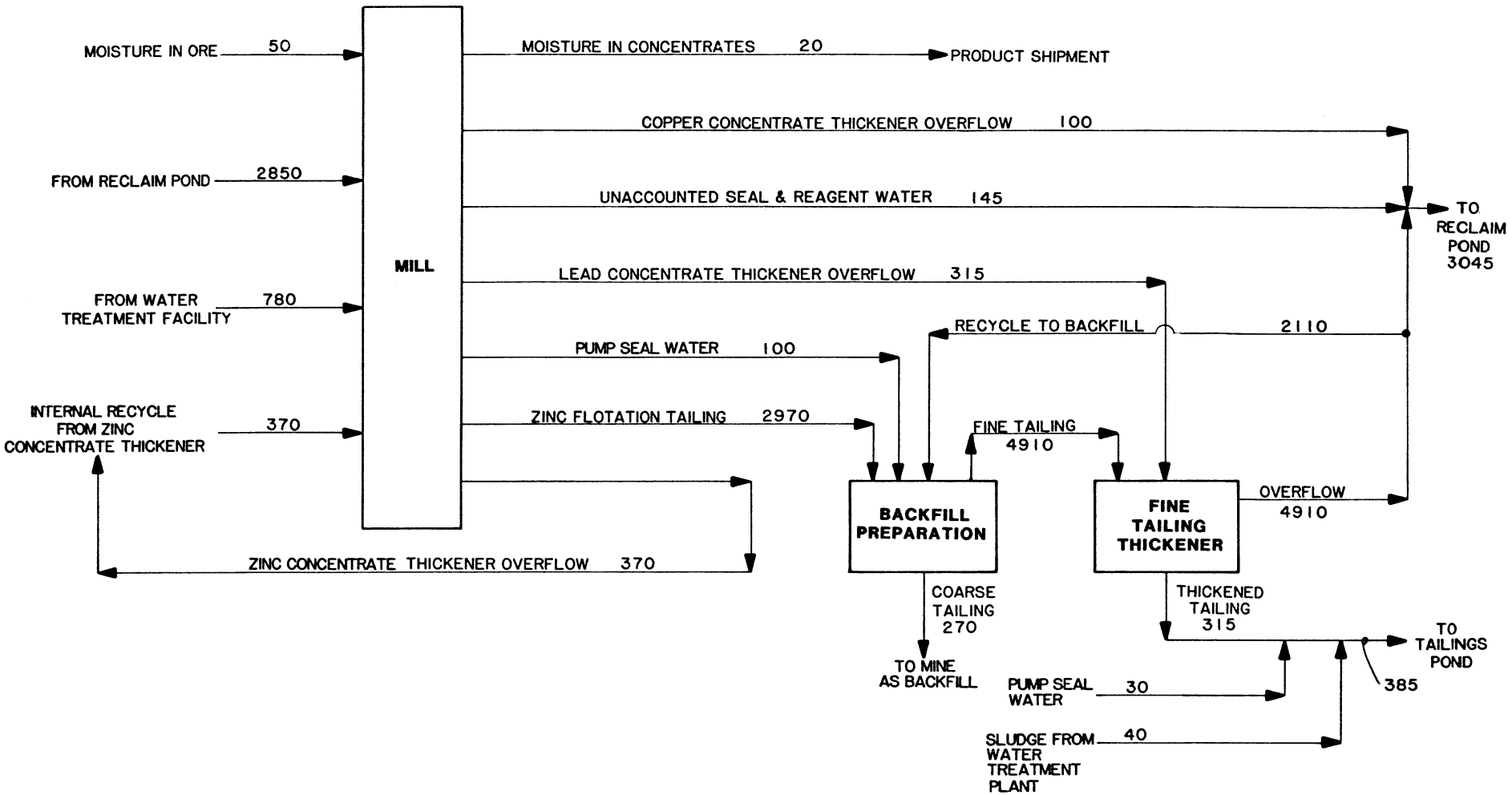
The sands will be reclaimed from the Marconaflo tanks using high pressure rotary jets to wash the material into the center cone. The Marconaflo jet pump will deliver the sand slurry at about 70 percent solids to the batch mixing tank for waste rock and cement addition (when needed). A density controller in the discharge line will maintain the required percent solids.

Cement will be added to the system by injection of the cement slurry directly into the mix tank. The variable speed drive of the rotary feeder at the discharge of the cement bin will be controlled by a mass cement/sands ratio.

High quality backfill mixture is assured by the two desliming cyclones placed in series and the precise density control and sands/cement ratio control which can be achieved with the system proposed.

3.2.3.5 Water Balance

A block flow diagram showing the water balance for the mill and related facilities is presented on Figure 3-6. This balance is based on the average ore throughput of 7,400 tons per day and is not intended to show the water balance for the entire mine and surface facilities. Additional information on the mill water balance is presented in the Water Treatment Facility Engineering Report prepared by CH2M-Hill, 1985.



NOTES:

(1) BALANCE IS BASED ON GALLONS PER MINUTE. FLOWS RECORDED TO THE NEAREST 5 GALLONS PER MINUTE .

(2) PUMP SEAL WATER TO BACKFILL PREPARATION TO TAILING THICKENER UNDERFLOW, AND UNACCOUNTED SEAL & REAGENT WATER ARE ACCOUNTED FOR AS STREAMS THAT EXIT THE MILL.

Typical Representation : Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WATER BALANCE
MILL & RELATED FACILITIES
ALL FLOWS AS GPM

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 12/83	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C. L. Schmidley	DATE 11/13/86
APPROVED BY	DATE	EXXON DE Pl...	DATE 1/...
DRAWING NO **FIGURE 3-6**		SHEET ___ OF ___	REVISION NO 1

3.2.3.6 Reagent Receiving, Storage, and Use

Chemical reagents will be used in the flotation process and in the water treatment processes. The reagent storage and handling areas will be designed to keep reagents segregated and allow for worker safety in transporting bulk reagents and in reagent preparation.

Summary data regarding reagent use are provided in Table 3.3. Figure 3-7 shows the reagent addition points in the process. Reagents received in drums, bags, or small containers, if damaged to the point of not being usable, will be returned to the vendor. Any associated spills would be recovered and also saved for use.

Non-returnable reagent containers, such as bags, may be disposed in the MRDF or in a licensed solid waste facility. Drums are generally returnable and reusable.

3.2.3.7 Spills and Odors

Occasionally, spills can occur in the grinding and concentration process areas. To avoid circuit contamination, spills in the grinding and flotation areas will be collected in floor sumps and pumped to an appropriate point in the process circuit to prevent contamination as well as the loss of valuable mineral. The concentrate storage and loadout area will be designed such that concentrates will be segregated from each other.

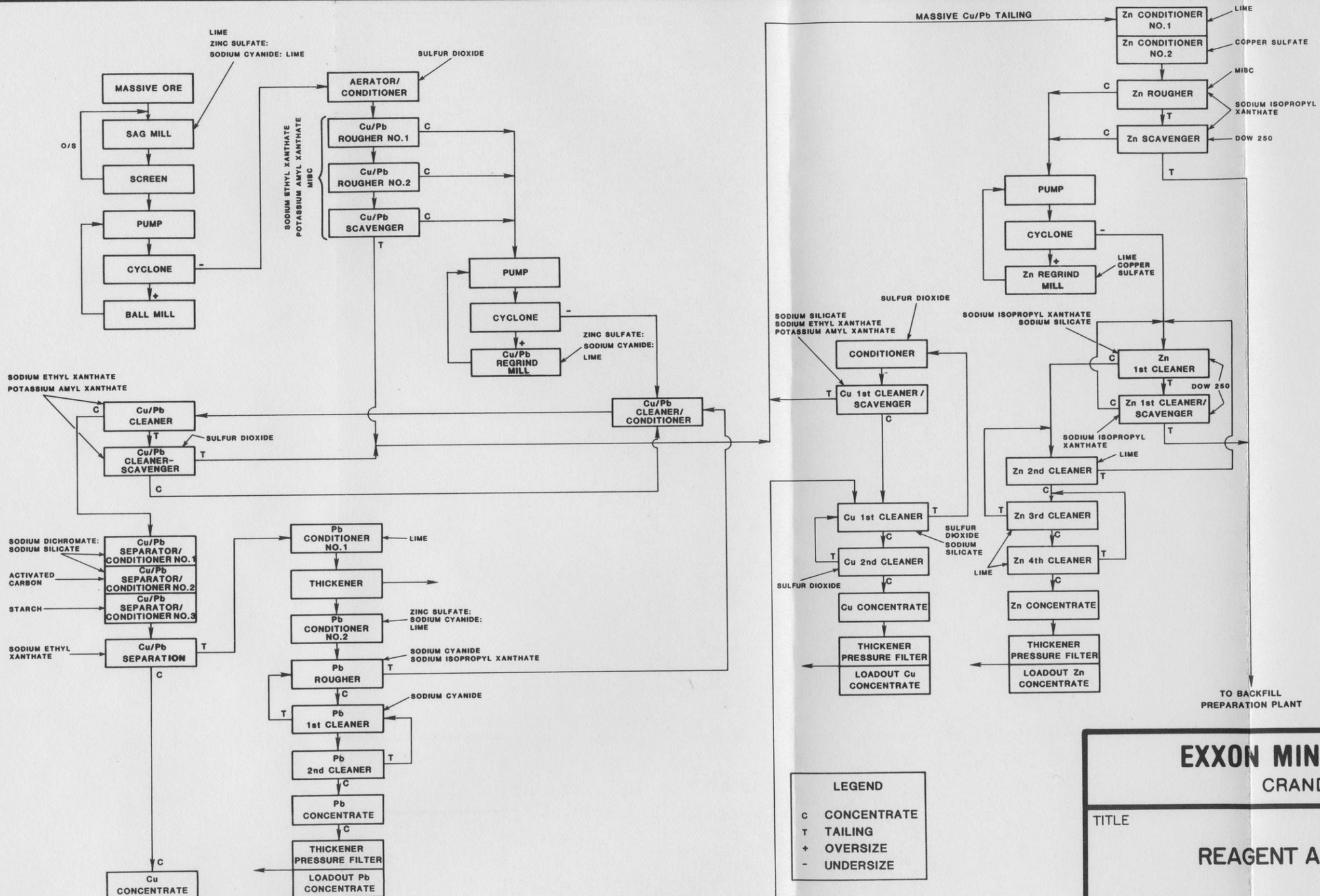
Any spills in the reagent storage and preparation area will be recovered in such a manner that they can still be used as intended. The bulk storage facilities outside the mill building are designed to contain any spills as well as the total contents of a bulk tank should a

TABLE 3.3

TYPICAL REAGENT USE AND CONSUMPTION RATE*

REAGENT	PRIMARY USE	ESTIMATED MONTHLY CONSUMPTION (TONS)
Sulfur Dioxide (SO_2)	Depressant	50
Copper Sulfate ($CuSO_4 \cdot 5H_2O$)	Activator	80
Sodium Cyanide (NaCN)	Depressant	7.2
Polypropylene Glycol Methyl Ether (Dowfroth 250)	Frother	2.0
Sodium Sulfide ($Na_2S \cdot 9H_2O$)	Activator & Precipitant	2.5
Xanthates	Collectors	18
Zinc Sulfate ($ZnSO_4 \cdot 7H_2O$)	Depressant	24
Starch	Depressant	11
Sodium Dichromate ($Na_2Cr_2O_7$)	Depressant	16
Sodium Silicate (Na_2SiO_3)	Dispersant	46
Activated Carbon	Absorbent	25
Methyl Isobutyl Carbinol (MIBC)	Frother	8
Lime (CaO)	pH Modifier	441
Flocculant (Type not chosen yet)	Flocculant	--
Caustic Soda (NaOH)	Preparation of Sodium Cyanide	0.12
Soda Ash (Na_2CO_3)	Water Treatment and pH Modifier	265
Sulfuric Acid	Water Treatment	39
Ferric Sulfate $Fe_2(SO_4)_3$	Water Treatment	7.5

*While this list is representative, it is only intended to show the reagent type, primary use and estimated monthly consumption for the major reagents required for Project operations. The actual use and consumption of reagents could change depending upon final operating conditions.



LEGEND

- C CONCENTRATE
- T TAILING
- \+ OVERSIZE
- \- UNDERSIZE

TYPICAL REPRESENTATIONS REFINEMENTS MAY BE MADE DURING FINAL ENGINEERING

EXXON MINERALS COMPANY

CRANDON PROJECT

TITLE

REAGENT ADDITION POINTS

SCALE NONE	STATE WISCONSIN		COUNTY FOREST
DRAWN BY B.W. MEDLIN	DATE 07/16/85	CHECKED BY	DATE
REVISION TYPE GENERAL	DATE 07/16/85	APPROVED BY M.JENNINGS	DATE 07/10/85
APPROVED BY	DATE	EXXON C.C. Schroeder	DATE 12/9/85
DRAWING NUMBER FIGURE 3-7		SHEET 1 OF 1	REVISION NUMBER 2

rupture occur. Any spills that occur in the reagent mixing area will be totally contained in blind sumps and be pumped back into the respective mixing tank. There should be no intentional disposal of reagents from the Project.

Some noticeable odors will occur in the reagent mixing area when xanthates are mixed. These odors will dissipate rapidly and will not be discharged by the buildings ventilation system in detectable amounts to the atmosphere.

Liquid sulfur dioxide will be metered directly from the bulk storage tanks to the various addition points. Once added to the ore slurries, sulfur dioxide will dissolve rapidly to form a weak solution of sulfurous acid and will not be emitted to the atmosphere as gaseous sulfur dioxide.

No process conditions will occur that are conducive to the production of hydrogen sulfide. Sodium sulfide will be added to the primary grinding circuit for stringer ore. This is used to precipitate any soluble metals, particularly copper, in the stringer ore slurry. Since this reagent is expensive, its use will be closely controlled to avoid excess use. Assuming 8.8 ounces of sodium sulfide are added per ton of stringer ore and the pH of the ground ore slurry is 10.3, the theoretical concentration of hydrogen sulfide in air just over the slurry would be less than 1 ppm. This is based on the assumption that 5 percent of the added sulfide exists as unreacted sulfide in the ore slurry and that all excess hydrogen sulfide reaches the air. Any hydrogen sulfide formed will react with soluble metals to form an insoluble metal sulfide. Hydrogen sulfide will also react with

polythionates in the recycle process water to form thiosulfate according to the following reaction:

$$2H_2S + 4S_4O_6^{=} + 3H_2O \text{ -----> } 9S_2O_3^{=} + 10H^{+}$$

Because these mechanisms prevent hydrogen sulfide from being emitted, hydrogen sulfide generation has not been identified as a problem in massive sulfide concentrators.

3.2.3.8 Lubrication

Lubricants for the mechanical equipment will include greases and oils as specified by the equipment manufacturers. Waste oil and grease that is collected will be retained in drums or holding tanks and returned to the supplier or jobber for reprocessing or disposal.

3.3 Mine Waste Disposal Operations

3.3.1 Waste Rock Disposal

Waste rock will be produced during the development and operation of the Project as described in subsection 2.3.1. Prior to installation of permanent rock handling facilities in the mine/mill area, rock will be brought to the surface and hauled by truck from the headframe area to the preproduction ore storage area, a one-way haul distance of approximately 0.5 mile.

3.3.2 Tailing Slurry and Water Transport Systems

The systems for transferring the tailing slurry to the disposal area and the reclaim water to and from the reclaim pond will consist of pumps and pipelines. The routing of the tailing and water lines and the waste rock haul road share the same corridor as discussed in subsection 2.3.3.

All pumps will be located either at the tailing thickener area in the mine/mill site or at the reclaim pond area. The only operations required for the system, except normal pump operations, will be routine inspection and maintenance, and the monitoring of system performance. The monitoring system will consist of pressure and flow rate checks throughout the system for operation control, and for warning and/or shutdown in the event of pipe rupture or other system failure.

In addition to the monitoring system, the pipeline corridor will be visually inspected periodically. Physical inspection of pipe materials will be conducted at the pump station during scheduled maintenance. Physical measurements of pipe wall thickness will be

completed routinely. If necessary, flanged pipe test spools will be inserted into the pipelines at selected intervals and in easily accessible locations.

In the event of a pipeline breakage, flowrate monitoring equipment would warn the operator to shutdown the pipeline system. Such an event could be cause for a complete plant shutdown. For the case of a pipeline break at the lowest elevation in the pipeline route, the contents of the pipe would drain to the low point. The contents of about 2100 feet length of line would leak from the pipeline. This is equal to a volume approximately of 5300 gallons of slurry. Because of the low elevation heads, the rate of leakage would be low and little solid material would escape.

3.3.3 Mine Waste Disposal Facility

Operation of the MWDF will include the deposition of tailing in the ponds, maintenance of the equipment associated with the tailing transport system, and the water recovery from the tailing ponds. A detailed description of the mine waste disposal ponds is presented in the MWDF Feasibility Report.

Pond Sequencing - The MWDF will consist of four ponds constructed, operated, and reclaimed in the sequence. Except for short periods of time when an operating pond is nearly filled with tailing and the next pond is prepared and ready to accept tailings, only one tailing pond will be in operation at any time.

Tailing Discharge - At full production approximately 3,000 tons per day of tailing will be disposed at the MWDF. Tailing will be

transported to the MWDF in a water based slurry at approximately 55 percent solids by weight. Slurry flow will be at an approximate rate of 555 gallons per minute. The tailing slurry will be deposited from one side of an operating pond. Protective rock will be provided at the end of the discharge pipe to protect the embankment face at the discharge point. Regular inspection and maintenance of the protective waste rock will ensure that erosion of the underlying layers does not occur. As each pond fills with tailings, the discharge points will be moved to optimize storage within the facility. The tailings will establish a beach in the ponds as they deposit with an approximate 0.5 percent slope. At the downstream end of the slope, water will pool and cover approximately 20 percent of the pond area. At the pond edge, the tailings slope will increase and water could pond to a depth of 20 feet.

The development of the pond water pool is dependent on the permeability of the exposed filter area on the embankment slope and the rate of decant pumping. The estimated pond water depth of 20 feet is consistent with the permeabilities anticipated and the decant water pumping rates planned.

Decant and Seepage Control Systems - Water will enter the tailing ponds with the tailing slurry and as rain and snow throughout the year. Water will be lost from the ponds as evaporation and seepage, and removed from the ponds through the underdrain system and by decant from the ponded surface water. A portion of the water will be retained in the ponds with the tailing.

The decant water system and the seepage control system are illustrated in Section 2.0 on Figures 2-19 and 2-20. Pumps in the underdrain system will operate as necessary to remove water seeping from the tailing. The barge mounted decant pumps will be operated at a rate to maintain a water depth of approximately 20 feet in the ponded water area. At the crest of the pond the two streams will be joined for transfer to the reclaim water pond cell B. Except for the trucks and other equipment associated with the construction of the various phases of the entire MWDF, the pumps in the decant and underdrain system represent the only operating equipment at the MWDF.

Operation of the seepage control system will be maintained during Project shutdowns. While the volume rate of underdrain pumping is not great, removal of water entering the underdrain is important to minimize the water head on the liner. This assures that seepage through the liner will be minimized. These flows will normally be pumped to the water reclaim pond. Water treatment and discharge facilities will be operated during plant shutdowns to handle mine inflow. In the event that the volume of water in the reclaim pond must be reduced and the mill is not operating, the water treatment plant could treat and discharge this water as well. However, there is excess capacity in the reclaim pond system for storage of additional water should it be necessary. Also, it would be possible to recirculate underdrain water within the tailing pond. This would increase the tailing pond water volume slightly, and increase the total water pumped from the underdrain, but would maintain the minimal tailing pond seepage rates.

3.3.4 Water Treatment

3.3.4.1 Water Reclaim System

An important feature of the Project will be the recycle of water for ore processing. The use of a reclaim water pond will ensure the ability to successfully recycle water to the mill. The primary functions of the reclaim pond are as follows:

1) Provide water surge capacity for all process-related surface facilities;

2) Allow sufficient residence time for settling of fine particulate matter;

3) Allow sufficient residence time for natural evaporation, oxidation, and biological processes to occur and thereby control the concentrations of certain chemical constituents in the water to be recycled to the mill.

The volume of the reclaim pond and tailing ponds will provide surge capacity for the water management system. It will ensure that temporary interruptions of service of any of the components in the system will not cause a complete shutdown of the mine or mill. The total operating volume of both cells of the reclaim pond is 174 million gallons. The total flow to the ponds including net precipitation is estimated to be 3,455 gallons per minute for a calculated residence time of about 35 days.

The two cells in the pond system are designated cell A and cell B. Each cell will have a depth of 33 feet. The maximum operating level in each pond will not exceed 21 feet. The normal volume in the pond will fluctuate depending on water requirements in the mill, volume of water being recovered from the tailing pond, and precipitation.

The reclaim pond system is designed as a two-celled system and shutdown of one of the cells is not planned nor anticipated. However, if a shutdown became necessary, a change in operating procedures would be required. If concentrator throughput were to be maintained, the retention time would be reduced which should not cause any problems for the length of time that the one cell is out of service.

The two largest streams that flow to the reclaim pond will contain small amounts of particulate matter. These are estimated as follows:

	Suspended Solids
Tailing Thickener Overflow	100 to 1000 mg/l
Decant and Underdrain Water from Tailing Pond	Trace to 100 mg/l

The amount of solids estimated to accumulate in the reclaim pond over the life of the Project has been conservatively estimated to be 140,000 cubic yards. This estimate is based on the volume of water expected to flow through the pond with an average suspended solids concentration of 415 ppm and a settled solids density of 50 percent solids by weight. This volume of sludge can be held in the reclaim pond system without affecting the operation of the pond.

Further discussion on the reclaim pond sludge can be found in subsection 2.3.6.

3.3.4.2 Water Treatment System

A system will be necessary to treat water pumped from the mine and to treat a sufficient amount of water from the reclaim pond to control gypsum scaling in the mill. Approximately 80 percent of the

contaminated mine water will be treated for discharge to Swamp Creek and the remaining 20 percent will be combined with a portion of the water from the reclaim pond and treated for recycle to the mill.

