Chapter 1.0: Sections 1.1 thru 1.5. Volume I

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CHAPTER 1

DESCRIPTION OF THE PROPOSED ACTION

CRANDON PROJECT

ENVIRONMENTAL IMPACT REPORT

REVISED
November 1985

CHAPTER 1

DESCRIPTION OF THE PROPOSED ACTION

Exxon Minerals Company (Exxon), the Applicant, a division of Exxon Corporation, proposes to construct and operate an underground zinc, copper, and lead mine and mill near Crandon, Wisconsin. This Project, referred to as the Crandon Project, is described in this chapter. The information presented contains a description of the Project, including surface and underground facilities, construction and operating procedures, and facilities removal and reclamation. The concepts and designs presented are based upon the results of engineering, environmental and economic studies completed to date.

This description provides the basis for evaluation of potential impacts upon the existing environment described in Chapter 2. The elements of the Project which could contribute to direct or indirect impacts are described in greater detail than those which would not have any effect on impact analyses.

Exxon has filed permit applications necessary for construction of the described facilities. There are a number of factors which will influence the decision to construct the facilities once acceptable permits are issued and Exxon is hopeful that all of the factors will be favorable toward going ahead with the Project when the permits are issued.

Although a substantial amount of effort has gone into the development of the proposed plan, there are a number of refinements that may be made as a result of additional engineering necessary for Project construction. Those refinements that relate to environmental impact evaluation will be brought to the attention of the Wisconsin Department of Natural Resources (DNR).

At present, studies indicate that the most probable estimate of mine recoverable reserves is 67.4 million tons. These data were used for design and evaluating environmental and socioeconomic impacts. The quantification of ore reserves is an ongoing process. To assure an adequate sizing for critical facilities, such as the mine waste disposal facility, a contingency has been included in the design of some facilities.

In Chapter 1, a description of various Project characteristics, such as location, history and background, need, schedules and costs, is presented in Section 1.1. The mine, mill, waste disposal, and ancillary facilities are described in Section 1.2. The location, dimensions and physical characteristics of each major Project facility and its components are described and geographically depicted. Construction and operating procedures are discussed in Sections 1.3 and 1.4, respectively. In the description of construction and operational aspects of the Project, emphasis is given to pollution control facilities and projected emissions and effluents. Project facilities will be constructed and operated in accordance with applicable Wisconsin Administrative Codes. Removal of Project facilities and reclaiming the site following closure of the mine/mill operation are described in Section 1.5.

1.1 GENERAL DESCRIPTION

The information presented in this section provides a broad overview of the Crandon Project to establish a frame of reference for the detailed discussions which follow in subsequent sections.

1.1.1 Action Requested of the DNR

Exxon Minerals Company, a division of Exxon Corporation, requests that the DNR initiate the following action on the documents being filed:

1) Review the Environmental Impact Report (EIR) and make a determination of completeness.

2) Confirm that the list of permits and approvals identified in subsection 1.1.3.2 is complete, and identify any omissions.

3) Prepare and finalize an Environmental Impact Statement (EIS) for the proposed Project described in the EIR.

4) Coordinate with the Wisconsin Public Service Commission to ensure that the Department's EIS will be responsive to the Commission's needs in regard to any proposed Project site- specific transmission line that might have to be built.

5) Coordinate with federal agencies such as the U.S. Army Corps of Engineers to ensure that the Department's EIS will be responsive to the needs of federal agencies that may have permitting jurisdiction over the proposed Project.

6) Inform the Applicant after the "Interagency procedure on proposed actions involving NEPA or WEPA (NR 150.10)" has been completed, whether any other agency or department (local, state, federal) will be involved in preparing the EIS on the Applicant's proposed Project.

7) Review and approve all permit applications, license applications, and similar documents regarding the proposed Project that are filed with and require approval of the Department.

A copy of the Exxon Corporation annual report is attached as Exhibit A and provides the corporate organization, financial data, and the areas of business involvement of the corporation.

Any questions and correspondence the Department has regarding the submittal should be directed to Permitting Manager, Exxon Minerals Company, P. O. Box 813, Rhinelander, Wisconsin 54501; telephone 715-369-2800. A list of consultants who provided input to this document is provided in Table 1.1-1.

1.1.2 Location of Proposed Action

The ore deposit is located in Forest County, in the Northern Highlands region of northeastern Wisconsin (Figure 1.1-1). Crandon, the county seat of Forest County, is located 5 miles due north of the proposed Project site. Other communities in the area include Rhinelander, 28 miles west, Antigo, 45 miles south, and Iron River, Michigan, 44 miles north of Crandon, respectively. 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, Town of Nashville, and in Section 30, Township 35 North, Range 13 East, Town of Lincoln. Physiographically, the deposit lies 0.25 mile north of Little Sand Lake and 1 mile south of Swamp Creek.

Exxon Controlled Land - Exxon currently controls approximately 7,960 acres within the Project site (Figure 1.1-2). The Project land is located in Sections 19, 20, 28, 29, 30, 31, 32, 33, and 34, Township 35

TABLE 1.1-1

CONSULTANTS RESPONSIBLE FOR INPUT TO THE CRANDON PROJECT EIR

Aero-Metric Engineering
4708 N. 40th Street
Sheboygan, WI 53801

Alan Lang Well & Pump Company
7514 Stettin Drive
Wausau, WI 54401

Black & Veatch
7315 Wisconsin Ave.
Bethesda, MD 20814

Camp Dresser & McKee
6132 West Fond Du Lac
Milwaukee, WI 53218

Cherry, Dr. John A.
Contaminant Hydrogeology
Department of Earth Sciences
Waterloo, Ontario, Canada N2L 3G1

CH2M Hill Central, Inc.
2929 North Mayfair Road
P. O. Box 2090
Milwaukee, WI 53201

Colorado School of Mines Research Institute
P.O. Box 112
Golden, CO 80402

Dames & Moore
1550 Northwest Highway
Park Ridge, IL 60068

D'Appolonia Consulting Engineers, Inc.
10 Duff Road
Pittsburgh, PA 15235

Davy Power Gas (Davy-McKee)
P. O. Drawer 5000
Lakeland, FL 33803

Denny's Drilling