The proposed water treatment system will be designed and operated to:

1) Produce an effluent that will meet all applicable state and federal regulations;

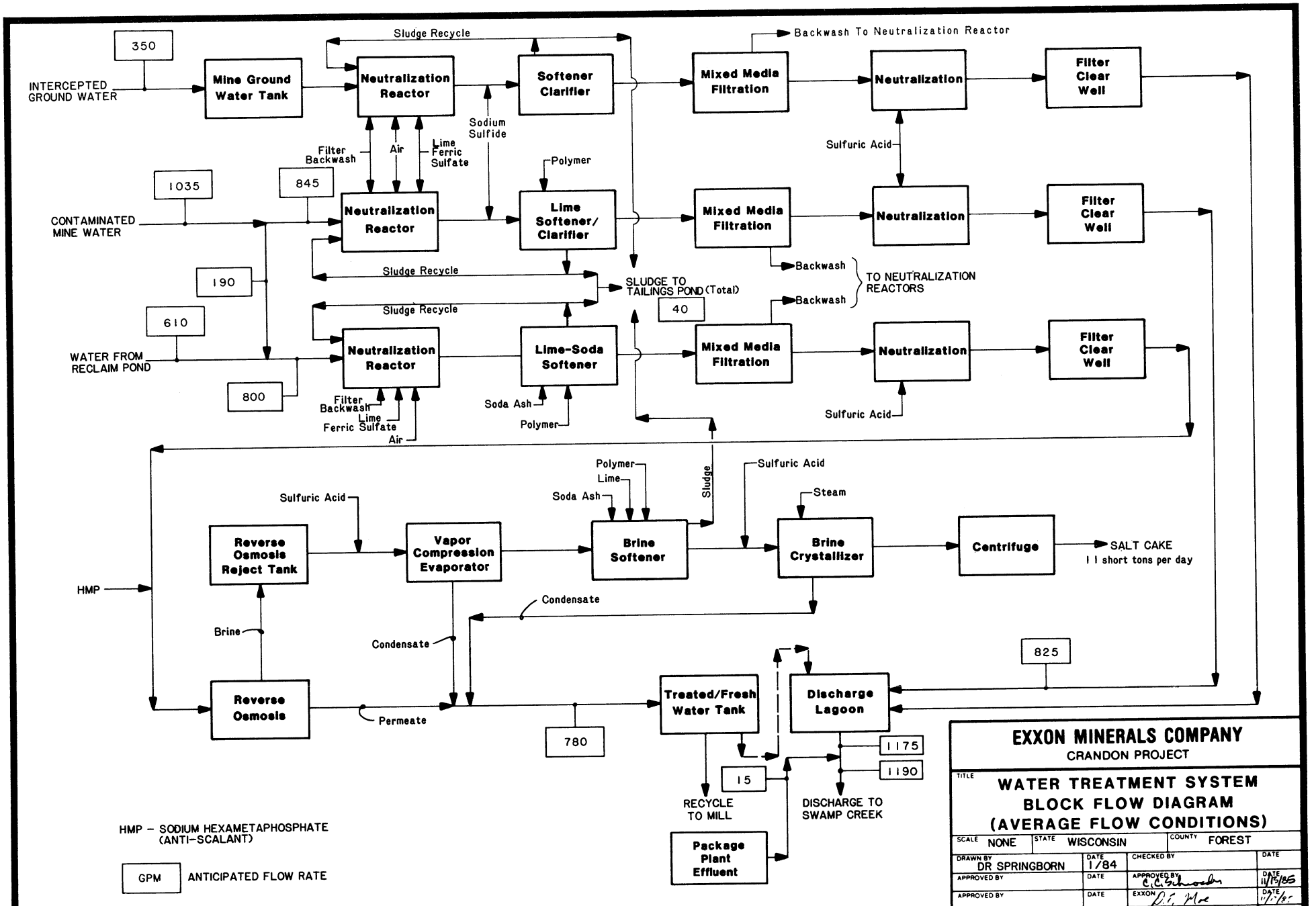
2) Provide removal of scale-forming compounds to permit recycle water use in the mill;

3) Be flexible with respect to influent water quality; and

4) Be operable during construction and mine development.

Water treatment will consist of three systems: one for treating contaminated mine water for discharge, one for treating intercepted ground water for discharge, and the third for treating a combination of mine water and reclaim pond water for recycle to the mill. Lime precipitation, sulfide precipitation and filtration will be used to treat contaminated mine water for discharge. Lime neutralization, sulfide precipitation and filtration will be used as needed to treat intercepted ground water for discharge. The treatment of water for recycle will employ lime/soda ash softening, filtration, reverse osmosis and vapor compression evaporation.

Block flow diagrams of the three treatment systems are shown on Figure 3-8. The equipment needed for lime precipitation, sulfide precipitation and filtration is the same as is needed for either lime neutralization, sulfide precipitation and filtration or as is needed for lime/soda softening/filtration. This implies that any of the three circuits can be used to treat water by lime precipitation, sulfide



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WATER TREATMENT SYSTEM BLOCK FLOW DIAGRAM (AVERAGE FLOW CONDITIONS)

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 1/84	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/15/85
APPROVED BY	DATE	EXXON D.T. Moe	DATE 11/19/85
DRAWING NO **FIGURE 3-8**		SHEET ___ OF ___	REVISION NO 2

precipitation and filtration. Therefore, the water plant will have the flexibility to handle a scenario in which no ground water interception is undertaken in the mine.

Treatment will be required for a total of 1,995 gallons per minute of water for discharge and recycle under average conditions. Based on the expected rate of mine inflow of 1,270 gallons per minute, influent flows to the water treatment systems during the normal mode of operation will include the following:

Source	Average Flow Rate (Gallons Per Minute) i.e.,
Contaminated Water Pumped From Mine	
Mine Seepage	770
Backfill Drainage	160
Utility Water	150
Excess Potable Water	5
Less Moisture in Ore	(-) 50
Subtotal	1,035
Reclaim Pond Water	610
Intercepted Ground Water	350
Total to Treatment	1,995*

*Of this quantity: 1,175 gpm is discharged to Swamp Creek; 780 gpm is recycled into the mill; and 40 gpm is recycled to the tailings.

In the event of a short-term shutdown of the contaminated water treatment system, that portion of the mine water that cannot be treated will be pumped to the reclaim pond. This will be accomplished by simply allowing the flow from the contaminated mine water tank to go to the tailing thickener overflow sump for transfer to the reclaim pond. Alternatively, that portion of the treatment plant that treats recycle

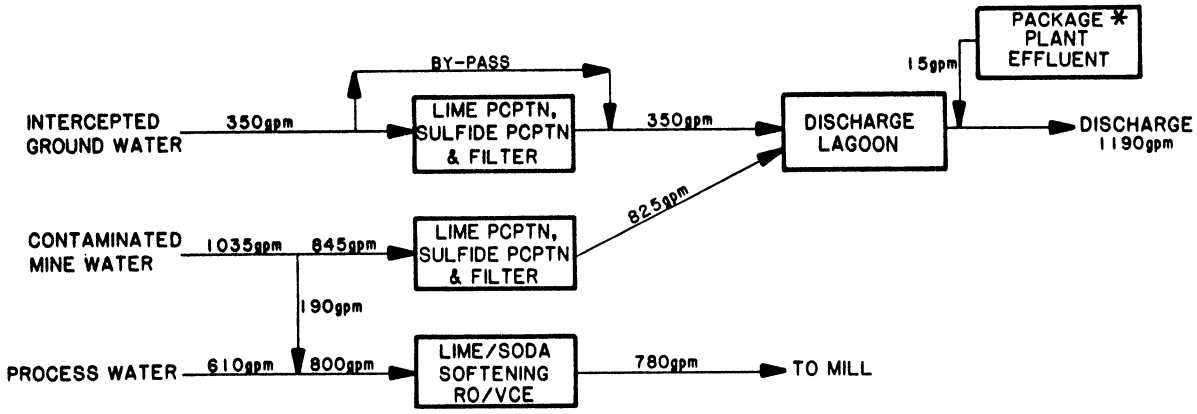
water could be operated as a lime treatment plant and used to treat mine water for discharge and treatment of water for recycle would cease temporarily.

Treated mine water and treated ground water will be sent to the discharge lagoons to be located immediately east of the tailing thickener. Discharge from the lagoons will be pumped via pipeline to the discharge point at Swamp Creek.

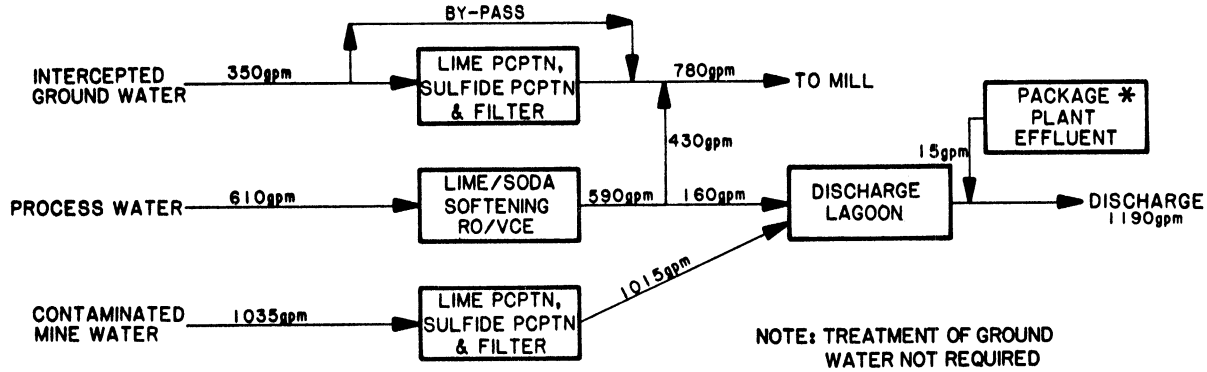
The normal mode of operation is shown on Figure 3-9 as the "Base Case." Also shown on this figure are two operating alternatives.

Alternative A depicts a mode of operation whereby process water treated by lime/soda softening, reverse osmosis and vapor compression evaporation is discharged with treated contaminated mine water. Alternative B shows a mode of operation whereby the mill make-up water is a mixture of intercepted ground water and treated reclaim water. These modes of operation demonstrate the flexibility that will be designed into the system.

In the unlikely event that the water treatment plant had to be completely shutdown and neither the contaminated nor intercepted ground water could be discharged without treatment, both mine waters could be pumped to the reclaim pond for 26 days before 75 percent of the total available freeboard volume in the reclaim ponds is used up. This would still leave freeboard for the 100-year, 24-hour storm and allowance for wave run-up, and continued operation of the mill at its normal capacity.

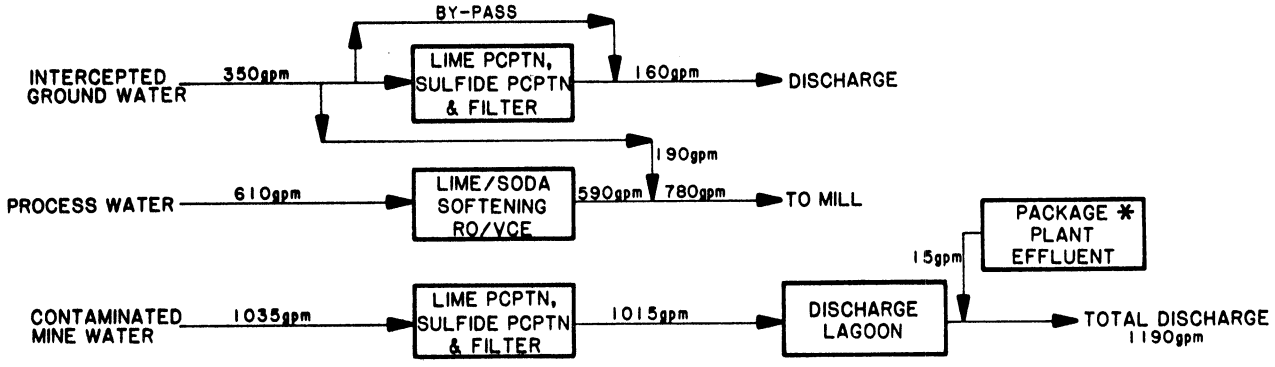


BASE CASE



NOTE: TREATMENT OF GROUND WATER NOT REQUIRED WHEN USED IN MILL.

OPERATING ALTERNATIVE A



OPERATING ALTERNATIVE B

*= SANITARY WASTE TREATMENT PLANT

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WATER MANAGEMENT & TREATMENT OPERATING ALTERNATIVES (AVERAGE FLOW CONDITIONS)

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	8/85		
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/19/85
APPROVED BY	DATE	EXXON D.F. Mac	DATE 11/21/85

DRAWING NO **FIGURE 3-9** SHEET ___ OF ___ REVISION NO

3.3.4.3 Treated Water Reuse and Disposal

Water that will be treated by the lime/soda softening, reverse osmosis, and vapor compression evaporation processes will be pumped to the mill treated/fresh water tank. This tank will provide water for the various cooling systems for the grinding mills, pump gland seal water, water for reagent preparation, and water for recycle to the mill process via the mill water tank. When the mill is not operating, there will be no need for recycled process water. If this portion of the water treatment plant is operating and the mill is not operating, this water will be discharged along with the treated mine water. This would occur if the volume in the reclaim pond had to be reduced due to an accumulation of precipitation or because mine water had to be previously pumped to the reclaim pond.

Treated mine water will be sent to the excess discharge lagoons and then pumped via pipeline to the discharge point adjacent to Swamp Creek.

Treatment systems will be provided with on-line instrumentation to measure and monitor effluent pH, conductivity, and turbidity. In addition, a composite sample of each treated water and final discharge from the lagoon system will be collected and analyzed in accordance with the WPDES Permit and Monitoring Plan for the facilities. The concentrations of contaminants in the water to be discharged will meet the effluent limitations to be determined by the DNR.

3.3.4.4 Water Treatment Wastes

Two waste materials will be produced in the water treatment processes. One material will be the combined waste from lime/ sulfide precipitation of the contaminated mine water and ground water and lime/soda ash softening of the process recycle water. The other waste product will be the ultimate result of the reverse osmosis, vapor compression evaporation, and crystallization processes.

The combined waste from the lime/sulfide precipitation and lime/soda ash softening steps will consist primarily of calcium carbonate and silt from suspended solids in mine water and is expected to contain less than 10 percent of other metal hydroxides, primarily zinc and iron. Other minor constituents including metal sulfide precipitates will amount to less than 0.2 percent. The projected amount of solids in the total sludge from these two unit operations will be about 17 tons per day, dry basis. This waste will be sent to the mill tailing thickener underflow sump and then disposed in the MWDF along with the mill tailings. The advantage of disposing this waste with the tailing is its acid neutralizing capacity.

The water treatment plant is scheduled for completion during month 17 of construction. However, due to the low projected mine inflow during months 18 through 30, it is expected that all of the mine drainage for this period can be contained in the reclaim pond. The water treatment facility will be test operated to ensure that it will perform as designed, but it is expected that water will not have to be routinely treated for discharge during this period. The sludge, which will be produced from either water treatment plant shake-down testing or treatment of water for discharge, will be stored in cell A of the

reclaim pond. This sludge will be small in volume and will have essentially the same composition as that produced by pH adjustment between cells B and A in the reclaim pond. No separate sludge containment area within the reclaim pond is planned.

The other waste material will result from the crystallization of the brine from the vapor compression evaporator. This waste will consist primarily of anhydrous sodium sulfate (commercially known as salt cake). This material could potentially be marketed for use in kraft pulp and paper mills.

Until the marketability of this material can be definitely determined, it will be stored in a separate isolated area in tailing pond T1.

One other small waste stream will be produced in the water treatment plant. This will be the cleaning solution used to periodically clean the reverse osmosis membranes to remove any accumulations of scale and to retard bacterial growth on the membranes. Up to 980 gallons of cleaning solution will be used each month. Three different cleaning solutions will be used on a rotating 3-month basis, i.e., one solution would be used when cleaning during the first month of a cycle, the second solution in the second month, and the third solution in the third month of the cycle. Ingredients to be used in each cleaning solution are as follows:

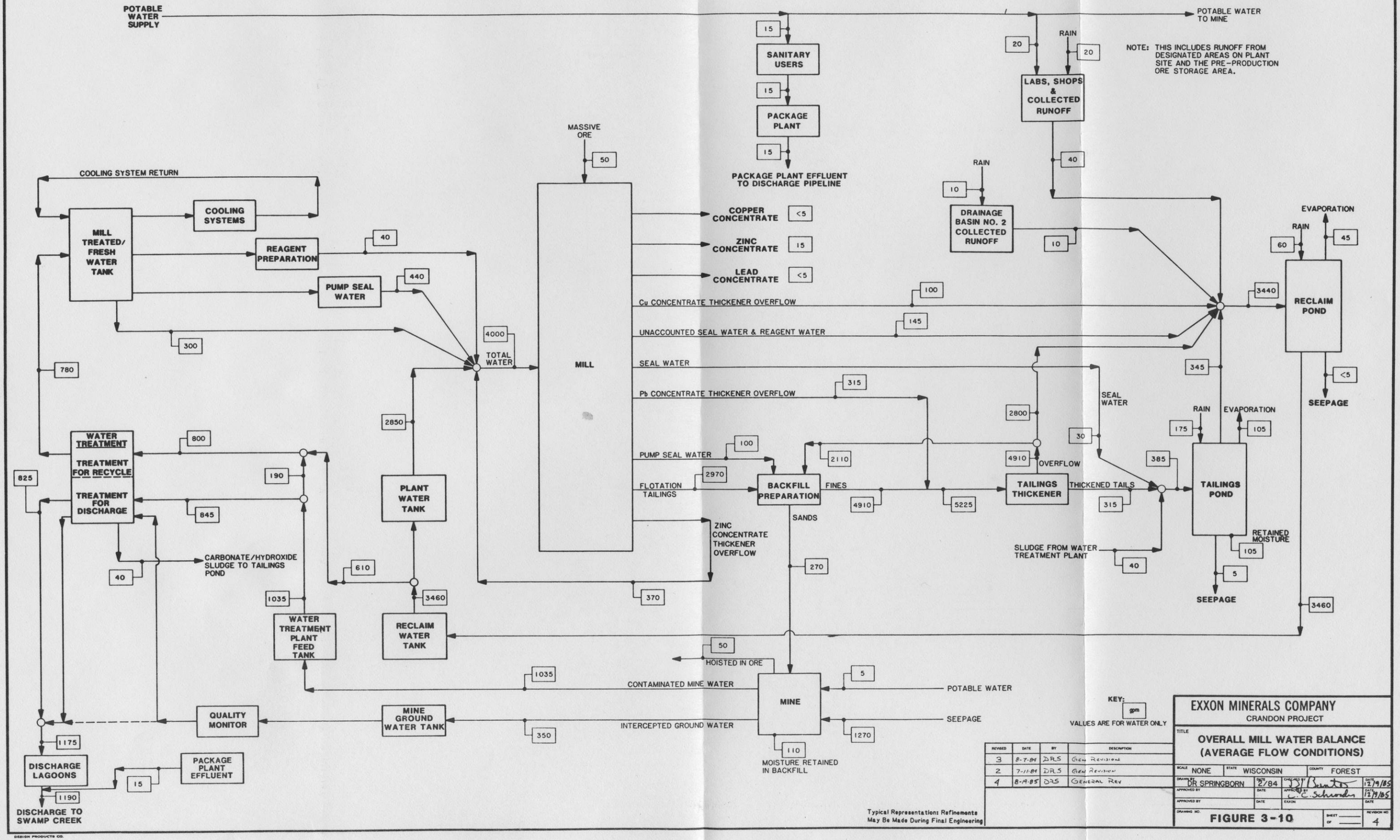
Cycle Month	Ingredient
1	Citric Acid Liquid Nonionic Detergent Ammonium Hydroxide
2	Sodium Tripolyphosphate Sodium - EDTA Liquid Nonionic Detergent Sulfuric Acid
3	Liquid Nonionic Detergent Sodium Perborate Sulfuric Acid

Spent cleaning solution will be metered into the tailing thickener underflow sump at a rate of about 125 gallons per day. The ingredients in the cleaning solution will be degraded by their action in cleaning the membranes.

3.3.4.5 Overall Water Balance

A water balance for mill operations is shown on Figure 3-10. The projected flow rates shown were based on metallurgical testing and engineering completed to date. The flows shown are for the average ore treatment capacity of 7,400 tons per day and the expected mine inflow of 1,270 gallons per minute. For the purpose of developing this balance, it was assumed that two tailing ponds were in use, i.e., one has just been filled and reclamation started, and another is receiving mill tailings.

The volume of water to be discharged to Swamp Creek will include up to 825 gallons per minute of mine water treated by lime



REVISED	DATE	BY	DESCRIPTION
3	8-7-84	DRS	GEN REVISION
2	7-11-84	DRS	GEN REVISION
4	8-19-85	DRS	GENERAL REV

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EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
OVERALL MILL WATER BALANCE
(AVERAGE FLOW CONDITIONS)

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	2/84	D.J. Bernatos	12/9/85
APPROVED BY	DATE	APPROVED BY	DATE
		C.C. Schroeder	12/9/85
APPROVED BY	DATE	EXXON	DATE
DRAWING NO.		SHEET OF	REVISION NO.

FIGURE 3-10

4

DESIGN PRODUCTS CO.

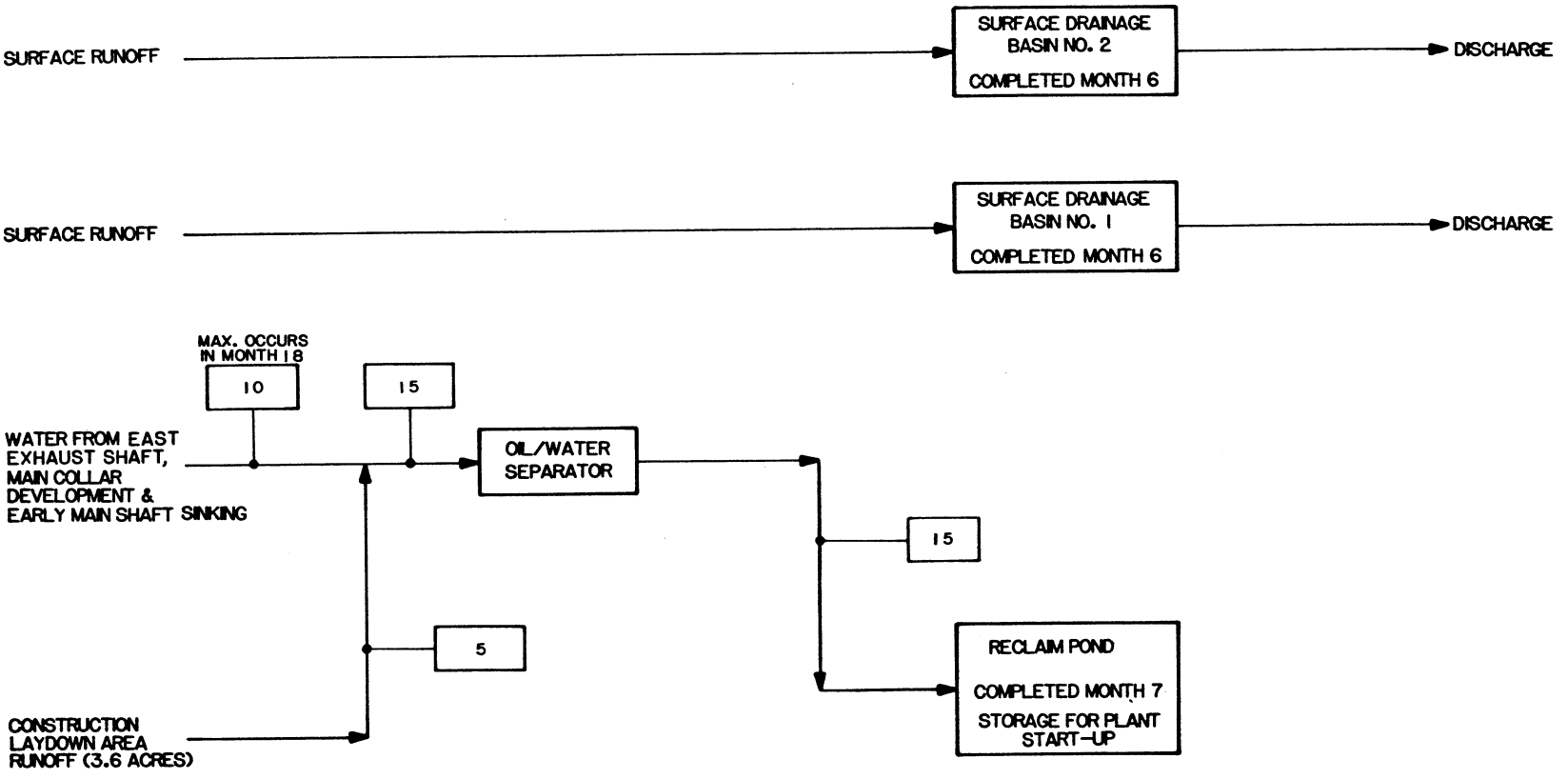
precipitation/sulfide precipitation/filtration and up to 350 gallons per minute of intercepted ground water recovered via the ground water interceptor system and treated, as required, by lime neutralization/sulfide precipitation/filtration. Also 15 gallons per minute of sanitary waste treatment plant effluent will be combined with the effluent from the discharge lagoons. This gives a total discharge of 1,190 gallons per minute.

The maximum amount of water to be discharged from the Project has been estimated as follows:

Source	Assumed Maximum Volume Flow Rates (Gallons Per Minute)
Treated Ground Water	1,200
Treated Contaminated Mine Water	1,365
Treated Reclaim Pond Water	435
TOTAL	3,000

Water balances for construction, start-up, and Project closure cannot be accurately shown because they represent periods when conditions will change continuously. Figures 3-11 and 3-12 show conceptually how water will be handled during two general phases in construction.

Figure 3-11 shows how water will be handled during the first phase of construction (about months 1 through 18). Surface drainage basins No. 1 and 2 are scheduled to be completed during the sixth month and will remain in use throughout the life of the Project as part of the erosion control system. They will serve to remove sediments from surface runoff and control the direction and rate of discharge of the runoff. Water from the east exhaust shaft and main shaft collar



LEGEND:

GPM

NOTE: AVERAGE FLOWS ROUNDED TO THE NEAREST 5 GPM

Typical Representation : Refinements May Be Made During Final Engineering

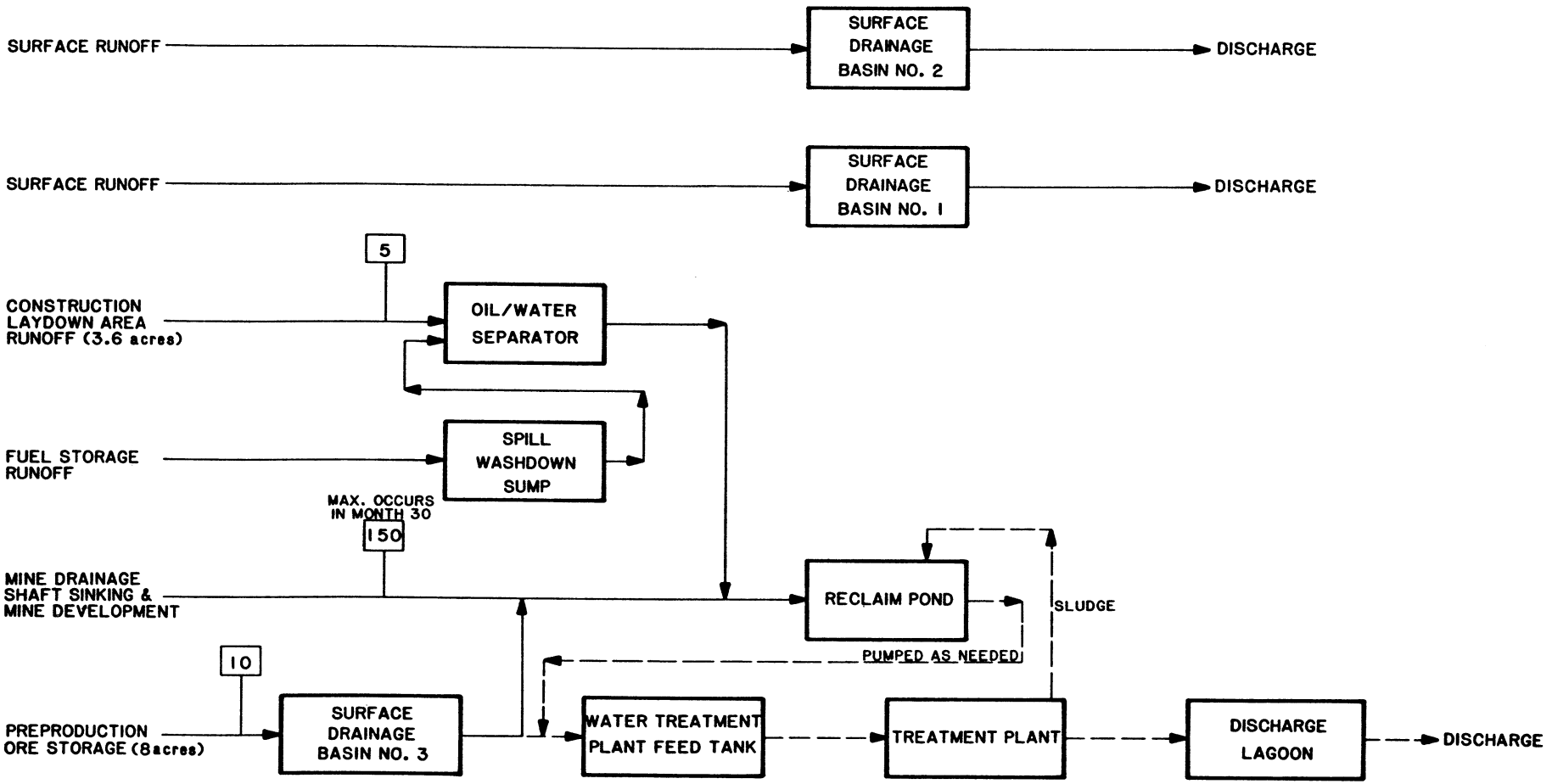
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WATER MANAGEMENT EARLY CONSTRUCTION

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	3/84		
APPROVED BY	DATE	APPROVED BY C.C. Schweden	DATE 11/8/05
APPROVED BY	DATE	EXXON DF Mc	DATE 7-12-

DRAWING NO **FIGURE 3-11** SHEET ____ OF ____ REVISION NO



LEGEND:

GPM

NOTE: AVERAGE FLOWS ROUNDED TO THE NEAREST 5 GPM

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WATER MANAGEMENT LATER CONSTRUCTION

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	9/85		
APPROVED BY	DATE	APPROVED BY C.C. Schneider	DATE 11/13/85
APPROVED BY	DATE	EXXON D.S. Ma	DATE 7/10/

DRAWING NO
FIGURE 3-12

SHEET ___ OF ___

REVISION NO

development will be collected and sent to an oil/water separator. Water from the separator will be sent to surface water drainage basin No. 1. During this same period, allowance has been made to collect runoff from a 3.8-acre area designated "equipment laydown area" in the mine/mill site area. There is potential for oil contamination in this water and it will also go to an oil/water separator. The average flow rate for runoff from this area is estimated to be about 5 gallons per minute and the estimated maximum flow rate is 285 gallons per minute which is equivalent to a 25-year, 24-hour storm event. The reclaim pond is scheduled to be completed during month 7. Water from the oil/water separator will be diverted to this pond upon its completion.

Figure 3-12 shows how water will be handled during the latter phase of construction (about months 19 through 30). Again both surface drainage ponds will be available to receive surface runoff from the Project site. Runoff from the preproduction ore storage area will be collected in surface drainage basin No. 3 and pumped directly to the reclaim pond or, alternatively, to the water treatment plant feed tank if necessary. The average flow rate from this area is estimated to be 10 gallons per minute. The maximum runoff volume for the preproduction ore storage area will be 45 gallons per minute. This is based on collection of runoff from a 25-year, 24-hour storm and pumping that volume to the treatment plant over a 14-day period.

The contaminated water from mine shaft sinking and mine development will gradually build up to a flow rate conservatively estimated to be about 150 gallons per minute at month 30. This water

will be sent to the reclaim pond and pumped to the water treatment plant feed tank as necessary. As stated previously, it is expected that all of the mine drainage during construction can be stored in the reclaim pond, and no routine discharge or treatment of this water will be required. Storage in the reclaim pond will provide water needed for mill start-up.

The expected peak flow of water from the mine of 1,385 gallons per minute (assuming 1,270 gallons per minute ground water inflow) will not occur until near month 70 after start of construction. Water from the equipment laydown area will continue to be treated by an oil/water separator and pumped to the reclaim pond. After mill start-up, runoff from surface drainage basin No. 2 will be pumped to the reclaim pond to ensure that any water entering this basin from an inadvertent spillage from the mill will not be discharged.

There may be some differences in the quality of the mine water between early and mature operations. During early operations mine backfill drainage will make up a larger portion of the total mine water flow than during mature operations. This is due to the projected slow buildup of mine water inflow to the steady state flow rate. However, the higher quality of water contained in the backfill during early operations will tend to offset the effect of the increased fraction of backfill drainage during this period.

The ore throughput during mill start-up will be gradually increasing and water flows to and from the tailing ponds and reclaim pond will be gradually increasing until they approach the volume flow rates predicted for operating at normal capacity. Treatment of water

for recycle use will start when it is determined that the concentration of soluble metals in the recycle water will be detrimental to the mill process, or when gypsum scaling is projected to become a problem in the mill. There should be no major difference in the ability of the water treatment system to meet the effluent limitations as progress is made from start-up to normal mill operating capacity.

A water balance for Project closure cannot be developed with certainty at this point, but the water management concepts can be discussed. Water will continue to be pumped from the mine until all salvageable equipment has been removed and mine closure operations have been completed. Contaminated water pumped from the mine will continue to be treated. Water from the tailing pond will be pumped to the reclaim pond as in the operational phase of the Project. Water will be pumped from the reclaim pond at a controlled rate to the treatment plant, treated, and discharged. The treatment plant will continue to operate during reclamation as long as there is contaminated water requiring treatment prior to discharge.

Additional water balance information is presented in the WPDES permit application for the Project.

3.4 Ancillary Facilities

3.4.1 Potable Water System

The potable water system will be separate from all other water systems in the mine/mill site. A separate 100 gallons per minute well, pump, pumphouse, fresh water tank, and distribution system will be provided for potable water. Treatment of the potable water probably will not be required. However, if some treatment is needed, a chlorinator treatment system will be provided.

The potable water system will supply a nominal demand of approximately 23 gallons per minute based on a work force and visitor estimate of 650 people, each with a 50-gallon per day water requirement. The system is sized to provide required reagent preparation water and pump gland water if necessary. The operation of the well pump will be controlled by level switches in the fresh water tank.

3.4.2 Treatment of Sanitary Wastes

Waste Water Quantity - The sanitary waste treatment system will be designed to accommodate sanitary wastes from surface activities as well as wastes from the mine.

Waste Water Quality - Per capita BOD and TSS contributions obtained from the literature are listed in Table 3.4. Based on a 9-10 hour overall work period, the sanitary waste water contributions for the Project were estimated at 0.10 pound BOD/person/day and 0.11 pound TSS/person/day. The estimated average daily sanitary waste water flow of approximately 23,500 gallons therefore has an average waste load of approximately 65 pounds per day BOD and 72 pounds per day TSS.

TABLE 3.4

SANITARY WASTEWATER QUALITY

TYPE OF SOURCE	BOD (lb/person/day)	TSS (lb/person/day)
Domestic	0.09 - 0.15	0.09 - 0.15
Construction Camp - With Food Service	0.15	--
Factories - With No Food Service	0.07	--

Treatment Plant - A general process diagram for the treatment plant system is presented on Figure 3-13. Sanitary waste will first enter a flow equalization zone in the plant and then pass through aeration, clarification, and a chlorine contact zone before disposal. Based on performance of similar plants, the 16 gallons per minute effluent stream quality will be in the range of 20-30 parts per million for both BOD and TSS.

The plant includes a small zone for sludge accumulation. A separate larger sludge holding tank will be included to reduce the frequency of sludge removal. Periodically, a licensed private contractor will be employed to remove and dispose of the sludge off-site.

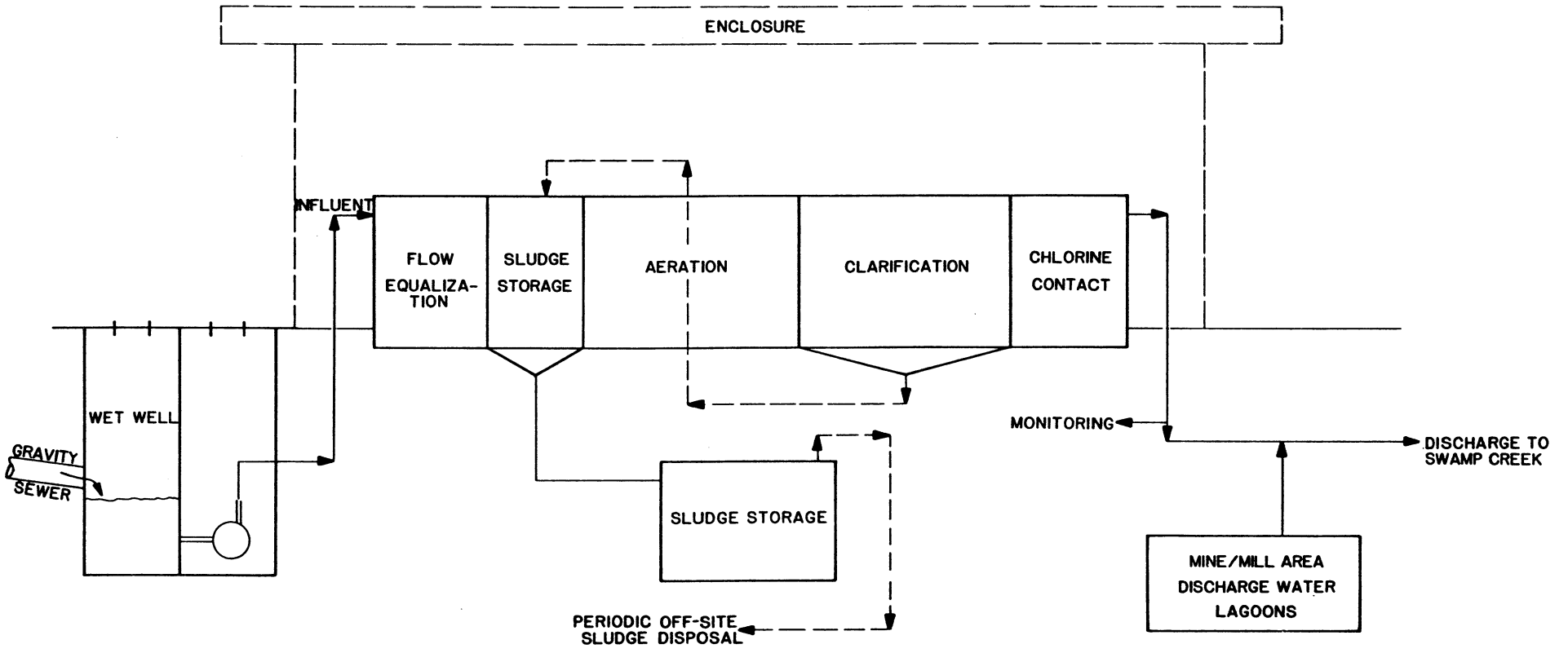
The plant will be operated and maintained to provide continuous satisfactory performance. Periodic effluent sampling and testing will be included in the overall Project monitoring plan.

The effluent stream will be added to the excess water discharge stream downstream of the discharge lagoon for ultimate discharge to Swamp Creek.

3.4.3 Refuse

The refuse normally generated by mine/mill operations will consist of wear related products, such as metal, rubber, wood, and lubricants, as well as the daily trash and garbage typical of an industrial work force.

Each year, scrap metal waste will result from normal mine/mill operations. This scrap will consist mostly of worn parts from process



Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
SANITARY WASTE TREATMENT PLANT SYSTEM

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	9/85		
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON DS Mo	DATE 11/1/11

DRAWING NO
FIGURE 3-13
SHEET ___ OF ___
REVISION NO

or production related equipment. Typically, this material will be collected in a specific location (e.g., the equipment laydown area south of the mine air heater or on the preproduction ore storage pad) and periodically it will be sorted and sold to a scrap metal contractor. Small scrap metal pieces will be collected in bins and larger pieces will be stored in a suitable outside area, such as the equipment laydown area southeast of the headframe.

The bulk of the scrap rubber will result from mobile equipment tires and process related equipment such as conveyor belting and air and water hoses. Used tires will be returned to vendors. In some cases, other worn rubber products can have secondary uses in the mine/mill operations for bumper blocks and machine skirting. However, some of the scrap rubber will require disposal in the MRDF and will be temporarily stored in the same area(s) used for scrap metal storage.

During operation of the mine/mill mobile mining equipment and process equipment, waste oils will be produced each year during the normal course of preventive equipment maintenance. This will include mobile equipment engine oil, hydraulic fluids, process equipment lubricating oil, and special lubricants. The waste oils, fluids, and oil recovered in oil/water separators will be collected in special containers as it is removed from equipment, and will be returned to the supplier or special contractor for reprocessing or disposal off-site.

The scrap wood materials and the trash and garbage will be collected and temporarily stored in containers (dumpsters) located throughout the facilities, including the underground mine. This waste material will then be periodically collected and removed from the

mine/mill site and disposed in the on-site MRDF.

Refuse from Project facilities will be collected for transfer to a centrally located, temporary storage area, where larger containers or receivers will allow accumulation of 3-4 days volume of refuse. From the central transfer point or points refuse will be hauled to the landfill for deposition approximately every 3-4 days.

For the refuse to be disposed on-site, estimates of the percentage of various waste categories are as follows:

Volume Waste Type	Percentage
Paper and Garbage	75
Plastic	5
Wood	5
Metal	10
Miscellaneous	5

Based on evaluations of similar industrial operations, the total volume of unsalvageable waste during operation is estimated to be approximately 2.5 tons per year per employee. Assuming 650 employees, the estimated annual waste generated will be approximately 1,625 tons.

Standard landfill operating practices will be followed in depositing, compacting and covering the refuse. Equipment for this periodic work will be available from the Project fleet. Transfer frequencies will be optimized considering refuse holding times, interim container/receiver sizes and necessary operations in the landfill.

Leachate collection and transfer will occur continuously. Collector pipes in the drainage blanket, overlying the bottom liner, will transfer leachate to an adjacent sump for pumping as necessary to

the first stage of the water reclaim pond. Conservatively assuming a 12-inch annual infiltration rate over the entire cell area, the average leachate generation rate will be less than 2 gallons per minute. This compares to a water transfer rate through the reclaim pond of approximately 5,000 gallons per minute. Periodically, the leachate will be sampled and tested to monitor quality.

Ground water also will be monitored through the wells being planned in the system to monitor the MWDF.

Additional operating detail is included in the MRDF Feasibility Report.

3.4.4 Fuels and Other Energy Requirements

The fuel and energy requirements for operating the mine/mill will be from four sources: electrical power, natural gas, diesel fuel, and gasoline. Electrical power will be used to operate all process equipment, ancillary facilities, waste disposal faciliteis, and all the underground mine equipment except mobile diesel equipment, and for general lighting and miscellaneous use. Electrical power will be provided by WPSC from the power network serving the general area of the mine/mill.

The major use of natural gas will be for heating the underground mine ventilation air. A lesser use of natural gas will be for general building and facility heating and for hot water heating. The only process requirement for natural gas is one small boiler in the water treatment plant. Natural gas will be supplied by WPSC and the local pipeline company from the gas pipeline system serving the area.

Diesel fuel will be used for all of the underground mobile mining equipment and for some diesel powered mobile equipment on the surface, such as the yard locomotive and waste rock haulage trucks. Fuel oil will be purchased on the open market from available sources, and will be delivered to the mine/mill site by either truck or railcar. On-site storage will be provided to maintain an ample supply for normal operations.

Gasoline will be used primarily for service and maintenance vehicles on the surface. Because gasoline will be used in lesser quantities, it will be delivered by truck only and stored in underground tanks similar to a commercial filling station.

3.5 Erosion Control

3.5.1 Erosion Control Procedures

3.5.1.1 Facilities Construction and Operation

All soil surfaces require some type of cover to reduce erosion sediment yields. To establish vegetation successfully on soil, it is important that the slopes be mechanically stable, the area be protected from runoff water, and surface erosion be temporarily minimized with a mulch, alone or in combination with a chemical soil stabilizer. On long slopes it may be necessary to reduce the segments of decreasing elevation with a system of diversion or bench terraces.

Erosion control is a pre-requisite to creating conditions favorable for plant growth. Design criteria for soil erosion and sediment control applicable to construction and mining sites have been described by the USDA-Soil Conservation Service (1972), U.S. Highway Research Board (1973), U.S. Environmental Protection Agency (1975, 1976a,b), and State of Wisconsin (1981).

Erosion control criteria should have these objectives:

1) Temporary control of sediment until more permanent structures and/or vegetation are established.

2) Detention of storm waters on the construction site and the release of these waters at non-erosive velocities.

3) Use of diversion terraces to divert water from the construction site.

4) Establishment of cut-and-fill slopes as flat as feasible consistent with the strenghs of soil involved and economics. Slope stability depends on length and steepness, soil strength, moisture content, density, and other factors.

Soil erosion and sediment control measures may be temporary or permanent, and include installation of one or more of the following: (1) sedimentation traps or basins, (2) berms, (3) slope drains, (4) toe-slope ditches, and (5) diversion channels. A summary of the advantages and other considerations of these measures together with additional erosion control criteria has been compiled by the U.S. Highway Research Board (1973) and is presented in Table 3.5

3.5.1.2 Design Storms-Quantification of Runoff

The permanent (for the Project operating life) surface drainage basins have been sized to contain runoff volumes from a 25-year, 24-hour rainfall event. As part of the erosion control planning, the mine/mill site will be developed so these surface drainage basins will be available from initial construction to provide temporary erosion control protection. Similarly, these basins will be utilized throughout reclamation until final vegetation is established and the soils have stabilized. At that time the basins would be removed and the areas revegetated.

During construction and reclamation phases, temporary erosion control measures will be used in areas that do not drain to the basins. Measures to be applied are summarized in Table 3.5.

3.5.1.3 General Engineering Techniques for Erosion Control

Although various techniques can be used for soil erosion control during the construction phase, some will predominate during development of the mine/mill surface facilities, reclaim ponds, mine

TABLE 3.5

SUMMARY OF SOIL EROSION AND SEDIMENT CONTROL METHODS DURING CONSTRUCTION

Treatment Practice	Advantages	Considerations
ROADWAY DITCHES		
Check Dams	Maintain low velocities. Catch sediment. Can be constructed of logs, shot rock, lumber, masonry, or concrete.	Close spacing on steep grades. Require clean-out. Unless keyed at sides and bottom, erosion may occur.
Sediment Traps/Straw Bale Filters	Can be located as necessary to collect sediment during construction. Clean-out often can be done with on-the-job equipment. Simple to construct.	Little direction on spacing and size. Sediment disposal may be difficult. Specification must include provisions for periodic clean-out. May require seeding, sodding, or pavement when removed during final clean-up.
Sodding	Easy to place with a minimum of preparation. Can be repaired during construction. Immediate protection.	Requires water during first few weeks. Sod not always available. Will not withstand high velocity or severe abrasion from sediment load.
Seeding with Mulch and Matting	Usually least expensive. Effective for ditches with low velocity.	Will not withstand medium to high velocity.
Paving, Rip-rap, Rubble	Effective for high velocities. May be part of the permanent erosion control effort.	Cannot always be placed when needed because of construction traffic and final grading and dressing. Initial cost is high.
ROADWAY SURFACE		
Crowning to Ditch or Sloping to Single Berm	Directing the surface water to a prepared or protected ditch minimizes erosion.	None - should be part of good construction procedures.
Compaction	The final lift of each day's work should be well compacted and bladed to drain to ditch or berm section. Loose or uncompacted material is more subject to erosion.	None - should be part of good construction procedures.
Aggregate Cover	Minimizes surface erosion. Permits construction traffic during adverse weather. May be used as part of permanent base construction.	Requires reworking and compaction if exposed for long periods of time. Loss of surface aggregates can be anticipated.
Seed/Mulch	Minimizes surface erosion.	Must be removed or is lost when construction of pavement is commenced.
Temporary Silt Fence	Simple to construct and remove. Other advantages similar to straw bale filters.	Requires cleanout and maintenance. Other considerations similar to straw bale filters.

TABLE 3.5 (continued)

Treatment Practice	Advantages	Considerations
CUT SLOPES		
Berm at Top of Cut	Diverts water from cut. Collects water for slope drains/paved ditches. May be constructed before grading is started.	Access to top of cut. Difficult to build on steep natural slope or rock surface. Concentrates water and may require channel protection or energy dissipation devices. Can cause water to enter ground, resulting in sloughing of the cut slope.
Diversion Dike	Collects and diverts water at a location selected to reduce erosion potential. May be incorporated in the permanent project drainage.	Access for construction. May be continuing maintenance problem if not paved or protected. Disturbed material or berm is easily eroded.
Slope Benches	Slows velocity of surface runoff. Collects sediment. Provides access to slope for seeding, mulching, and maintenance. Collects water for slope drains or may divert water to natural ground.	May cause sloughing of slopes if water infiltrates. Requires additional ROW. Not always possible due to rotten material, etc. Requires maintenance to be effective. Increases excavation quantities.
Slope Drains (pipe, paved, etc.)	Prevents erosion on slope. Can be temporary or part of permanent construction. Can be constructed or extended as grading progresses.	Requires supporting effort to collect water. Permanent construction is not always compatible with other project work. Usually requires some type of energy dissipation.
Seeding/Mulching	The end objective is to have a completely grassed slope. Early placement is a step in this direction. The mulch provides temporary erosion protection until grass is rooted. Temporary or permanent seeding may be used. Mulch should be anchored. Larger slopes can be seeded and mulched with smaller equipment if stage techniques are used.	Difficult to schedule high production units for small increments. Time of year may be less desirable. May require supplemental water.
Sodding	Provides immediate protection. Can be used to protect adjacent property from sediment and turbidity.	Difficult to place until cut is complete. Sod not always available. May be expensive.
Slope Pavement, Rip-rap	Provides immediate protection for high risk areas and under structures.	Expensive. Difficult to place on high slopes. May be difficult to maintain.

TABLE 3.5 (continued)

Treatment Practice	Advantages	Considerations
Temporary Cover	Plastics are available in wide rolls and large sheets that may be used to provide temporary protection for cut or fill slopes. Easy to place and remove. Useful to protect high risk areas from temporary erosion.	Provides only temporary protection. Original surface usually requires additional treatment when plastic is removed. Must be anchored to prevent wind damage.
Serrated Slope	Lowers velocity of surface runoff. Collects sediment. Holds moisture. Minimizes amount of sediment reaching roadside ditch.	May cause minor sloughing if water infiltrates. Construction compliance.
FILL SLOPES		
Berms at Top of Embankment	Prevent runoff from embankment surface from flowing over face of fill. Collect runoff for slope drains or protected ditch. Can be placed as a part of the normal construction operation and incorporated into fill or shoulders.	Cooperation of construction operators to place final lifts at edge for shaping into berm. Failure to compact outside lift when work is resumed. Sediment build-up and berm failure.
Slope Drains	Prevent fill slope erosion caused by embankment surface runoff. Can be constructed of full or half section pipe, bituminous, metal, concrete, plastic, or other waterproof material. Can be extended as construction progresses. May be either temporary or permanent.	Permanent construction as needed may not be considered desirable by contractor. Removal of temporary drains may disturb growing vegetation. Energy dissipation devices are required at the outlets.
Fill Berms or Benches	Slows velocity of slope runoff. Collects sediment. Provides access for maintenance. Collects water for slope drains. May utilize waste.	Requires additional fill material if waste is not available. May cause sloughing. Additional ROW may be needed.
Seeding/Mulching	Timely application of mulch and seeding decreases the period a slope is subject to severe erosion. Mulch that is cut in or otherwise anchored will collect sediment. The furrows made will also hold water and sediment.	Seeding season may not be favorable. Not 100 percent effective in preventing erosion. Watering may be necessary. Steep slopes or locations with high velocities may require supplemental treatment.
PROTECTION OF ADJACENT PROPERTY		
Brush Barriers	Use slashing and logs from clearing operation. Can be covered and seeded rather than removed. Eliminates need for burning or disposal off ROW.	May be considered unsightly in urban areas.

TABLE 3.5 (continued)

Treatment Practice	Advantages	Considerations
Straw Bale Barriers	Straw is readily available in many areas. When properly installed, they filter sediment and some turbidity from runoff.	Require removal. Subject to vandal damage. Flow is slow through straw requiring considerable area.
Sediment Traps	Collect much of the sediment spill from fill slopes and storm drain ditches. Inexpensive. Can be cleaned and expanded to meet need.	Do not eliminate all sediment and turibidity. Space is not always available. Must be removed (usually).
Sediment Pools	Can be designed to handle large volumes of flow. Both sediment and turibidity are removed. May be incorporated into permanent erosion control plan.	Require prior planning, additional ROW and/or flow easement. If removal is necessary, can present a major effort during final construction stage. Clean-out volumes can be large. Access for clean-out not always convenient.
Energy Dissipators	Slow velocity to permit sediment collection and to minimize channel erosion off project.	Collect debris and require cleaning. Require special design and construction of large shot rock or other suitable material from project.
Level Spreaders	Convert collected channel or pipe flow back to sheet flow. Avoid channel easements and construction off project. Simple to construct.	Adequate spreader length may not be available. Sodding of overflow berm is usually required. Must be a part of the permanent erosion control effort. Maintenance forces must maintain spreader until no long required.
Plastic Filter Sheet	Permit good drainage and control of soil particle movement. Cost and long-term effectiveness.	Variability in effectiveness between products. Requires careful installation for long-term effectiveness.
Construction Dike	Permits work to continue during normal stream stages. Controlled flooding can be accomplished during periods of inactivity.	Usually requires pumping of work site water into sediment pond. Subject to erosion from stream and from direct rainfall on dike.
Cofferdam	Work can be continued during most anticipated stream conditions. Clear water can be pumped directly back into stream. No material deposited in stream.	Expensive.
Temporary Stream Channel Change	Prepared channel keeps normal flows away from construction.	New channel usually will require protection. Stream must be returned to old channel and temporary channel refilled.

TABLE 3.5 (continued)

Treatment Practice	Advantages	Considerations
Riprap	Sacked sand with cement or stone easy to stockpile and place. Can be installed in increments as needed.	Expensive.
Temporary Culverts for Haul Roads	Eliminate stream turbulance and turbidity. Provide unobstructed passage for fish and other water life. Capacity for normal flow can be provided with storm water flowing over the roadway.	Space not always available without conflicting with permanent structure work. May be expensive, especially for larger sizes of pipe. Subject to washout.
Rock-lined Low-level Crossing	Minimizes stream turbidity. Inexpensive. May also serve as ditch check or sediment trap.	May not be fordable during rainstorms. During periods of low flow passage of fish may be blocked.
BORROW AREAS		
Selective Grading and Shaping	Water can be directed to minimize off-site damage. Flatter slopes enable mulch to be cut into soil.	May not be most economical work method for contractor.
Stripping and Replacing of Topsoil	Provides better seed bed. Conventional equipment can be used to stockpile and spread topsoil.	May restrict volume of material that can be obtained for a site. Topsoil stockpiles must be located to minimize sediment damage. Cost of rehandling material.
Dikes, Berms Diversion Ditches Settling Basins Sediment Traps Seeding and Mulch	See other practices.	See other practices.

waste disposal facility, railroad spur and access road. They are diversion dikes, filter fabric, sediment traps/straw bale filters, sediment ponds, slope benches, and riprap.

3.5.1.4 Vegetation Techniques for Erosion Control

Topsoil Removal and Preservation - Wisconsin NR 132.08(2)(f) requires that all topsoil from surface areas disturbed by mining operations be removed and stored in an environmentally acceptable manner for use in subsequent reclamation. Topsoil removal (preservation) during construction of the Crandon Project will be difficult over most of the land surface disturbed.

The major soil series present in the Project area is the Iron River Series and is described as having "poor" topsoil characteristics.

The official description of the term "poor" is "Soils rated as poor are very sandy soils, very firm clayey soils, soils with suitable layers less than 8 inches thick, soils having large amounts of gravel, stones or soluble salt, steep soils and poorly drained soils."

The construction plan that has been developed assumes topsoil will be salvaged to a depth of about 9 inches. This material will be stored and re-used during reclamation.

Peat Humus - Although NR 182.04(50) does not include "peat humus" in the definition of topsoil, it will form a valuable material for the generation or sustenance of plant growth. Therefore, where applicable, peat humus will be salvaged during construction activities and utilized during reclamation.

Topsoil/Peat Humus Standards - Where applicable, the standards for removal, storage and utilization of topsoil and peat humus will be comparable to those of the Wisconsin Department of Transportation.

3.5.1.5 Fertilizer Use

The predominance of Iron River Series subsoils in the Project area will, of necessity, entail their use in the construction of berms, dams, and dikes. Establishment of forage type plant species for purposes of erosion control may, therefore, require fertilizer applications to achieve a satisfactory vegetative cover. However, data obtained from preliminary evaluations of the vegetation potential of the Crandon Project site soil indicate that higher levels of fertilizer application may not always be required.

As major Project facilities are constructed and the areas associated with, or adjacent to, these facilities are graded and ready for establishment of vegetative cover, soil samples will be taken and analyzed to determine the most appropriate fertilizer application. Each of these areas also will be analyzed (i.e., topography, exposure, drainage and future use) to determine the best seed mixture and practice for seeding.

The proposed seed mixtures that will be most commonly used for temporary erosion control are also composed of species tolerant of low soil fertility. Fertilizer requirements for non-herbaceous vegetation, whether planted directly into subsoils or into topsoil applied over subsoil, will follow the general recommendations for such practice by the USDA-Soil Conservation Service and State of Wisconsin.

3.5.1.6 Species Selection

Species selection for erosion control during the construction phase will be dependent upon the proposed life of the area concerned. Where an area is likely to be exposed for the period May to October only, species which exhibit rapid establishment and growth may be seeded, depending upon specific site conditions. Examples of such species include oats (Avena sativa), rye (Secale cereale), and perennial rye grass (Lolium perenne) (Table 3.6).

Erosion control during the period October to May is equally as important as from May to October. Construction areas having exposed soils that will not be disturbed from October to May will be stabilized in late summer or early autumn with grass-based seed mixtures. These seed mixtures will be supplemented with mulch and/or soil surface stabilizers to ensure establishment of vegetative cover prior to the non-growing season. Vegetative cover will be established as early as possible on these areas so that the soils are stabilized and erosion potential is minimized.

Exposed surfaces requiring surface stabilization for periods longer than those mentioned above will be seeded with one of three general mixtures. Surfaces formed during construction, which will exist for the duration of the Project, but which will be destroyed during final recontouring at abandonment, will be seeded according to the following guidelines:

1) Where the surface is to form part of a formal landscaped area, a general all-purpose grass mixture will be established and maintained until such time as non-herbaceous species are introduced.

TABLE 3.6

POTENTIAL FORAGE-TYPE SPECIES FOR USE IN TEMPORARY AND PERMANENT SOIL STABILIZATION

Scientific Name	Common Name
Grasses	
Avena sativa	Oats
Bromus inermis	Bromegrass
Dactylis glomerata	Orchard grass
Festuca arundinacea	Tall fescue (Reed fescue)
Festuca ovina var. duriuscula	Durar hard fescue
Festuca rubra	Creeping red fescue
Lolium perenne	Perennial ryegrass
Panicum clandestinum	Deer tongue
Panicum virgatum	Switchgrass
Phalaris arundinacea	Reed canarygrass
Phleum pratense	Timothy
Poa pratensis	Kentucky bluegrass
Secale cereale	Rye
Legumes	
Coronilla varia	Crownvetch
Lathyrus latifolius	Perennial pea
Lathyrus sylvestris	Wagner flat pea
Lotus corniculatus	Birdsfoot trefoil
Trifolium hybridum	Alsike clover
Trifolium pratense	Red clover
Trifolium repens	Ladino clover; White Dutch clover

2) Where the surface is to form part of a landscape having a natural appearance and where colonization of the surface area by native species is not detrimental to operational procedures, a birdsfoot trefoil (Lotus corniculatus) based seed mixture will be established.

3) Where erosion control is required, but colonization by native species would be deemed detrimental to operational procedures, a self-sustaining and maintenance-free seed mixture based on crownvetch (Coronilla varia) will be established.

Exposed surfaces formed during construction and for which grade will remain as part of the final topography at abandonment will also be seeded with a birdsfoot trefoil based seed mixture. Such mixtures are considered to be permanent, self-sustaining and maintenance free. However, infrequent maintenance practices of mowing or herbicide spraying may be imposed to control native shrub and tree invasion where such invasion is considered undesirable. Reduction or elimination of maintenance practices several years before abandonment will permit native plant species to become established and provide a natural transition for the vegetation cover on these surfaces to a vegetative cover approaching that of the surrounding area.

Use of the above mentioned species is not necessarily absolute. As detailed plans are completed for erosion control during construction and for implementation of reclamation as mining operations begin, consideration will be given to the need or desirability for utilizing other forage-type species identified in Table 3.6. Revised seed mixtures will be approved by the DNR prior to use.

3.5.1.7 Methods of Seeding

During the construction phases of the Project seeding will be undertaken using both hydroseeding and mechanical methods. Specific site characteristics, but primarily slope, will determine which method is selected.

3.5.1.8 Time of Seeding

The optimum seeding period for legume-based seed mixtures is April to June, whereas the optimum period for grass-based seed mixtures is August and September. Where completion of construction of various facilities does not permit an optimum seeding time, temporary erosion control methods will be utilized (see subsection 3.5.2, Table 3.5).

3.5.1.9 Mulches and Soil Surface Stabilizers

Numerous types of mulches and soil surface stabilizers can be used when hydroseeding. Selection will be dependent upon the recommendation of a reclamation specialist, cost and availability.

3.5.2 Surface Facilities Construction

3.5.2.1 Mine/Mill Site

Site Preparation and Erosion Control - Site preparation will be performed in two stages:

1) Initially, the mine/mill site will be cleared of shrubs and trees and then rough-graded.

2) Following clearing, grubbing and rough grading, disturbed areas not required in the early phases of construction development will be seeded to control erosion and runoff.

Erosion control will be developed as necessary with the rough grading. To the extent possible, the surface drainage basins will be used for runoff control. The basin areas will be excavated first with grading work generally progressing outward from the basins. Where portions of the storm drainage system are not installed concurrently with the rough grading, separate provisions for runoff and erosion control will be made. These provisions will consist of temporary siltation basins or hay or straw bale ditch retention checks.

Graded areas not scheduled for immediate development will be revegetated with a temporary ground cover following the grading work to reduce siltation from runoff erosion. As an area is subsequently developed, any portions of the final storm drainage system not installed with the initial site work would first be installed for the area before beginning other construction. At that point, runoff would be controlled by the final system, although some hay or straw bale ditch checks may still be used to prevent downstream siltation of the system. Development of the site in this manner will reduce the need for short-term temporary erosion control measures. The long-term control will be through the final surface water drainage system. Through application of these procedures the major effects of construction activity will be contained within the construction area boundaries.

3.5.2.2 Railroad Spur

Clearing, grubbing, and material disposal for the railroad spur will be performed in the same manner as that planned for mine/mill site preparation. Earthwork operations will follow as closely behind the clearing and grubbing operation as is practical. Erosion and runoff

control techniques, as described in subsection 3.5.1, will be used with permanent culverts and a system of retention basins built into ditch bottoms to eliminate the unrestricted flow of runoff. Riprap, filter fabric and hay matting in conjunction with settling basins, built as an integral part of the ditch system, will eliminate sediment flow into adjacent wetland areas.

Locations of the temporary erosion control facilities to be utilized during construction, such as the straw bale and filter fabric silt traps and the sheet piling at the area of the Swamp Creek crossing structure, will be determined during final engineering and detailed construction planning for the railroad. Once construction is complete, and vegetation has been reestablished in the disturbed areas, the temporary erosion control facilities will be removed.

Wetland material not suitable for roadbed construction will be excavated and organic peat material will be replaced with select material from on-site excavation. Placement of sub-ballast and ballast on the subgrade will complete the railroad bed before ties and rails are installed.

The bridge at Swamp Creek will be provided with concrete abutments and wingwalls and the stream banks will be protected by riprap to prevent erosion and resulting runoff of sediments into the stream. Prior to construction of bridge abutments and approaches, sheet piling will be driven into the ground parallel with the stream banks before any grading is done on the approaches. Grading will be performed behind the piling and loosened materials will be contained and prevented from spilling into the stream. The sheet piling will be removed after

the banks are fully stabilized. All construction practices adjacent to Swamp Creek will be performed in accordance with the Chapter 30/31 Permit approval.

No special vegetation selection and establishment practices are considered necessary along the railroad spur. Species selection, fertilizer use and methods of establishment will follow the requirements described earlier.

During the operation of the railroad spur, standard erosion control and vegetation maintenance procedures will be utilized. These procedures will include fertilization, mowing, brush control, and reseeding of areas disturbed during railroad maintenance, as required.

Herbicides will be used to selectively treat undesirable woody plant species that encroach within the railroad spur right-of-way. Only EPA approved herbicides will be applied. Selective applications of herbicides will be completed by a private contractor in accordance with standard railroad maintenance practices.

3.5.2.3 Access Road

Implementation of runoff and erosion control methods will be completed concurrently with the earthwork activities. These methods include hydroseeding and salvaged topsoil placement where feasible following final grading to reduce the exposure of bare ground.

Wetland crossings will include temporary berms at the edge of the fill slopes or the equivalent to contain runoff and divert it outside of the wetland for sediment removal before the water enters the wetland. Organic peat removed from wetlands will be replaced with

selected cut materials from locations within the road alignment. Materials excavated from wetlands will be utilized as surface cover.

The bridge at the Swamp Creek crossing will be provided with concrete abutments with wingwalls and the stream banks on the bridge approaches will be protected by riprap to minimize erosion and sediment runoff into the stream. Prior to construction of bridge abutments and approaches, sheet piling will be driven into the ground parallel with the stream banks. Grading will be performed behind the piling and loose material will be contained and prevented from spilling into the stream. The sheet piling will be removed after the banks are fully stabilized. All construction practices adjacent to Swamp Creek will be performed in accordance with the Chapter 30/31 Permit approval.

Vegetation selection and establishment practices along the access road will not require any unusual procedures. Species selection, fertilizer use and establishment techniques will follow the guidelines described earlier.

During use of the access road, standard erosion control and vegetation maintenance procedures will be utilized. These procedures will include fertilization and mowing of shoulders, brush control along the right-of-way, maintenance of surface water runoff control structures and reseeding of areas disturbed during highway maintenance, as appropriate.

3.5.2.4 Haul Road/Tailings Transport and Water Pipeline Corridor

Typical temporary erosion control techniques will be used during construction and until the new vegetation has been established.

Specific details and locations of the temporary erosion control measures used during construction (straw bale silt traps, filter fabric fences or similar measures) would be determined during final engineering.

Following construction, the route will be seeded to provide erosion control and improve aesthetic aspects. During the operation of the mine/mill facilities, landscape maintenance practices will be used to minimize invasion of shrubs and trees which would interrupt normal operating and line maintenance/repair procedures.

3.5.2.5 Pipelines and Water Discharge Structure Construction

During construction of pipelines, exposed areas with potential for runoff of sediments will be controlled with straw bale sediment traps. Seeding and reestablishment of vegetation will follow after trench backfilling.

Area disturbance for construction of the discharge structure on Swamp Creek will be minimal. Lightweight equipment, swamp mats and other appropriate precautions will be taken to lessen working difficulties and disturbance in wetlands adjacent to the discharge structures.

In the construction zone for the discharge structure, straw bales or geotextile materials will be used to trap silts to minimize sediment runoff to Swamp Creek. These measures will be continued after completion of construction until the soils have stabilized and sediment runoff is no longer a problem.

Installation of pipe through the wetland areas will require additional precautions. Muck and organic soil conditions as well as

season of the year will determine the most effective equipment to use. In areas where there is potential for erosion, the materials will be contained with silt fences (geotextiles) or other appropriate methods. Because of the nature of wetland soils, wider disturbed areas will result in the wetlands. Lighter equipment and swamp mats will probably be used unless a winter time construction schedule is determined to be beneficial.

3.5.2.6 Mine Waste Disposal Facility, Reclaim Ponds and Mine Refuse Disposal Facility

Construction of the MWDF and MRDF will be scheduled so that completion of each of the ponds or cells occurs at the time at which it is required for disposal of tailings or refuse. The limited construction season in the area requires the concentration of construction effort during the May through November period to meet the schedule in each phase of the work.

During each phase of construction, control of surface water runoff will be accomplished by constructing a series of ditches, dikes, and retention ponds, and use of temporary vegetation, soil stabilizers and mulches. Figures 3-14 through 3-19 detail the drainage patterns and location of required control features for each phase of construction for the MWDF, reclaim pond and MRDF. Surface water runoff with the potential for high suspended solids content will be diverted through sedimentation ponds with overflow weirs before being discharged into the drainage system of the surrounding area. These sedimentation ponds will allow settling of the suspended solids. As each construction

N 33,000 N 34,000 N 35,000 N 36,000

E 696,000

E 697,000

DEEP HOLE LAKE

DUCK LAKE

SKUNK LAKE

El. 495.0
Q_{100}= 4.1 cms
SP-A

El. 500.2
Q_{100}= 1.4 cms
SP-B

El. 517.1
Q_{100}= 1.0 cms
SP-C

El. 514.0
Q_{100}= 1.6 cms
SP-T

HBF-M El. 518.0
Q_{100}= 1.0 cms

Reclaim Pond

Reclaim Pond

T1

T2

T4

T5

Toe Of Embankment Slope

Toe Of Embankment Slope

Temporary Stockpile Area

CONSTRUCTION SUPPORT AREA

MINE REFUSE DISPOSAL FACILITY

CREEK

HEMLOCK

LEGEND

HBF-A	Hay Bale Filter A With Stone Spillway
	Dike
	Drainage Ditch & Flow Direction
	Drainage Basin Limits
5	Drainage Basin #5
El. 520	Discharge Point & Spillway Elevation
Q_{100}= 1.2 cms	100 Year Discharge (Cubic Meters/Second)
T4	Tailings Pond T-4
SP-A	Sedimentation Pond A
	Area Of Construction
	Area Of Confinement
	Area Of Reclamation

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

REVISED	DATE	BY	DESCRIPTION

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 1

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY CJD	DATE 11-85	CHECKED BY C. Schuyler	DATE 12/6/85	
APPROVED BY WJW	DATE 11-85	ENGINEER W. J. Lewis	DATE 12/6/85	
APPROVED BY TKD	DATE 11-85	EXXON	DATE	
DRAWING NO FIGURE 3-14	SHEET 2 OF 7			REVISION NO

N 33,000 N 34,000 N 35,000 N 36,000

E 696,000

E 697,000

DEEP HOLE LAKE

DUCK LAKE

SKUNK LAKE

CREEK

HEMLOCK

El. 495.0
Q_{100}= 2.8 cms
SP-D

El. 496.0
Q_{100}= 1.8 cms
SP-A

El. 500.2
Q_{100}= 0.7 cms
SP-B

El. 517.1
Q_{100}= 0.6 cms
SP-C

El. 513.2
Q_{100}= 0.7 cms
SP-R

El. 514.0
Q_{100}= 1.8 cms
SP-P

HBF-M El. 518.0
Q_{100}= 0.6 cms

Reclaim Pond

Reclaim Pond

Toe Of Embankment Slope

Toe Of Embankment Slope

CONSTRUCTION SUPPORT AREA

MINE REFUSE DISPOSAL FACILITY

T1 T2 T3 T4

1 2 3 4 5 6 7

LEGEND

HBF-A	Hay Bale Filter A With Stone Spillway
	Dike
	Drainage Ditch & Flow Direction
	Drainage Basin Limits
5	Drainage Basin #5
El. 520	Discharge Point & Spillway Elevation
Q_{100}= 1.2 cms	100 Year Discharge (Cubic Meters/Second)
T4	Tailings Pond T-4
SP-A	Sedimentation Pond A
	Area Of Construction
	Area Of Confinement
	Area Of Reclamation

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

REVISED	DATE	BY	DESCRIPTION

Typical Representations: Refinement: May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 2

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY CJD	DATE 11-85	CHECKED BY C.E. Schroeder	DATE 12/6/85		
APPROVED BY WJW	DATE 11-85	APPROVED BY W.S. Lewis	DATE 12/18/85		
APPROVED BY TKD	DATE 11-85	EXXON	DATE		
DRAWING NO FIGURE 3-15		SHEET 3 OF 7	REVISION NO		

DESIGN PRODUCTS CO —

N 33,000 N 34,000 N 35,000 N 36,000

E 696,000 E 697,000

DEEP HOLE LAKE

DUCK LAKE

SKUNK LAKE

HEMLOCK CREEK

El. 495.0
Q_{100}= 3.1 cms
SP-A

El. 500.2
Q_{100}= 0.7 cms
SP-B

El. 485.0
Q_{100}= 1.3 cms
SP-D

Toe Of Embankment Slope

Reclaim Pond

Reclaim Pond

Toe Of Embankment Slope

SP-B

El. 513.2
Q_{100}= 0.6 cms

El. 513.6
Q_{100}= 2.3 cms
HBF-Q

El. 517.1
Q_{100}= 0.9 cms
SP-C

CONSTRUCTION SUPPORT AREA

MINE REFUSE DISPOSAL FACILITY

SP-L

El. 521.2
Q_{100}= 0.1 cms
HBF-S

El. 517.0
Q_{100}= 0.9 cms

LEGEND

HBF-A	Hay Bale Filter A With Stone Spillway
	Dike
	Drainage Ditch & Flow Direction
	Drainage Basin Limits
5	Drainage Basin #5
El. 520	Discharge Point & Spillway Elevation
Q_{100}= 1.2 cms	100 Year Discharge (Cubic Meters/Second)
T4	Tailings Pond T-4
SP-A	Sedimentation Pond A
	Area Of Construction
	Area Of Confinement
	Area Of Reclamation

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 3

SCALE: AS SHOWN	STATE: WISCONSIN		COUNTY: FOREST		
DRAWN BY: CJD	DATE: 11-85	CHECKED BY: C.J. Snowden	DATE: 12/6/85		
APPROVED BY: WJW	DATE: 11-85	COMPANY: H.S. Lewis	DATE: 12/85		
APPROVED BY: TKD	DATE: 11-85	EXXON	DATE		
DRAWING NO: FIGURE 3-16	SHEET 4 OF 7				REVISION NO

REVISED	DATE	BY	DESCRIPTION

N 33.000 N 34.000 N 35.000 N 36.000

E 696.000

E 697.000

DEEP HOLE LAKE

DUCK LAKE

SKUNK LAKE

HEMLOCK CREEK

El. 495.0
Q_{100}= 1.6 cms

El. 495.0
Q_{100}= 2.7 cms

El. 500.2
Q_{100}= 0.7 cms

Reclaim Pond

Reclaim Pond

Toe Of Embankment Slope

El. 517.1
Q_{100}= 0.9 cms

SP-C

CONSTRUCTION SUPPORT AREA

MINE REFUSE DISPOSAL FACILITY

El. 512.3
Q_{100}= 3.3 cms

SP-F

Toe Of Embankment Slope

SP-L

El. 517.0
Q_{100}= 0.9 cms

SP-G

SP-H

El. 511.5
Q_{100}= 0.3 cms

El. 504.5
Q_{100}= 1.8 cms

LEGEND

HBF-A	Hay Bale Filter A With Stone Spillway
	Dike
	Drainage Ditch & Flow Direction
	Drainage Basin Limits
5	Drainage Basin #5
El. 520	Discharge Point & Spillway Elevation
Q_{100}= 1.2 cms	100 Year Discharge (Cubic Meters/Second)
T4	Tailings Pond T-4
SP-A	Sedimentation Pond A
	Area Of Construction
	Area Of Confinement
	Area Of Reclamation

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

REVISED	DATE	BY	DESCRIPTION

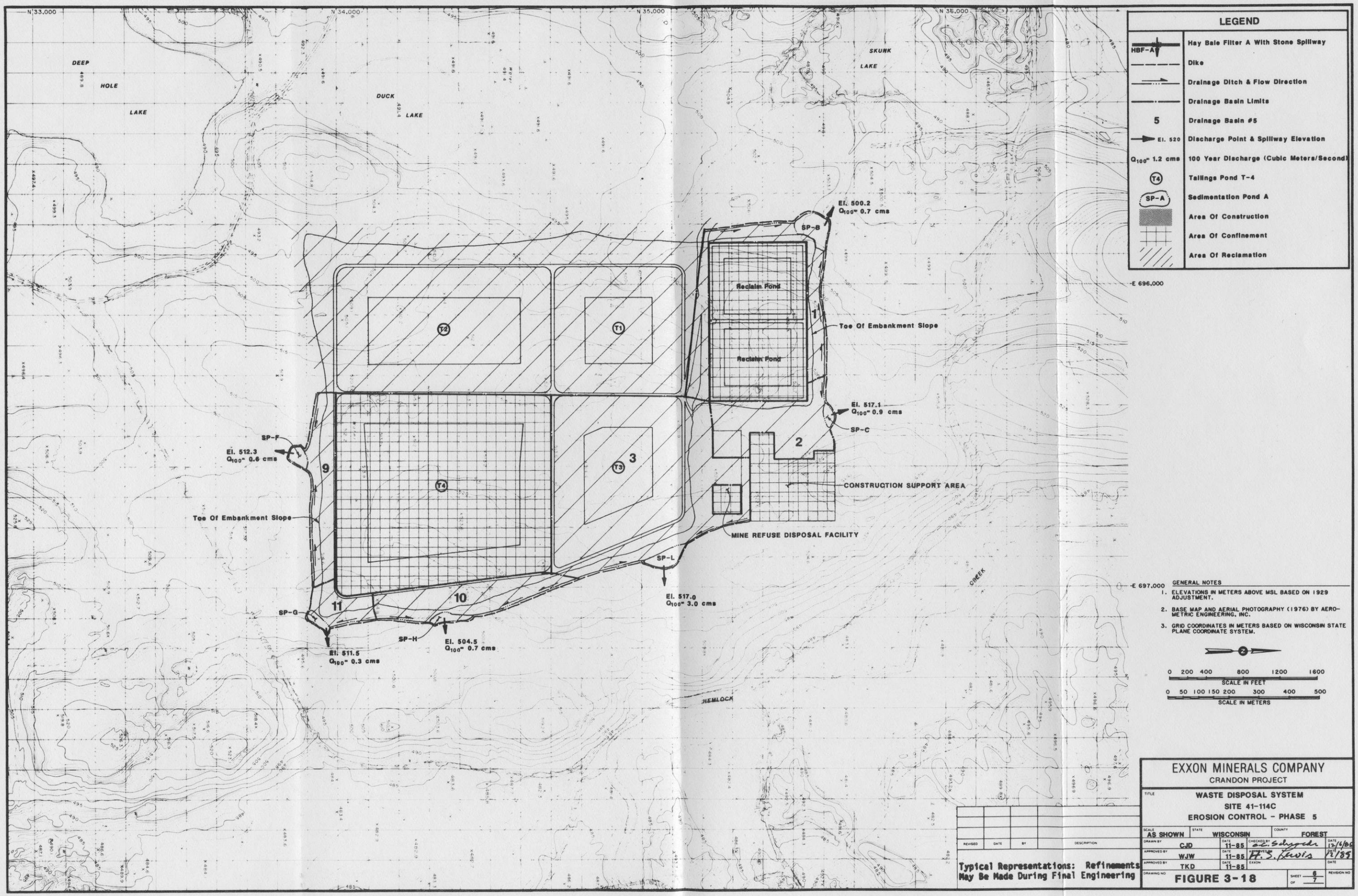
Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 4

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY CJD	DATE 11-85	CHECKED BY C.C. Schroeder	DATE 12/6/85		
APPROVED BY WJW	DATE 11-85	APPROVED T.K. Lewis	DATE 12/7/85		
APPROVED BY TKD	DATE 11-85	EXXON	DATE		
DRAWING NO	FIGURE 3-17	SHEET 6 OF 7	REVISION NO		

DESIGN PRODUCTS CO —



GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

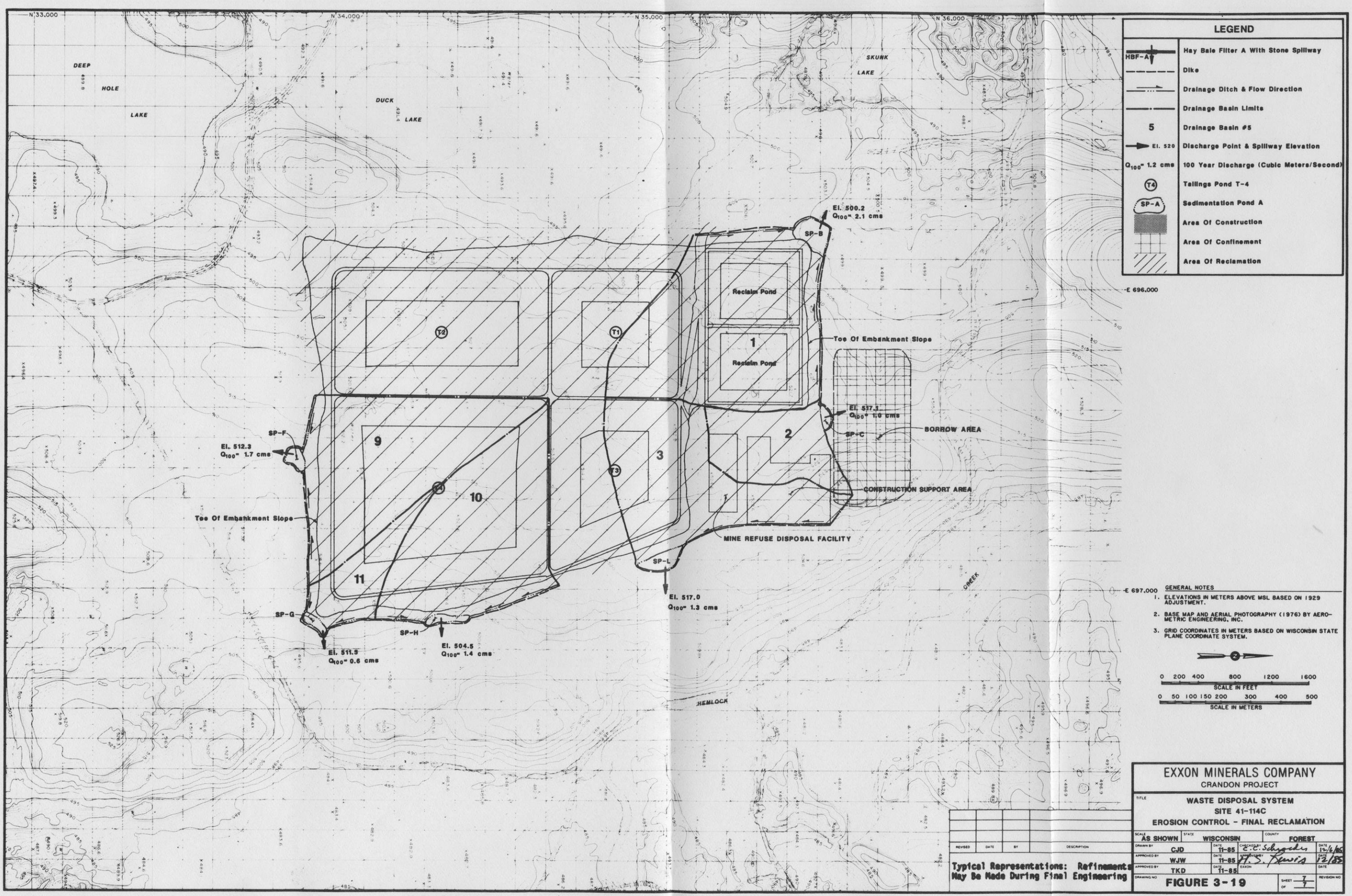
REVISED	DATE	BY	DESCRIPTION

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 5

SCALE AS SHOWN	STATE WISCONSIN			COUNTY FOREST	
DRAWN BY CJD	DATE 11-85	CHECKED BY C.J. Schroeder	DATE 12/4/85		
APPROVED BY WJW	DATE 11-85	APPROVED BY EXXON H.S. Lewis	DATE 12/85		
APPROVED BY TKD	DATE 11-85	EXXON	DATE		
DRAWING NO FIGURE 3-18		SHEET 6 OF 7		REVISION NO	


N 33,000
N 34,000
N 35,000
N 36,000
E 696,000
E 697,000
DEEP HOLE LAKE
DUCK LAKE
SKUNK LAKE
HEMLOCK CREEK
El. 500.2
Q100= 2.1 cms
SP-B
Reclaim Pond
1
Reclaim Pond
Toe Of Embankment Slope
El. 517.3
Q100= 1.0 cms
SP-C
BORROW AREA
CONSTRUCTION SUPPORT AREA
MINE REFUSE DISPOSAL FACILITY
SP-L
El. 517.0
Q100= 1.3 cms
SP-F
El. 512.3
Q100= 1.7 cms
Toe Of Embankment Slope
SP-G
El. 511.5
Q100= 0.6 cms
SP-H
El. 504.5
Q100= 1.4 cms
T1
T2
T3
T4
9
10
11
2
3
LEGEND
HBF-A
Hay Bale Filter A With Stone Spillway
Dike
Drainage Ditch & Flow Direction
Drainage Basin Limits
5
Drainage Basin #5
El. 520
Discharge Point & Spillway Elevation
Q100= 1.2 cms
100 Year Discharge (Cubic Meters/Second)
T4
Tailings Pond T-4
SP-A
Sedimentation Pond A
Area Of Construction
Area Of Confinement
Area Of Reclamation
GENERAL NOTES
1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.
0 200 400 800 1200 1600
SCALE IN FEET
0 50 100 150 200 300 400 500
SCALE IN METERS
REVISED DATE BY DESCRIPTION
Typical Representations: Refinements May Be Made During Final Engineering
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - FINAL RECLAMATION
SCALE AS SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY CJD DATE 11-85
CHECKED BY C.C. Schneider DATE 12/6/85
APPROVED BY WJW DATE 11-85
ENGINEER W.S. Lewis DATE 12/6/85
APPROVED BY TKD DATE 11-85
EXXON DATE
DRAWING NO FIGURE 3-19
SHEET 1 OF 1
REVISION NO

phase is completed, temporary and final vegetative cover will be established where appropriate.

Since these facilities is located in a topographical high area, there are no large quantities of surface flow through the site. Therefore, only minor surface water diversion is required in the MWDF area and there are no major water diversions or other water handling structures proposed. Also, during operation of the facilities with the tailings pond(s) open, total runoff in the area of the MWDF, reclaim pond and MRDF will be reduced because all rainfall over the ponds will be collected in the pond(s).

Vegetation Aspects - Selection of vegetation for use in erosion control during each construction phase of the MWDF will be dependent upon the month in which construction is completed and will follow the same criteria as other facilities. Erosion control and maintenance of soil quality on the long-term stockpile created during phase 3 of MWDF construction will be achieved by seeding with a short-term vegetative cover.

Two basic seed mixtures will be used to establish short-term vegetative cover on the MWDF area. The composition of these seed mixtures is presented in the Reclamation Plan.

3.5.3 Erosion Control During Closure and Final Reclamation

General Facilities - The same erosion control techniques used during construction of major Project facilities will be employed during the 3-year closure and final reclamation phase of the Project. Use of these techniques will minimize the amount of erosion during the removal

of facilities, final grading and reestablishment of vegetation. During the 3-year reclamation period, erosion control measures will be installed and maintained until the regraded soil surface is stabilized and vegetative cover is established.

3.5.3.1 Mine Waste Disposal Facility, Reclaim Pond and Mine Refuse Disposal Facility

During each phase of reclamation grading, temporary silt control basins will be constructed to contain surface water runoff from exposed soils. These structures will be similar to those used during construction of the MWDF, reclaim pond and MRDF. After final grading and contouring of each tailings pond, a herbaceous cover of grasses and legumes will be established to stabilize the soil surface and minimize erosion on the reclamation cap. Invasion of native plant species from adjacent undisturbed areas will be allowed to occur on the reclamation cap as each pond is reclaimed. Permanent vegetative cover on the reclaimed MWDF, reclaim pond and MRDF will consist of those species that invade and become established on the cap. The temporary erosion control structures will be removed after the vegetation has stabilized the soil surface.

The temporary sedimentation basins and straw bale ditch checks proposed for the construction and reclamation phases will be removed after all surface soils disturbed during construction have been stabilized with vegetation and no further need exists for erosion control. With the uniform grades planned for the MWDF and MRDF reclamation cap after final reclamation, surface runoff will be

distributed around the MWDF perimeter where it will again reenter existing watershed areas and resume runoff patterns similar to those that existed prior to construction. Overall, total runoff in the MWDF area after final reclamation will be slightly less than during existing conditions because the final reclamation grade (2 percent) is less than the average existing grades in the area.

4.0 ENVIRONMENTAL PROTECTION

The information contained in this section on environmental protection is presented in accordance with Section NR 132.07(3), Wisconsin Administrative Code.

Environmental studies performed from 1977 through 1985 form the basis for information and data presented in Chapter 2, Description of the Existing Environment, for the Crandon Project Environmental Impact Report (EIR). The purposes of these studies were to document existing environmental conditions, provide a basis for the assessment of impacts associated with potential Project development, facilitate planning of mitigation measures, and provide a basis for the design of future environmental protection and monitoring programs.

This section deals specifically with air quality protection and water quality protection. The surface water impact mitigation plans are currently under discussion with the DNR. After these plans are finalized they will be incorporated into the High Capacity Well Approval Application.

4.1 Air Quality Protection

Estimated air emissions for construction, operation and reclamation of the mine, mill and mine waste disposal facility are presented in the Air Permit Application. Since these air contaminant emission rates are below the 250 ton per year limit, the Project is exempt from the requirement to obtain a Prevention of Significant Deterioration (PSD) permit. For each process unit an emission rate was calculated using the documented emission factor, expected production rate, and its control efficiency as presented in the Air Permit Application.

In order to provide air quality protection, Project dust control technology has been applied to have control efficiencies ranging from 90 percent for passive filters to 99.99 percent for the insertable collectors (see also Appendix B of the Air Permit Application). Insertable collectors were selected for sources where the particulates were fine and could be returned directly to the process.

The insertable particle collectors currently included are designed for continuous operation for applications, where product or nuisance dusts are involved, and where high collection efficiencies are required. They are capable of filtering heavy dust burdens at a high air velocity and constant level of resistance. Collection efficiency often exceeds 99.99 percent.

The principle of operation is that dust laden air is drawn onto the filter envelope where the particles are retained on the outer

surface of the fabric. Continuous operation is maintained by periodic reverse jet air pulses which dislodge the dust from the fabric surface. The dislodged dust is collected and returned to the process stream being cleaned.

For additional information on air quality protection refer to the Air Permit Application Report, the Monitoring and Quality Assurance Plan and the Malfunction Prevention and Abatement Plan (Air Permit).

4.2 Water Quality and Quantity Protection

Water management for the Project is discussed in subsections 3.3.4.2, Water Treatment, and 3.3.4.5, Overall Water Balance. The potable water system and the treatment of sanitary waste water are discussed in subsection 3.1.13 and 3.1.14, respectively.

One of the most important water management controls of the Project for protecting water quality is the recycle and reuse of water for ore processing. Further, the controls will ensure that temporary interruptions of any service (i.e., electricity outage, water treatment plant filter maintenance) will not cause a complete stoppage of the mine or mill activities because of water management problems. In addition, the volume of the reclaim and tailing ponds will provide surge capacity for water management.

The water management design of the Project also protects water quality by collecting within the site (i.e., in the sedimentation and drainage basins), water used for the construction activities in developing the facilities. Surface water drainage from precipitation and water spraying to suppress dust is also collected in these basins to prevent dissolved materials from being distributed in the surrounding water bodies. It also protects water quality by maintaining as much as possible the current water drainage patterns of the site area.

The quantity of water withdrawn from the aquifer and discharged to Swamp Creek will be in accordance with the High Capacity Well Approval and the WPDES Permit.

4.2.1 Surface Water

The primary effluent from the Project will be the discharge of water from the water treatment plant pipeline to Swamp Creek below County Road M. Surface water drainage will occur from non-contaminated

(building and parking) areas. Potentially contaminated (waste rock and pre-development ore storage piles) runoff will be collected in retention ponds and pumped to the reclaim ponds. Water from the reclaim ponds will be treated for use in the mill.

4.2.2 Erosion and Drainage Control

Detailed erosion and drainage control measures to be employed during the construction and operation phases are presented in subsection 3.5, Erosion Control. As discussed in this Plan and the Reclamation Plan, considerable attention has been given to controlling erosion through the use of properly designed surface water drainage systems and vegetative cover. The slope and ground vegetation on the existing terrain generally account for low erosion potential.

Erosion may potentially occur in the following three areas: mine/mill site; access road and railroad corridors; and the mine waste disposal facility. The greatest potential for erosion is estimated for the confines of the mine/mill site. Exposure of bare soils during the grading phase in Year 1 will temporarily expose approximately 115 acres of ground. Construction of the access road and railroad will disturb approximately 80 acres.

Special precautions are planned for access road and railroad construction in wetland areas. Construction methods will include use of temporary retaining berms to prevent disruption of the wetland hydrology. Bridges will be constructed with culverts to maintain water continuity within the wetlands. For those areas where bridges cross streams, temporary retaining walls along the shoreline to contain soil particles will be constructed of sheet piling.

The primary source of effluents during construction will be storm water drainage causing increased levels of suspended solids in nearby water bodies. During construction the primary source of contaminated water will be from the developing mine. Figures 3-11 and 3-12 in Section 3.0 show how the water will be managed during the construction period.

Although most construction activities will occur prior to mill operations, those for the MWDF will be continuous and be staged to correspond with tailings production. There will be six periods of construction activity for the mine waste disposal facility with the length of each varying from 2 to 4 years and with several years when no major work would occur between periods. During each period of construction, control of uncontaminated surface water runoff will be accomplished by constructing a series of ditches, dikes, and retention ponds. Surface water drainage with the potential for high suspended solids content will be directed through sedimentation ponds. These sedimentation ponds will allow settling of the suspended solids. Bales of hay will also be used as needed to provide small dikes for control of drainage in localized areas.

Drainage basin No. 3 will be used to collect surface water runoff from the preproduction ore storage pad. This ore storage pad will be lined with bentonite and sloped to provide drainage to the bentonite lined basin. Water from the drainage basin will be pumped to the water treatment plant.

Another potential source of contaminated water is sanitary wastes. Although the permanent facility will be constructed as soon as possible, portable facilities will be in operation during approximately

the first 2 years of construction. The wastes will be collected and transported off-site to a municipal facility for treatment. Thus, no additional environmental loadings will be generated on-site during this period.

Control measures for rainwater drainage during operations include retention barriers to contain mine/mill site storm water. These barriers, established during the construction phase, are formed by the roads, railroad, and special runoff retention berms, and all serve to divert the water to the large drainage basins located at the north and south boundaries of the mine/mill site. The drainage basins allow settling of suspended materials and slow discharge of water from percolation and outflow piping.

In addition to these basins, special treatment to remove grease and oil will be provided for the equipment maintenance shop area runoff. Oily waste water runoff from the maintenance area will be collected in an underground sewer system. Water will be collected by small area drains that will flow into two trunk lines. These trunk lines flow into a sump located in the paved area south of the fuel oil garage. An interceptor will remove oil and grit which will be transported to an approved disposal area. The waste water will be pumped to the tailings sump.

4.2.3 Ground Water

Some seepage to ground water will occur from the drainage basins, retention, reclaim, sedimentation, and tailing ponds. The drainage basins, retention and sedimentation ponds will mainly collect

surface water drainage from precipitation and dissolved solids. Their bottoms will consist of compacted soil. The reclaim and tailing ponds will be lined to largely reduce seepage. The liner system for the reclaim pond will consist of two parts -- a bentonite-modified soil liner overlain by a synthetic membrane. The membrane will be protected from beneath by a sand cushion, and overlain by sand. The bentonite liner system for the tailing ponds will include an underdrain and filter system with no synthetic membrane. For more information on the tailing pond liner/underdrain system refer to Sections 2.0 and 3.0.

During the operation phase, it is estimated that the maximum rate of seepage from the tailing and reclaim ponds will be less than 15 gallons per minute. After reclamation, following shutdown of the underdrain pumps in the last tailing pond, seepage is estimated to have a maximum rate of less than 20 gallons per minute and then decrease to an eventual steady state seepage rate from the tailing ponds of less than 2 gallons per minute. With these seepage rate estimates, the mine waste disposal facility will meet the ground water quality requirements of NR 182 at the compliance boundary.

4.3 Monitoring and Contingency Plans

Detailed Monitoring and Quality Assurance and Contingency plans have been prepared and submitted to the DNR in accordance with requirements set forth in NR 132 and NR 182. A Monitoring and Quality Assurance Plan was developed utilizing physical and chemical paramater water analyses data for ground and surface water in and nearby the permitted area. This Plan will enable expedient identification of problem areas and appropriate action. The Monitoring and Quality Assurance Plan contains details of the program.

A Contingency Plan for the protection of ground water has been submitted as part of the NR 182 Mine Waste Disposal Facility Feasibility Report. Refer to the Feasibility Report for additional information on the Contingency Plan.

5.0 RISK ASSESSMENT

5.1 Introduction

This risk assessment has been conducted to be responsive to the Wisconsin Administrative Code NE 132.08(i). That portion of the code states:

> "The applicant shall prepare a risk assessment of possible accidental health and other environmental hazards potentially associated with the mine operation. Contingency measures with respect to these risks and hazards, and the assumptions in this assessment, shall be explicitly stated."

The risk assessment reported here has been conducted to evaluate the risks associated with the proposed mine/mill and waste disposal facility. The assessment was structured to evaluate several situations not expected to occur during the normal operation and/or lifetime of the facility. Potential environmental consequences of normal operation for the Project are discussed in the EIR.

Risk assessment under preliminary design conditions has been based on engineering judgment of experienced technical personnel, historical data from related, relevant fields, and semi-quantitative techniques.

This assessment was conducted in parallel with the development of the EIR and other studies integral to the Mining Plan while the actual risk assessment was conducted by D'Appolonia. Exxon personnel provided background, answered questions, and prepared some sections of the assessment. Where pollution control systems and equipment or

administrative controls will be used in the Project under normal operating conditions, the performance of these control measures was considered in this risk assessment.

The probabilities of events occurring have been based on engineering judgment. The probabilities of common industrial accidents (small spills, leaking valves) are in the range of 10^{-2} or higher per year. The probabilities of events with large potential consequences are much lower.

For this study, the probability of various risk scenarios has been combined in a semiquantitative manner to cover both the probability of occurrence and the probability of realizing the consequence discussed. Risk scenarios judged to have probabilities of 10^{-2} per year (e.g., one incident every 100 years) or greater are classified as "high." Risk scenarios judged to have probabilities of 10^{-4} per year or smaller are classified as "low". Risk scenarios classified as "moderate" lie between these two. It is emphasized that these classifications are qualitative and are based on engineering judgment and industrial experience.

5.2 Concentrate Spills

At the Crandon Project, three concentrates will be produced. These are copper, lead, and zinc concentrates. Chemically, each of these concentrates will be composed principally of the sulfide mineral form. Physically, the concentrates will be a relatively fine-grained material.

On an average basis, the Project will produce approximately 1,060 short tons per day of zinc concentrate, 140 short tons per day of copper concentrate, and 55 short tons per day of lead concentrate. The concentrates will be handled using conventional covered conveyor technology. The concentrates will be loaded into railroad cars for off-site transportation. To minimize potential dust emissions from the concentrate handling, dust collection systems will be used for each load out circuit. After each rail car is loaded, a protective cover will be placed over the load (e.g., fiberglass cover, or plastic sheet, or antidusting agent) to eliminate blowing dust and concentrate losses during transport.

5.2.1 Assessment of Risk

To represent a potential risk, concentrate spills would have to result in large quantities of material being released off-site. Spills which would occur during the materials handling and loading procedures inside of the mill do not represent a potential source of risk.

For a concentrate spill on-site to present a source of risk, the spilled concentrate would have to be transported off-site.

Potential transport mechanisms include:

1) Airborne, as a particulate.

2) Waterborne, as a particulate in a surface watercourse.

3) Waterborne, as a leachate introduced to either surface water or ground water regimes.

Spills of concentrates off-site could occur by several mechanisms. None of these mechanisms are expected to occur but are possible. Spills could occur because of either of the following two mechanisms:

1) Derailment of a rail car.

2) Malfunctioning rail car cover and high wind speed resulting in generation of dust.

The last mechanism is highly unlikely to occur and would not result in large quantities of concentrate spilled in a localized area.

Should a concentrate spill caused by a derailment result in airborne particulates being released, the potential effects would depend upon whether or not the particulates deposit or remain airborne. The concentrate has a large fraction of very fine grained material; some of it is less than 10 μm.

For the larger particulates, it is likely that they would deposit relatively soon after becoming entrained. This would result in a "dust film" being deposited downwind of the spill location. As a solid, this material may be unsightly but does not exhibit any known toxicological effects on plants. Should the dust be ingested by the local animal population, it is doubtful that any effect would result (Sax, 1979). Hence, any effect would be short-term and reversible.

A major portion of the concentrate exists as particles small enough to be classified as respirable particulates. Given that the spill would occur at or very near ground level and that most of the local terrain is heavily forested, it is highly unlikely that even these particles would travel appreciable distances. Such an event would be short-term, as opposed to continuous, and would not pose an appreciable inhalation risk to the local population. Health effects caused by inhalation of particles in the respirable range are generally exhibited after long-term (chronic) exposure. It is not anticipated that any long-term exposure will result from concentrate spills, given the expected low frequency of occurrence, the low elevation of release, the filtering effects of the surface vegetation, and the low population density.

Derailment of concentrate cars under unusually dry, windy weather conditions may present neither short-term nor long-term risks to people with respiratory sensitivities. The concentrates are dense and inert and their economic value dictates that recovery of the product would occur as soon as practicable after the spill.

Also, the concentrate is not a dry powder and will not be readily suspended by wind unless the material is not recovered and dries. The concentrate will be shipped at 8 to 10 percent moisture content which will preclude immediate dusting of the material after an accident. Following the spill and before the concentrate is allowed to dry, sufficient time would be available to clean the area to preclude any impact to sensitive populations.

The probability of a train accident is low. In a systematic study of transportation accidents (R. K. Clarke, et al., 1976), it was determined that the probability is 1.5×10^{-6} car accidents per car mile. This was based on nationwide data for transportation of all types of commodities (rather than passengers) and for all types of operating conditions for the trains. The report noted that 83 percent of all train accidents evaluated involved derailments, which do not normally occur at low train speeds over well maintained tracks. Since the operation of all trains within the Project site boundary will meet these conditions, and since the concentrate rail cars will be inspected to assure that they are not leaking product prior to the train being cleared to leave the property, the probability of a major release of concentrate is judged to be even lower than the 1.5×10^{-6} determined in the Sandia evaluation.

A concentrate spill may have the potential to be harmful to people with chronic respiratory ailments under certain conditions. However, the probability of this event happening is extremely low when considering the other factors that must also be present at the time of a train accident that would allow the concentrates to dry and become airborne, i.e.,:

1) Hot, dry weather with windy conditions lasting several days.

2) The rail carrier and Exxon Minerals Company (EMC) not taking remedial action.

In order for concentrate particles to escape into the atmosphere they have to be dry and carried by wind. Even under hot, dry, windy, conditions it takes several days for spillage to dry to the extent particles can become wind-borne.

If a release should occur, Exxon would work closely with the rail carrier to begin immediate corrective action. This action will be highly dependent on the location, nature, and magnitude of a particular release. As discussed above, major releases due to train accidents are expected to be a low probability event.

The possibility exists that an accident involving transportation of concentrate could result in a spill into a water body. However, the probability of such an occurrence is small and impacts minor. Specific probabilities of accidents involving shipment of concentrates are not available. As discussed in a study performed by Sandia Laboratory (R. K. Clarke, et al., 1976), the probability of a train accident resulting in a cargo being spilled into a water body is even more remote than for a train accident resulting with a spill onto land. In part, this is due to the small fraction of the rail system that is built on bridges, and the typically low operating speeds for trains when on bridges. In part, it is also due to the buffer zone of land that normally is present when a rail track is adjacent to a stream, lake, river or other water body. The Sandia study concluded that the conditional probability of a train accident occuring on a bridge over water is 9×10^{-5}. This probability must be combined with the probability of 1.5×10^{-6} car accidents per car mile to give a net probability of 1.4×10^{-10} car accidents per car mile on a bridge. While the accuracy of these probabilities is subject to uncertainty, they are clearly low probability events.

Even if such a low probability incident did occur the risks would be short-term, highly localized, and primarily a mechanical disturbance of the environment. The high density of the material would

promote rapid settling, should it be introduced to a surface watercourse. There is very limited potential for heavy metal being leached from the concentrate because of the high insolubility of the metal sulfides in water. Under equilibrium conditions, the solubility of the concentrates in water is less than the U. S. Environmental Protection Agency (EPA) limits for the metals established for the protection of freshwater aquatic life or human health (U. S. EPA, 1980). Should very low pH water be encountered, it is possible for the concentrates to dissolve. However, even under these conditions, the metals would be attenuated by the sorption properties of soils. A persistent, high concentration source will not be established.

Because the concentrates are both inert and immobile, remedial measures can occur in a timely manner to recover the spilled material. Because of the economic value of the concentrate, recovery operations would occur immediately. Specific techniques used to recover spilled concentrate will depend on the amount of concentrate spilled and the location. However, the concentrate will be recovered to the maximum extent practicable.

5.2.2 Conclusions

The overall risk from concentrate spills is low. The relative immobility and chemical inertness of the concentrates avoids any short-term effects (except for some spills which could result in highly localized mechanical disturbance). Because of the highly localized nature of spills, recovery operations are facilitated. Recovery is technically feasible and any concentrate which is spilled will not result in a long-term contamination source.

The plausible consequences to the environment (e.g., dusting) are not severe and are reversible. The potential effects on human health are believed to be almost nonexistent in the short- and long-term because the heavy metals are not present in a mobile form and because they will not result in long-term (chronic) exposure, even at low levels of concentration, due to recovery measures.

Thus, the most likely risks from concentrate spills are believed to be short-term, highly localized, mechanical disturbance of the environment. Because of its inherent nature and because of the driving forces for recovery, this effect is reversible.

5.3 Reagent Spills

During the life of the Project, the mill operation will receive many different types of reagents for use in the ore processing. The anticipated quantities of reagents which will be stored on-site, the mode of transportation to the site from the supplier, and reagent form (liquid or solid), are presented in Section 2.0, Table 2.5. The reagents will be unloaded and placed in storage.

Reagent storage and delivery systems will be designed based on reagent characteristics to prevent leaks or spills. Appropriate ventilation will be provided to remove gases and odors from the area.

All equipment and operating procedures will be designed to meet applicable fire protection regulations. Emergency showers, eyewashes, and other first aid equipment will be conveniently located in this area.

5.3.1 Assessment of Risk

5.3.1.1 Local Reagent Use

The major concern with the use of reagents is spills. Spills could occur during unloading, mixing, storage, and/or use in the process. If no action is taken, these spills could produce localized hazardous conditions. Certain chemicals, if mixed, could react to cause gaseous by-products. These gases could be toxic.

The Project procedures will provide for curbing and will ensure that spills are contained and handled properly, thereby avoiding accumulation in the soil to toxic levels and preventing surface runoff

into nearby lakes or streams. This will eliminate any long-term consequence which could adversely affect the environment and, ultimately, the public health and safety.

Reagent spills during operation are the main focus of this assessment. The likelihood of these kinds of spills occurring within the Project boundary are considered negligible. The occurrence of spills during transport of hazardous materials is certainly known, but these are low probability events. Recent information for truck transport during 1983 (Chemical and Engineering News, page 6, 10 September 1984) indicates that the probability of spills was 2.7×10^{-5} per truck shipment. Engineering judgment would indicate even lower probabilities for truck transport accidents within the Project boundary because of the low truck speeds, low traffic densities and high quality of the roads. In addition, approximately 80 percent of the spills reported in 1983 were not of a serious nature, as determined by U.S. Department of Transportation (DOT). Similar 1983 data for railroad transport of chemicals is not currently available, but is expected to be equivalent. This judgement is reached by comparing truck and rail transport accident probabilities, as reported by Sandia Laboratories (R. K. Clarke, et al., 1976). The access road will be maintained and the posted speed will ensure safe operation. The railroad spur will be inspected and maintained regularly. In addition, the grade will be less than 1 percent and the operating speed will be slow. The assumption has also been made that all equipment will be maintained in a condition which complies with all the Department of Transportataion requirements.

Therefore, equipment failure becomes a negligible factor (Transport Canada, 1980).

Reagent spills are an important consideration in plant design. Spills present hazardous working conditions for the worker; they pose a potential threat to the environment; spills are costly, and adversely affect plant operating efficiency. Generally, sound engineering design is required to ensure that reagent spill events have a low probability of occurrence. It is important to note that this assessment was conducted with the assumption that spills were unattended, and no effort was made to contain or clean up the spill. In actual operation, this would not occur.

Sulfur dioxide, sodium cyanide, sodium dichromate, and sulfuric acid are the only reagents listed in Section 2.0, Table 2.5 which were considered to present a potential risk.

A spill of liquid sulfur dioxide in large quantities could pose a short-term, environmental consequence. This effect would be transported mainly by air, due to the chemical properties. Liquid sulfur dioxide, if spilled, would vaporize rapidly from the liquid state at temperatures above 14 degrees Fahrenheit. Therefore, contamination of surface waters would not occur. During winter months, spilled liquid sulfur dioxide would remain in a liquid form and, if contact were made with surface water, a low pH would result. This condition would be short-term and reversible.

Sulfur dioxide spills which occur during warmer months would vaporize and the vapor would be transported by air beyond the Project boundary. The effect would be directly dependent on the size of the

spill, the wind direction, and velocity. In general, the immediate effects would be short-term and reversible. Public health and safety impairment from airborne SO_2 would be very small, depending on location.

The construction materials required for storage and the equipment required for safe handling of liquid sulfur dioxide are well defined. Sulfur dioxide is used in many industries and is handled, stored, and used daily in a safe, acceptable manner. Some other major industrial users include: paper mills, food and grain processing, malting, and waste water treatment.

The sulfur dioxide storage area will be within an enclosed building adjacent to the mill, with a concrete floor and washdown facilities which drain to the water treatment system. Personnel will be trained for standard operating and emergency procedures. Safety equipment will also be available. In addition, the Facility will be designed to comply with appropriate Mine Safety and Health Administration (MSHA) regulations. When properly engineered and operated, the risk of sulfur dioxide spills will have an extremely low probability of occurrence.

Sodium cyanide will be received as briquettes and this will minimize dusting during operations. The briquettes will be received in Flo-Bins™ which contain 3,000 pounds. The empty bins will be returned to the supplier. The bins will be stored inside the mill. A briquette spill would have no public health and safety consequence due to airborne particles.

If a spill of sodium cyanide occurs to surface water, it has potential to temporarily affect surface water quality. Sodium cyanide solution could be transported beyond the Project boundaries. However, sodium cyanide solutions require high alkalinity to maintain a free cyanide form. At pH below 9.3, sodium cyanide will hydrolyze to form sodium hydroxide and hydrogen cyanide(HCN). The hydrogen cyanide has a high vapor pressure and, therefore, reacts further to set up an equilibrium between HCN (liquid) and HCN (vapor). In addition to decreasing pH, increased temperature and turbulence (such as mixing) will accelerate volatilization of HCN. Any HCN remaining in liquid form will tend to oxidize to the cyanate (CNO) form, which can be complexed with metal ions or can further decompose to ammonia (NH_3) and carbonate (CO_3).

Because of the unstable nature of free cyanide, it is unlikely that sodium cyanide will remain in its original form, if it reaches surface water. Volatilization and oxidation will occur as well as complexing and decomposition with the result that minimal, environmental effects will be realized beyond the Project boundary. Therefore, any effect realized offsite would be short-term and reversible.

Reagent mixing and solution storage will be designed in compliance with MSHA regulations. The floor in the reagent area will be concrete and designed to contain reagent spills separately. Solid spills will be swept into containers and the area washed. Liquid spills will be washed into the sump and pumped to the tailing thickener for treatment.

Materials of construction and other associated equipment required for sodium cyanide storage and handling will reduce the probability of a major cyanide spill. Containment and control of minor, accidental spills will further reduce the risk of potential environmental impact to a low probability. With a properly engineered and operated system, the risks to the environment are eliminated.

As with sodium cyanide, spills of sodium dichromate solution could pose potential environmental consequences through transport by surface water. Concentrated solutions are moderately strong oxidizing agents. Effects on the environment could occur in two ways: (1) hexavalent chromium (Cr^{+6}) concentrations higher than allowable water quality standards could result, and (2) aquatic and terrestrial plant uptake of chromium. The environmental effects of hexavalent chromium are documented in the literature (U.S. EPA, 1980). In lieu of developing a detailed hypothetical situation, all spills involving sodium dichromate will be regarded as having potentially serious consequences. Should sodium dichromate solution infiltrate the soil on-site, studies performed have shown that chromium ions will be attenuated by the soil (D'Appolonia, 1982). The effects of sodium dichromate would be short-term and reversible.

Sodium dichromate handling and storage systems will be designed with the proper construction materials and equipment to prevent accidental spills. Proper design will mitigate the event of a spill to a low probability. Within the concentrator building and the storage area, all spills will be contained and kept separate from other materials. This will afford the operator an opportunity to control and clean up spills in a safe manner.

Sulfuric acid will be received in bulk by truck or rail and will be stored in an above ground tank. The tank will be bermed and the berm will be lined to contain all spills. Materials of construction for vessels containing concentrated sulfuric acid are well defined.

With a proper design which complies with the MSHA regulations, the possibility of a spill becomes a low probability event. Containment of spills in the storage area and the areas of use (water treatment) mitigate the potential effects to the environment. Should accidental sulfuric acid spills reach surface water, the pH of the water would be reduced in proportion to the amount of dilution. This effect would be short-term and reversible.

The effect outside the Project boundary would be small in that major consequences would require a continual spill of sizable quantity over a long period of time.

The risks associated with polypropylene glycol methyl ether and methyl isobutyl carbinol are minor to nonexistent. In-plant controls and containment facilities will preclude environmental impact from reagent spills in the mill and associated facilities. Transportation of these reagents within the facility boundaries, as with the other reagents discussed, is the only mode of potential environmental risk.

The likelihood of these kinds of spills occurring within the Project boundary is considered negligible. As previously mentioned, the access road will be maintained and the posted speed will ensure safe operation. The railroad spur will be inspected and maintained regularly. In addition, the grade will be less than 1 percent and the

operating speed will be slow. All equipment will be maintained in a condition which complies with all the Department of Transportation requirements. Therefore, the expected accident or spill probabilities should be lower than the National averages which are already quite low (Chemical and Engineering News, 10 September 1984, p. 6). Should a spill occur in transit, the effects would be short-term, reversible, and would constitute little to no threat to human health.

Polypropylene glycol methyl ether and methyl isobutyl carbinol are common reagents used as frothers in the flotation process. They are relatively stable, non-corrosive, and non-reactive agents, requiring no special handling, and present no special health or safety hazard from acute or chronic exposure. Methyl isobutyl carbinol will be stored outside the mill building.

5.3.1.2 Major Reagent Spill

Although a remote possibility, if a major reagent spill occurs on-site, the following contingency actions will be initiated. The spill will be reported to the environmental compliance staff and to the security personnel. In the event such a spill occurs when the environmental staff is not on duty, security personnel will be contacted initially and then environmental staff at home, if necessary. The following information will be provided:

Observer Reporting

1) Identity of reagent spilled.

2) Location of spill.

3) Estimated amount of material spilled.

4) Time spill occurred.

5) Is anyone injured or in immediate danger as a result of the spill.

All responsible personnel will receive training to assure the following actions:

Action Following Notification

1) Stay clear of the area (i.e., if the spilled reagent is identified on the master list of toxic agents).

2) Assist in preventing entry to the area by unauthorized personnel.

3) Do not leave the vicinity (i.e., in an assured safety zone) until someone arrives to assume the duty of isolating the area and commencing mitigative procedures.

4) Notify the proper authorities (i.e., DNR and appropriate federal agencies), environmental staff if not previously notified, and any safety or medical personnel required, indicating the information obtained from the observer.

The responsible staff will initiate recovery and isolation of the spill consistent with the concerns for public safety and environmental protection. Actions will include the following (not in order of performance):

Spill Recovery and Isolation

1) Secure the spill site to prevent entry to the area by unauthorized personnel.

2) Use only those personnel specifically trained and protected for handling such an emergency.

3) Contain the spilled material to prevent further spread.

4) Begin immediate recovery steps to assure maximum retention and isolation of the spilled material so that public exposure and environmental impact is kept to a minimum.

5) Assure the storage or treatment of the recovered material.

6) Begin disposal of the unusable material and aids (i.e., rags, containers) at a predesignated site approved for receipt of this material.

7) Notify responsible state, federal, and company authorities of the occurrence and remedial actions initiated and implement all planned mitigation procedures.

8) Begin investigation to determine cause of spill and to the maximum extent possible prevent future occurrences.

All substances possessing toxic properties will be handled in accordance with state and federal regulations. Also, employee exposure to these substances will be monitored and controlled through the industrial hygiene program. Material safety data sheets for the following list of reagents were provided to the DNR in a previous submittal:

Activated Carbon
CMC-7LT
Copper Sulfate
Dowfroth 250
Flocculant
Lime
Methyl Isobutyl Carbinol
Potassium Amyl Xanthate
Soda Ash
Sodium Cyanide
Sodium Dichromate
Sodium Ethyl Xanthate
Sodium Hexametaphosphate
Sodium Isopropyl Xanthate
Sodium Silicate
Sodium Sulfide
Sulfur Dioxide
Sulfuric Acid
Zinc Sulfate

5.3.2 Conclusions

The risk of accidental reagent spills during routine Project operation will be a low probability event with properly designed reagent

handling and storage systems. Consequences of small spills during reagent use will be mitigated by the containment and proper handling of each spill. Because these spills would be minor, discrete, short term events, the consequences would not be severe. Since accidental spills would be localized, no threat to public health and safety will arise.

Contingency plans will be provided for the use of each reagent prior to operation. These plans will be developed prior to operation and used as training guides for the operators in the reagent area.

5.4 Fuel Spills

Large quantities of diesel fuel and lesser amounts of gasoline will be required during construction, operation, and reclamation phases of the Project. During the construction phase, diesel fuel will be required for earth moving equipment and, initially, will be dispensed from a tanker truck. Soon after construction begins, a temporary storage facility will be constructed and used. Lesser amounts of gasoline will be used for other vehicles and equipment. Storage will be provided on-site.

During the operation phase, two 15,000 gallon tanks will provide storage for diesel fuel. This fuel will be used primarily for the underground mining equipment; however, the storage tanks will be designed with the capability of fueling surface vehicles as well. Diesel fuel will be piped to underground storage tanks through a borehole. Gasoline storage quantity should be about the same as during the construction period and will be located close to the vehicle repair shops.

Fuel requirements during reclamation will be provided by existing facilities. When permanent fuel storage is removed, fuel will be provided in the same manner as in the construction phase.

5.4.1 Assessment of Risk

The risk associated with fueling of vehicles and equipment, regardless of phase, comes from accidental fuel spills. Fuel spills could occur from leaking pipes and hoses or careless handling. This could occur during transfer of bulk fuel to storage or fueling of

equipment. This assessment focuses on small quantity spills from handling rather than the rupture of a storage tank. Handling of fuel presents the greatest opportunity for human error to be incorporated into the fuel storage and handling system.

During the construction phase, before construction of the fuel storage tanks and berms, fuel spills would be absorbed in the soils. This absorption will hinder the migration of fuel off-site. Because of the discrete nature of a spill, and the sorptive properties of the soil, these accidental spills can be easily contained and cleaned up. The only short-term effects will be highly localized contamination of soil and volatile emissions of the fuel vapor. There will be no long-term or irreversible effects because the contaminated soil will be removed following a spill. The actual disposition of any affected soil will be specified in the SPCC Plan which will be developed at a later stage in Project development.

During operation, fuel will be supplied only from the fuel station. This station will incorporate modern dispensing equipment, hard surface drives, curbs, and sewers. Small accidental spills can be cleaned up using sorption materials or flushed with water to the storm sewers and ultimately to treatment. The only short-term effect will be emission of fuel vapor. There will be no long-term or irreversible effects.

The fuel storage facilities are designed to ensure no environmental impact as a result of tank rupture. The fuel storage tanks will be located within containment dikes sufficient in size to hold the entire tank volume.

The area within the containment dikes surrounding the fuel storage facility will be lined to prevent spills and contaminated runoff from reaching soil, surface water or ground water. Any minor spills, washdown, or runoff from this area will be transferred to the industrial wastewater treatment system. (This system also collects washdown and runoff from around the shops and other areas of potential oil/grit contamination.)

The effects of spills during reclamation, will be similar to those discussed during construction and operation. As in those phases, there will be no short- or long-term irreversible effects.

5.4.2 Conclusions

With the mitigating factors discussed, fuel spills will not be a concern. Fuel spills will be a low probability event. Spills which do occur will have no consequences outside the operating area.

Contingency plans are required under the federal SPCC regulations. Development of these plans will commence prior to the start of construction and will be incorporated into personnel training. Good inventory control practices will provide early warning of leakage from storage tanks.

5.5 Leachate Control System Failure

During normal operation, a percentage of fine tailing must be disposed of in a surface waste disposal facility. Information on waste characterization and mine waste disposal facility engineering is presented in the Revised MWDF Feasibility Report.

The bottom of each pond is lined to create a seepage barrier. The liner is used to control the seepage flow rate from the pond.

5.5.1 Assessment of Risk

Potential risk could exist if the leachate control system fails during operation and results in an increased seepage rate through the liner. The water quality of the seepage represents risk of ground water contamination.

The increased seepage rate through the liner could occur in several different ways. If the underdrain fails to provide adequate hydraulic capacity or is damaged in some manner, the head (water pressure) created by the saturated tailing on the liner would increase. Increased head will cause increased seepage through the liner. Liner failure could also cause increased seepage. This might occur as a result of damage to the liner during construction or because of chemical reactions with the liner soil materials. Risk of increased seepage rate also exists during reclamation, if the tailing pond cap is improperly constructed.

If the seepage rate exceeds current estimates, regardless of the cause, a potential effect on the local ground water system exists. The seepage could migrate from the mine waste disposal facility with the

ground water and at the 1,200 foot compliance boundary, the ground water quality may exceed the allowable standards if no contingency measures are taken. Continued migration beyond the operating boundary, could result in contamination off-site. Depending on the duration of the increased seepage rate and water quality, a long-term effect could result. This effect would be reversible.

The mine waste disposal facility design has incorporated many features in order to reduce the seepage rate. The ultimate objective of the design is to minimize seepage flow rate from the pond so that ground water quality at the 1,200 foot compliance boundary meets ground water standards. To insure ground water standards are met at the compliance boundary, the following controls have been incorporated into the mine waste disposal facility design:

1) The facility has been sited so that a substantial soil buffer exists between the pond bottom and the water table.

2) The low permeability and attenuative properties of the glacial tills help to mitigate effects of seepage from the mine waste disposal facility.

3) The facility has been designed to operate in stages rather than as one large facility. This limits the area impacted.

4) Water in the tailing pond has been minimized through the use of a tailing thickener as well as decanting as much water as practical from the pooled water. In addition, water leachate seeping past the tailing solids will be intercepted by the underdrain and pumped to the reclaim pond.

5) For long-term MWDF performance the tailing pond seal (cap) is more important than the pond liner and underdrain in leachate control. The cap will consist of a composite soil-bentonite and synthetic membrane seal overlain by a coarse sand and gravel drain layer that directs precipitation infiltration away from the pond. A 5 foot soil cover is included as a final cover to protect the drain and seal.

6) Conservative values of permeability content of the liner and liner thickness have been selected.

7) Conservative assumptions have been used for the tailing pond cap design.

8) For each pond, submersible pumps located around the perimeter pipe provide backup in the underdrain pumping system.

9) If, after closure of the tailing ponds, seepage continues at higher than predicted rates for an extended period, flexibility exists to extend the underdrain pumping schedule.

10) Monitoring and sampling will be provided through a system of lysimeters and wells.

(Note: Additional documentation on tailings pond engineering design, construction, operation and reclamation is provided in the NR 182 Mine Waste Disposal Feasibility Report.)

With these design concepts, seepage flow rate will be controlled so that compliance with ground water standards at the 1,200 foot boundary is achieved. The chance of seepage migrating off-site is seen to be a low probability event, based on engineering judgment.

5.5.2 Conclusions

Assessment of the risk of a leachate control system failure demonstrates that the chances of off-site effects are a low probability event. A contingency plan for this low probability event has been prepared in accordance with Wisconsin Administrative Code NR 182 which will prevent off-site effects.

5.6 Accidental Detonation Of Surface Stored Explosives

Blasting will be required for underground mine development and operation. Explosive storage will be maintained on the surface in a secure area, northeast of the mine/mill site. In this location, explosives will be stored in three separate areas. One area will be for ammonium nitrate/fuel oil (ANFO) type explosive, a second area for the water-gel type explosive, and a third area for the caps, primers, and detonating cord. Explosives and materials will be transferred by truck to the headframe for distribution in the mine.

5.6.1 Assessment of Risk

The risk involved is that the entire storage of explosives could be detonated accidentally. This might occur as a result of impact, shock, fire, or an electrical charge.

Potential effects off-site of an accidental detonation are related to the environment, rather than public health and safety. The magazine will be designed in accordance with applicable codes, standards, and regulations. This will assure that debris generated by the detonation, and the associated shock wave, will present minimal hazard to the surrounding buildings and structures. The risk of an accidental detonation causing a subsequent accident in some other area of the Project site is minimized. The most likely effects from an accidental detonation would be on-site caused by falling debris or fires caused by hot debris.

Design features, which are required for the surface storage of explosives, are well documented in federal and state regulations, MSHA, and the Wisconsin Department of Industry, Labor and Human Relations (DILHR), respectively. Some of these features which will be included in the final design of the facility can be summarized as follows:

1) Storage areas will be located at required distances from inhabited buildings, public highways, and passenger roads.

2) Barricades (berms) constructed around the area will be in compliance with federal and state regulations (Bureau of Alcohol, Tobacco, and Firearms, 1976, and Wisconsin Administrative Code, DILHR, 1973).

3) Storage buildings or shelters will be designed to be bullet-resistant, fire-resistant, weather-resistant, theft-resistant, and adequately ventilated. The interior of the magazines will be lined with non-sparking material.

4) Only battery-activated safety lights will be used in a magazine.

5) Doors will be designed so that hinges and hasps cannot be removed when the door is closed. Two locks, or the equivalent, are required.

6) Smoking or the carrying of matches or lighters is not permitted in a magazine.

7) The area within 25 feet of the storage magazine will be kept clear of all combustible materials.

With these design factors and the enforcement of all appropriate federal and state regulations, the probability of an accidental detonation is low.

Historical data from the mining industry indicate accidental detonation of surface stored explosives would constitute an extremely rare event. A report prepared by the U.S. Department of Labor, Mine

Safety and Health Administraton, January 1981, "The Explosion Hazard in Mines", does not cite any surface explosions being caused by detonation of surface stored explosives.

5.6.2 Conclusions

Risks associated with the storage of explosives are low. Safety standards have been built into storage area design to reduce the potential risk of accidental detonation and to mitigate consequences, should a detonation occur.

No contingency plans are required; however, standard procedures for handling and storage set forth by the Institute of Makers of Explosives (IME) will be used.

5.7 Forest Fires

In the area of the Project, forest fires present a potential hazard. Because of the nature of other commercial and recreational activities which occur in the region, considerable expense and effort are placed in developing fire-fighting capability. This provides a mitigating measure, should a forest fire occur. In addition to the development of these mitigating measures, additional effort and expense is placed in educating the local population, both permanent and transient, in their role in reducing the potential to cause forest fires.

If controlled burning is conducted to eliminate waste wood that remains following Project clearing activities, a DNR burning permit will be obtained, as required. Measures specified on the burning permit will be followed to prevent forest fires.

For the Project, there are two separate questions which must be evaluated with respect to forest fires: (1) What is the potential effect of a nearby forest fire started off-site? (2) Is there some unique feature about the Project which could potentially lead to the initiation of a forest fire?

5.7.1 Assessment of Risk

Forest fires could occur during construction, operation or reclamation. The potential for a forest fire to be initiated away from the Project area is always present and independent of the existence of the Project. For an external event like this to have a potential effect

on the Project, it would have to occur relatively near the Project and would have to be unaffected by fire-fighting efforts before reaching the Project. Should a forest fire reach the perimeter of the mine/mill site, the damage done prior to that time would be independent of the Project. The fire break around the Project area would divert the fire path.

Forest fires may originate within the Project boundary and move off-site. Such an event must be considered during the construction, operation, or early reclamation phases. Historical data for mine/mill facilities are not available, but data for large electric power stations (Hockenbury, 1980) indicate that fires occur on-site more frequently during the construction phase than during operation. There is nothing to suggest that the frequency pattern is unique to electric power plants.

Should an off-site forest fire spread to pose a threat to the Project, the expected effect of the Project on the fire is expected to be small. The most severe hazard that the forest fire would represent to the Project would be to eliminate the normal electrical power lines and telephone communication lines. The loss of these services would cause the interruption of normal mine/mill operations. During construction or operation, no further on-site consequences are expected. Certain vital services will be powered from an on-site emergency electric power station. For example, this will allow man-hoists to be operated.

Because of the large amount of land surface which will be cleared, the Project may act to impede the spread of a forest fire. In addition, the fire-fighting units from the Project will be available on a volunteer basis to assist others in controlling and extinguishing the fire.

If the situation is considered where some on-site activity causes a fire, the potential for this fire to spread off-site exists. However, once off-site, there is nothing to distinguish this fire from any other forest fire, started from another source. The consequences would not be unique.

Because of safety standards employed during construction and operation, there is little probability of an on-site fire during the life of the Project. On-site fires have not historically been a serious problem in zinc, copper, and lead mining and milling facilities.

Using data on surface fires at underground mines published by the Bureau of Mines in "An Annotated Bibliography of Metal and Nonmetal Mine Fire Reports," December 5, 1980, the probability of a surface fire at the Crandon Project would be less than one fire during the life of the Project. The duration of this postulated fire based on the same report would be less than 4 hours. Because of the fire prevention standards, and detection systems to be used at the Project, the probability of fires and their duration should be less than the probability presented here and as such on-site fires do not represent a serious risk.

The Project will incorporate a large cleared area which will serve as a fire break. During the life of the Project, a number of on-site incidents which involve fires can be anticipated. These range

from fires which are intentionally started during clearing and grubbing activities to those fires which might start in the laboratory. In all cases, the amount of cleared land around the structures tends to eliminate the possibility of an on-site fire spreading to the surrounding environment. Trained personnel will be on-site at all times. Operating procedures for those functions which do involve the potential for or existence of fire will recognize the need for control.

In general, the potential of electrical fires starting along the powerline corridor is very low based on the experience of Wisconsin Public Service Corporation in their service area (Mr. Mark Eversman, personal communication, Wisconsin Public Service Corporation, October 25, 1983). Following preparation of the corridor for the powerline, it will be maintained in a vegetative cover of herbaceous plants and low growing shrubs. Growth of undesirable woody plant species in the corridor will be controlled through the use of EPA-approved herbicides. The edges of the corridor will be maintained by periodically trimming the limbs that may extend into the right-of-way. The powerline corridor and adjacent access road will serve as a fire break for any local fires that may occur in areas bordering these Project-related facilities.

The ballast section of the railroad spur will be kept entirely free of vegetation through the use of EPA-approved herbicides to assist in preventing forest fires. Undesirable weeds and woody plants within the right-of-way also will be controlled by mowing or through the use of EPA-approved herbicides. During Project operation the railroad spur will receive limited use (approximately 15 round trips between the siding and the mine/mill site per week). These conditions will minimize

the potential for fires along the railroad spur. The railroad spur also will provide a fire break which will help to control spreading of local fires originating in forest land along either side of the corridor. The design of the railroad spur and the operations on it will be very similar to other industrial rail spur tracks.

5.7.2 Conclusions

Certain on-site activities involve the potential for fires to occur. Careful design, thorough work procedures, and the fire-fighting force provide assurance that even those small accidental fires which do occur will not develop into forest fires.

5.8 Mine Subsidence

Mine subsidence could present a potential source of risk during all phases of the Project. The two main causes of subsidence would be overburden consolidation and rock collapse. If subsidence would occur, it would be limited to the surface area immediately over and adjacent to the orebody. Predicted maximum possible subsidence is within allowable limits for conventionally designed buildings.

The mining methods and stope sequences planned for extraction of the Crandon orebody were selected to control mine area rock mass stability and preclude surface subsidence. A permanent bridge or "crown pillar" of bedrock directly beneath the glacial overburden will be purposely excluded from mining activity. This bedrock barrier will maintain surface stability and prevent piping of overburden materials into active mine workings.

Beneath the orebody crown pillar, stoping methods and sequences will be arranged to maintain local rock mass integrity and avoid disturbance of the crown pillar. All proposed mining methods provide for backfilling of stopes immediately following ore extraction. Depletion of reserves will generally proceed from depth and the orebody extremities toward the surface, with mining directly below the permanent crown pillar planned for the final third of mine life. These practices, combined with the fact that approximately 10 percent of the mineable ore will be left in place as pillars throughout the mine, will assure perpetual stability of the mine area bedrock surface and glacial overburden.

The selection of mining methods for preservation of the crown pillar was based on a suite of physical testing programs including soil mechanics, rock mechanics, and mine backfill. These studies determined the soil characteristics, rock mass strengths, inherent rock stresses, and backfill properties such as density, compaction, and percent cement addition necessary for a structurally safe mine design.

John D. Smith Engineering Associates Limited, mine rock mechanics specialist, prepared a summary report, "Evaluation of Surface Effects" in April 1982. Their analysis integrated all the related test work and described and quantified potential subsidence mechanisms:

1) Overburden Compaction - Because of the consolidated nature of the glacial overburden, partial dewatering of these soils will result in little additional compaction and resultant subsidence.

2) Gross Rock Failure - Mine stope dimension, methods, development sequences, and backfilling practices have been designed to preclude failure of the crown pillar or rock surrounding the ore deposit during and after normal mine operations. Maintenance of the surface is contingent on the stability of the bedrock subcrop.

3) Backfill Compression - Long-term, post-operation, rock failure mechanisms investigated included rotational failure of the hanging wall, wedge failure of the hanging wall, and crown pillar collapse. Each of these failure modes is related to backfill compressibility and placement practices. The properties are such that with proper placement, particularly beneath the crown pillar, the bedrock surrounding the mine workings should remain perpetually stable.

The conclusion of all subsidence evaluations is that the combined effects of any bedrock/soil movements will result in less than 6 inch maximum change in surface elevations over the ore deposit.

Settlements of this magnitude distributed through glacial overburden of varying thickness will have a negligible effect o nsurface topography or land use.

Since mine subsidence does not represent a potential hazard to people or the environment off-site, it was not believed to be a credible source of risk.

5.9 Mine Fires

A number of combustible materials will be used underground. The most serious potential effects would be to those workers underground. Because of this, appropriate precautionary and mitigating measures will be incorporated into planned mine operations, as required by MSHA regulations. In some other sulfide mines, there is the potential for combustion which involves the ore. Those ores contain the sulfide mineral pyrrhotite. Crandon ores do not contain pyrrhotite and the backfill material is not combustible. For these reasons, the likelihood of a mine fire is believed to be minimal. Fires which do occur will have short duration and be highly localized. The consequences would be confined to the Project area.

Based on information in a report by the Bureau of Mines entitled "An Annotated Bibliography of Metal and Nonmetal Mine Fire Reports," the Project would not expect mine fires at a frequency greater than 0.2 fires per year. The estimate of no more than one fire in 5 years is much more than Exxon Minerals Company expects will actually occur. The estimate is based on industry records from all types of copper, lead, and zinc operations from 1968 to 1979. Over 40 percent of the fires reported were ignited by electrical short circuits which should be a minor potential source in a mine using primarily diesel production equipment. Also, over 40 percent of the applicable industry fires resulted from combustion of timber or insulation which should be a minor problem in a mine using limited amounts of timber for support and little or no insulation.

5.10 Tailing Pipeline Failure

A buried high density polyethelene (HDPE) pipeline will connect the thickener and the tailing ponds. A complete break of the pipeline is not credible, since displacement of the piping ends could not occur. The pipe will be designed to operate for the Project duration without replacement. Pipewall thickness will accommodate operating pressure and internal wear. In addition, quality control of material welds and installation, coupled with flow and pressure instrumentation, make the presence of small, undetected leaks negligible. The pipeline run will be periodically inspected.

If leaks were to occur, they would be detected, repaired, and the spill cleaned up. The consequences would be reversible and confined to the immediate area around the pipeline. Thus, the risk to the off-site environment is judged to be low.

5.11 Pond Embankment Failure

A failure of a pond embankment could result in a serious, but reversible, effect on large areas of land both off-site and on-site. For this reason, embankments will be designed and constructed to accommodate a number of severe, abnormal conditions. The ponds, both tailing and reclaim, will be designed and constructed to contain the 100-year, 24-hour storm and the Probable Maximum Precipitation event. The 100-year design wind is combined with the 100-year storm to account for cresting in design of freeboard. The embankment slopes will be designed for stability to cover the coincident conditions of a saturated embankment and a seismic event.

There is no mining industry experience of embankment failures with an underdrain system design as proposed for the Project. There is almost no possibility of such a failure.

Although we do not expect any partial or complete sectional failures of the embankments, in the unlikely event something of this nature occurred, immediate response would be implemented to provide public safety. After that, appropriate reclamation and restoration of the affected areas would be initiated in conjunction with a thorough evaluation of the resulting consequences. Additional evaluation would occur to enable necessary remedial actions to prevent another failure.

However, in the unlikely event that embankment leakage would occur, the Contingency Plan presented in the NR 182 Mine Waste Disposal Feasibility Report would implement a program of immediate repair of any such location and the additional construction and/or design for the facility to prevent any further erosion. Following these activities,

activities, further evaluation of the cause of any leakage would occur immediately, and necessary design or construction improvements would be implemented as an additional preventative mechanism.

Because of the manner in which the embankment will be designed and the manner in which the ponds and embankments will be operated and inspected, failure of the embankments is taken to be extremely unlikely, based on engineering judgment.

5.12 Water Treatment System

An advanced system has been proposed to treat water prior to discharge and for reuse within the mill. Should the treatment plant malfunction to the point where the water will not meet the criteria for discharge or reuse, it will be diverted to the reclaim ponds. The treatment system will be repaired and the water retreated prior to discharge or reuse. Because of the size of the reclaim ponds, several days of water treatment plant outage can be tolerated while performing maintenance. Data showing the frequency, duration, and reason for equipment shutdowns for water treatment plants with similar unit operations are shown in Table 5.1.

During partial or complete shutdown of either the mine water or process water treatment systems, all Project water can be held within the storage capacity of the facilities (i.e., reclaim or tailing ponds) until full operating conditions are restored as needed.

A number of unplanned occurrences are shown in Table 5.1. This does not imply that a large number of failures are expected nor that there will be frequent failures. Unplanned failures may never occur and do not constitute high frequency risks. However, the list is provided to indicate that certain failures could occur and that sufficient redundancy (spares, both installed and available standbys) will prevent long shutdowns of the treatment plant.

There will be a preventive maintenance program for the water treatment plant designed to keep unplanned equipment failures to a minimum. This is represented in Table 5.1 by the normal shutdowns for

LIME/SULFIDE PRECIPITATION TREATMENT OF CONTAMINATED MINE WATER AND INTERCEPTED GROUND WATER
EQUIPMENT SHUTDOWN AND MAINTENANCE DATA

UNIT OPERATION	REASON FOR SHUTDOWN	FREQUENCY	DURATION OF SHUTDOWN
Neutralization	• Lime Addition Valve Plugs	Unplanned	• No downtime; back-up system available.
	• Loss of Sodium Sulfide or Ferric Sulfate Pump	Unplanned	• No downtime; back-up system available.
	• Agitator Motor Failure	Unplanned	• 1-3 days; stop treating process water and use softening equipment for process water treatment to treat mine water.
	• pH Control System Failure	Unplanned	• 1/2 day replacement; plant continues to operate.
Clarification	• Rake Drive Motor Failure	Unplanned	• 1-3 days; stop treating process water and use softening equipment for process water treatment to treat mine water.
	• Loss of Polymer Feed Pump	Unplanned	• No downtime; replace with backup.
	• Sludge Pump or Valve Failure	Unplanned	• 1/2 day; replace with backup.
	• Shutdown for Normal Cleanout	1 per year	• 1-2 days; stop treating process water and use softening equipment from process water treatment to treat mine water.
Filtering	• Filter Media Replacement	1 every 3 to 5 yrs.	• 1 week; operate contaminated mine water treatment line at about 75% capacity, and intercepted ground water line at about 67% capacity.
	• Feed or Outlet Valve Failure	Unplanned	• 1-2 days; operate at 75% capacity.
	• Air Blower Failure	Unplanned	• No downtime; 1-3 day repair; air scouring for filter not used.
	• Backwash Pump Failure	Unplanned	• No downtime; replace with backup.
	• Backwash or Air Line Failure	Unplanned	• 1 week; operate at 75% capacity.
pH Adjustment	• Agitator Motor Failure	Unplanned	• No downtime; 1-3 day repair.
	• pH Control System Failure	Unplanned	• No downtime; 1/2 day to replace signal transmitter.
	• Loss of Acid Pump	Unplanned	• No downtime; replace with backup.

UNIT OPERATION	REASON FOR SHUTDOWN	FREQUENCY	DURATION OF SHUTDOWN
Neutralization	Same as for treatment of mine water for discharge		
Reactor/Clairfier	• Loss of Soda Ash Feed Pump	Unplanned	• No downtime; replace with backup.
	-- Others; same as for clarification in treatment of mine water for discharge		
Filtering	Same as for treatment of mine water for discharge		
Reverse Osmosis (RO)	• Membrane Replacement	3-yr Interval	• 1 week; stop treating process water.
	• Cleaning of RO Module	6-12 times/yr	• 1 day; operate at 75% capacity.
	• Replace Cartridge Filter	12-15 times/yr	• No downtime; 2 to 4 hours to replace.
	• Booster Pump Failure	Unplanned	• No downtime; replace with backup.
	• Feed or Reject Control Valve Failure	Unplanned	• 1 day; operate at 75% capacity.
	• Membrane Failure	Unplanned	• 1 day; operate at 75% capacity or immediately replace with backup.
	• SHMP or Acid Pump Failure	Unplanned	• No downtime; replace with backup.
	• Flow element or pH Element Failure	Unplanned	• 4 hours; operate at 75% capacity.
Evaporator	• Feed or Condensate Pump Failure	Unplanned	• No downtime; replace with backup.
	• Recirculation pump-Impeller Failure	Unplanned	• 1-2 days.
	• Recirculation Pump-Other	Unplanned	• 1 day-2 weeks depending on problem.
	• Compressor Failure-Impeller	Unplanned	• 1-2 days.
	• Compressor Failure-Other	Unplanned	• 2 days to 3 weeks depending on problem.
	• General Maintenance Inspection	1 per year	• 1-2 weeks.
Brine Softener	Same as for Reactor/Clarifier		
Crystallizer	• General Maintenance Inspection	1 per year	• 1 week.
	• Feed, Product, or Condensate Pump Failure	Unplanned	• No downtime; backup available.
	• Recirculation Pump Failure-Impeller	Unplanned	• 1-2 days.
	• Recirculation Pump Failure-Other	Unplanned	• 2 days to 3 weeks depending on problem.

general inspection, cleanout, filter media replacement, and reverse osmosis (RO) module cleaning and replacement. Equipment such as mixers and reactor/clarifiers are quite simple, reliable, and require little maintenance beyond normal inspection and cleaning. An unplanned shutdown of a reactor clarifier is estimated by one equipment vendor (EIMCO) to occur possibly once in 10 years; however, with normal maintenance, this event should never occur.

There will be eleven mixed media filters installed in the plant, four will be used for treating contaminated mine water, three for treating intercepted ground water, and four for treating a combination of mine water and reclaim pond water for recycle. If a filter used for treating contaminated mine water is shutdown for media replacement, the plant can still operate at about 75 percent capacity. During this short period of reduced capacity, excess contaminated mine water would be collected in the overflow system on the water treatment plant feed tank and be pumped to the reclaim pond. If a filter used for treating water for process recycle is taken out of service for media replacement, the treatment capacity for that part of the plant will simply be reduced. This will have no effect on other operations, because additional makeup water, if needed at that time, can be pumped from the intercepted ground water tank.

Reverse osmosis systems operate quite reliably. At the water treatment plant for the R. D. Nixon Power Plant in Colorado Springs, Colorado, there have been no shutdowns due to a failure of the RO systems. The availability of spare high pressure booster pumps and

periodic cleaning of the RO modules ensures operating availability. As indicated, membranes would be replaced after about 3 years of operation.

Vapor compression evaporators use very reliable equipment. The water treatment plant at the R. D. Nixon Power Plant has experienced only one shutdown of their evaporators. This was a planned shutdown to replace the original compressor impeller with an impeller having different alloy steel.

Most reagent feeding systems will have backup capability. For example, if a lime addition system to the neutralizing mixer plugs, a parallel system will take over. Other reagent feeding systems have backup metering pumps available.

There is little probability of failure of the surface water discharge pipeline. The pipeline will not be exposed to corrosive materials nor extremes in internal or external pressures which could result in pipe failure. At the current stage of Project engineering the water discharge pipeline is expected to be constructed of 14-inch diameter high density polyethylene (HDPE) pipe and buried below ground to beneath the frost line. Current engineering calculations show that HDPE pipe rated at 250 psi internal design pressure would be well above expected pipeline pressures.

5.13 Air Pollution Control Systems

Several discrete air pollution control systems will be incorporated into the Project. The normal airborne emissions will be only a few percent of allowable regulatory limits as discussed in the EIR. As a result, if one or more of these systems were to malfunction or fail, considerable margin exists, even if operations are continued during repairs. It is not credible to assume that all air pollution control systems will fail simultaneously and that normal mine/mill production would continue. Thus, no off-site impact in violation of the regulatory limits can be foreseen. A Malfunction Prevention and Abatement Plan for credible failures of air pollution control systems will be covered under the Air Permit.

The risk and potential hazard from "dust episodes" at the MWDF is judged to be low. The paper prepared by Exxon dated February 1983 and entitled "Tailings Surface Dusting From Wind Erosion" describes the conditions for the MWDF that could lead to tailings dusting. In addition, the various dust control methods are discussed in the paper. Proper water management within the tailing ponds will be relied upon to achieve dust control.

5.14 Leaching from the Abandoned Mine

During mining operations, the mined-out areas will be backfilled. Water entering the mine will be removed and treated. Any contaminants which will be leached from the mine under these conditions will be removed and disposed of with the tailings.

Upon abandonment of the underground portions of the mine facilities, mechanical and electrical equipment will be removed, provided this equipment has sufficient resale value to offset the cost of removal. As mining areas are systematically depleted and levels abandoned throughout the mine life, installed facilities and materials will be salvaged for reuse when practicable. Abandonment of any mine area will also include removal of any equipment or material containing toxic agents or other decay-prone substances. Similarly, at final mine closure all materials and equipment with residual value or with potential for ground water contamination will be reclaimed prior to inundation and shaft sealing. Items which may remain underground include pipelines, electrical switchgear, shaft and crusher station steel, and obsolete machine parts. Normal mine water pumping operations will continue through this mine salvage and clean-up period.

Following the removal of salvageable equipment and potentially toxic materials, the mine will be allowed to flood. Preparations for mine inundation will include cement grouting of any ground water interceptor system drill holes that penetrate into the overburden, the mine backfill delivery boreholes, and the diesel fuel supply pipeline. Some of the mine pumping equipment may be salvaged. Reinforced concrete isolation barriers may be placed in vertical openings at selected

locations on the uppermost mine levels. These measures will limit the post-mining circulation of overburden aquifer ground water to the undisturbed crown pillar of the orebody, the uppermost mine area drifts, and stopes which will universally contain cement stabilized backfill. Complete flooding of the mine will occur within 2 to 3 years after inundation preparations are complete and mine drainage pumping ceases.

Ground water quality and potentiometric data developed during the environmental baseline studies indicate that there is no active, measurable vertical interaction between the water in the orebody and the water in the overlying glacial material. Furthermore, exploratory drilling has shown the rock around the orebody to be virtually impermeable. Fractures that were encountered in the boreholes were virtually all sealed with secondary mineralization and/or weathered clay minerals. Therefore, when mining operations have terminated and the mine is sealed, it is expected that the hydrologic regime will return to its pre-mining condition.

Site geotechnical investigations and hydrologic studies have concluded that the bedrock is not now and at mine closure will not be a functional component of the Project area geohydrologic regime. This conclusion is based upon the absence of major bedrock fracturing now, and the premise that planned mining methods will not disturb the rocks adjacent to the ore deposit and the overburden. Possible convective ground water flow through zones of orebody weathering should have approximately the same potential after mining as in baseline conditions. Any such water flows would be so small compared to the transient volume of the glacial overburden that their presence would likely be

undetectable. If a measurable impact were to occur, bentonite grouting of the overburden/bedrock interface could be used to control such an excursion.

The final aspect of underground mine reclamation activities will be the abandonment of the four shafts leading to surface (main production and hoisting shaft, mine intake air shaft, east exhaust raise, and west exhaust raise). Surface mine air heating equipment and/or main exhaust fans will be removed from the shaft collars. Only the main production and hoisting shaft will contain in-shaft salvageable equipment, namely the shaft conveyances which will be dismantled in conjunction with demolition of the main shaft concrete tower headframes.

All shafts to surface will be sealed with concrete plugs supported by structural steel beams constructed at the bottoms of the collar sections, or at top of competent bedrock. These plugs will be connected to the shaft linings so that they are completely supported on competent rock. The steel will be entirely encased in concrete to prevent rusting.

5.15 Severe Natural Phenomena

5.15.1 Seismic

The Crandon site exists in a region of low seismic risk (Algermissen, 1976). The appropriate seismic levels have been incorporated into the design of surface and subsurface facilities, as discussed in the EIR. Therefore, no unusual seismic risk exists for the facility.

5.15.2 Tornados

While not as frequent as in other areas of the Midwest, tornados have been known to occur in upper Wisconsin (Thom, 1963). The probability of such events is rare and the presence of the Project would have little effect on the event. Damage at the Project site is assumed to be slight under these conditions because of the safety margins incorporated into the structures for other extreme loads.

5.15.3 High Precipitation

Several structures will be designed for the effects of high precipitation. The 100-year, 24-hour precipitation event will be incorporated into most designs; the Probable Maximum Precipitation event will be incorporated into the design of several structures. Because of the length and severity of the northern Wisconsin winters, snow and wind loadings used for design are high.

No off-site consequences of high precipitation events at the Project have been identified.

Except for the tailing and water reclaim ponds, other Project water retention facilities retain relatively minor amounts of water. The largest drainage basin in the mine/mill area has a volume of approximately 6.9 acre-feet. Failure of a facility like this (either the embankment or the outlet structure) would cause localized erosion damage in the immediate area of the basin. However, the total water volume available is not large enough to cause widespread damage. These failures are easily repaired.

The temporary facilities (straw bale berms or ditch checks and earth berms and overflow pipes) used during construction will be planned to impound water from relatively small areas and thus contain relatively small volumes of water. As with any construction project, facilities of this nature are continually maintained during their temporary use and rebuilt, enlarged or otherwise modified to assure they perform satisfactorily. However, even in the event of a complete failure, the water volumes are small and localized erosion would be the worst damage anticipated. Vegetation cover in the area would also reduce the extent of the erosion effects and act to stabilize the soils.

Remedial actions for failures of this nature or for similiar failures of other drainage structures such as the mine/mill site culverts would be corrected by rebuilding the failures. Regrading and reestablishment of washed out vegetation would be included to stabilize damaged area. If it was determined a facility was underdesigned, the design would be upgraded.

5.16 Aircraft Crashes

The Crandon Municipal Airport is located approximately 2.5 miles north-northwest of the mine/mill site. A grass air strip, currently not in use, runs north-south in general alignment with the site.

The headframe of the mine will be the tallest man-made object within several miles of the Project including the Crandon airport. The headframe will be situated outside the "physical envelope" required for approach paths to airports. As a result, the likelihood of an aircraft crash is remote.

5.17 Reclaim Pond Seepage

The reclaim pond double liner system makes the risk of seepage a remote probability. Contingency plans for the reclaim ponds are covered by the Contingency Plan for the MWDF.

During reclamation, the reclaim ponds will be ripped up, removed, and the area reclaimed. Therefore, no cover is required and no risk exists for contamination of ground water after the Project is completed.

5.18 Summary

5.18.1 Conclusions

This risk assessment has covered several classes of events which may present a potential risk to the environment and/or local population near the Project. In most cases, the hypothetical events evaluated examine consequences which go beyond those discussed in the EIR and the consequences are believed to be reversible and short-term. In only a few cases, the results were considered to be long-term and reversible.

For example, the environmental effects of a forest fire must be regarded as long-term, but ultimately reversible. The effects are independent of the presence or absence of the facility except for a beneficial effect of having a trained force of fire fighters associated with the facility.

Without exception, no long-term effects on human health were identified. For those events which present a potential risk to human health, adequate mitigating measures exist. In fact, many of these measures will be incorporated into the design of Project facilities. The design and operation measures incorporated into the Project will comply with all applicable state and Federal regulations to ensure pollution of the public health and safety. For example, the safety systems incorporated to comply with MSHA and the pollution control measures taken in compliance with DNR and U.S. EPA provide a strong measure of protection to the environment and to public health.

5.18.2 Comparison with Other Sources of Risk

The metallic mineral mining industry is well established in the United States. Because of this history, the potential environmental and public health effects can be based on engineering judgment of those associated with the industry. In the recent past, metallic minerals mine/mill operations have operated with a low level or risk to public health and the environment. The Crandon Project will be designed and operated in compliance with criteria and regulations equivalent to those applied to current mine/mill operations.

The design of Project facilities is such that contractor experience and the experience gained by EMC staff through visits to several operating metallic mineral mines throughout the world have been incorporated. There is nothing in the facilities design to suggest that the low risk operation will be compromised.

5.19 References Cited

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6.0 EMERGENCY NOTIFICATION PROCEDURES

All incidents will be reported to the Environmental Compliance Engineer (ECE), who will make a determination whether the incident presents a hazardous condition or if a regulatory reporting requirement exists. If no hazardous condition exists, the ECE will report the information to the Crandon Mine management who will direct corrective action to be taken.

If a potentially hazardous condition exists or regulations require, appropriate local, state, and federal governmental agencies will be notified. Generally, the notification procedure will follow the outline shown in Figure 6.1. Depending on the nature of each incident, a decision will be made as to what outside agencies require notification. Normally all environmentally related incidents subject to DNR reporting requirements will be reported to the DNR and all pertinent data will be shared with the DNR.

In accordance with section NR 154.06(2)(f), EMC will report air pollution control equipment malfunctions to the DNR within eight (8) hours of their occurrence. In general, other response times will be dependent on the nature of the event, but would not be expected to exceed 24 hours from the time the event is determined to be reportable.

Immediate notification will be given to federal and state authorities for malfunctions which might have significant environmental impact (e.g., spills of oils or toxics into waters of the United States).

Typical examples of incidents which will require reporting to the ECE:

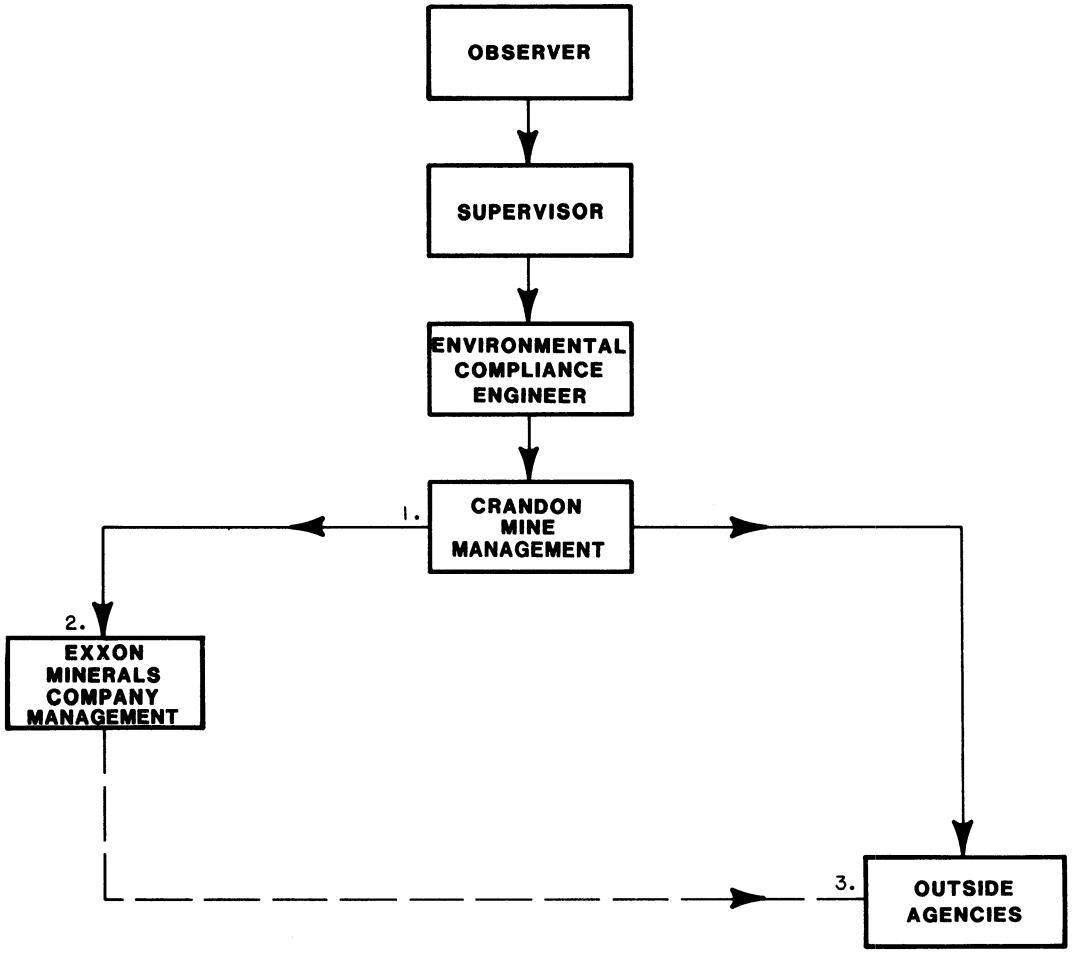
1) Outside chemical spills during unloading;

2) Leaking tanks or railroad cars;

3) Equipment failure in the water and sanitary waste treatment facilities;

4) Fuel and oil spills; and

5) Water contamination as noted in the monitoring plan.



1. **MINE MANAGEMENT** (Dependent on Nature of Incident)
   - a. Superintendent(s) in charge
   - b. Mine Manager
   - c. Safety Coordinator

2. **COMPANY MANAGEMENT**
   - a. U.S. Operations Manager
   - b. Vice President Operations
   - c. Senior Vice President
   - d. President
   - e. Regulatory Affairs Manager
   - f. Public Affairs Manager

3. **OUTSIDE AGENCIES**

   A. Local
   - a. Sheriff's Office/ Civil Defense
   - b. Fire Department(s)
   - c. County Commissioners
   - d. Neighboring Towns/Villages

   B. State
   - a. Wisconsin DNR
   - b. Highway Patrol
   - c. DILHR–Mine Inspectors

   C. Federal
   - a. MSHA
   - b. U.S.C.G.
   - c. U.S.E.P.A.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
EMERGENCY NOTIFICATION PROCEDURE

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 10/82	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 1-23-86
APPROVED BY	DATE	EXXON	DATE 1-23-86
DRAWING NO **FIGURE 6-1**		SHEET 1 OF 1	REVISION NO 0

7.0 GEOLOGICAL/GEOTECHNICAL INVESTIGATIONS

As part of the predevelopment phase of the Project, data were collected in the site area to document existing geological/geotechnical conditions. A comprehensive description of the geological/geotechnical investigations and drilling programs that have been completed is presented in Section 2.2, Geology of the EIR. The field and laboratory methods that were used in these investigations and a discussion of the results are contained in this section of the EIR.

During final engineering and construction, test borings will be completed to determine soil conditions at the sites of buildings, equipment foundations, roads, railroads, bridges, tailings dams, and any other locations where it is important to know the bearing capacity of the subgrade. Typically for this kind of program, holes of 2 to 4 inches in diameter are bored to a depth of 6 to 20 feet. At intervals of a few feet, a split spoon or other sampling device is driven to obtain a soil sample. The number of blows to drive the device is noted as a measure of soil density. The samples are tested in a laboratory to determine their engineering properties.

As part of the mine development and operations stope delineation drilling will be conducted. This will be accomplished by drilling holes from underground openings to collect data on the geologic formation. Exploration drilling will be conducted in a similar fashion from underground drill locations. During the life of the operation, very few exploration holes would be drilled from surface to gain additional detail on the Crandon orebody. All drill holes will be constructed and closed in accordance with applicable state standards.

8.0 PRE-BLASTING SURVEY PLAN

In accordance with NR 132.07 (5) a Project area Pre-Blasting Survey Plan will be conducted as follows:

A) All permanent structures within a 0.5 mile radius of any of the three mine access or ventilation shafts (Figure 8-1) will be inspected.

B) Such inspections will be conducted by qualified professionals just prior to the start of site blasting, with an appropriate allowance of time for submission of survey results to State agencies prior to commencement.

C) Property inspection elements will include:

1) Foundations;
2) Concrete Slabs;
3) Exterior and Interior Masonry;
4) Structural Framing;
5) Exterior and Interior Wall Treatments;
6) Ceiling and Floor Treatments;
7) Windows and Doors (framing and glass);
8) Visible Plumbing;
9) Exterior Utility Services;
10) Exterior Structures (antennas, flag poles, etc.);
11) Miscellaneous elements as required.

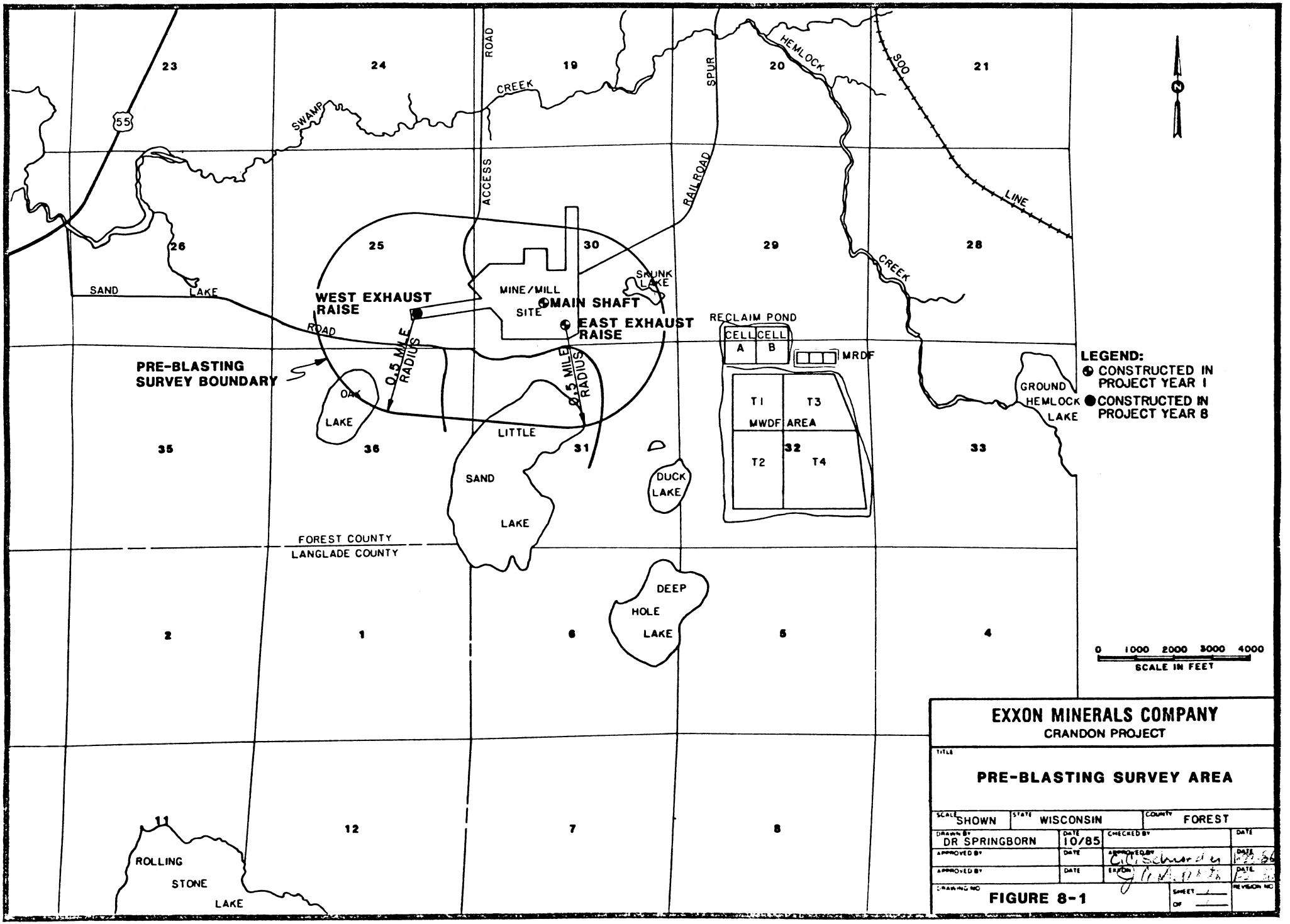
Inspected elements will be fully documented, including photographs where appropriate. Element age and state of general maintenance will be noted.

D) Inspections will be made with property owner consent and universally in the case of Exxon Minerals Company owned structures.

E) Copies of the pre-blasting survey inspection sheets, photographs, and property condition report will be submitted to each private owner and State agencies. File copies will be retained for use at the mine site.

The nominal 0.5 mile survey radius planned will likely exceed the limit of any significant blasting effects. In fact, neither seismic stress nor air blast concussion of a magnitude sufficient to cause structural damage is expected immediately adjacent to the shaft collars. The 0.5 mile survey

radius was chosen based on estimates of ground movement caused by on-site blasting. Studies to date indicate that Project blasting events will fall well below the human response threshold at a 0.5 mile observation distance. Seismic motion from bedrock blasting will be dampened by the overlying glacial sands and gravels (minimum 69 feet thick). Air blasts will be muffled by the length of mine workings and/or shafts coursed to reach the surface.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
PRE-BLASTING SURVEY AREA

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
APPROVED BY	DATE	ENGR	DATE
DRAWING NO **FIGURE 8-1**			SHEET OF REVISION NO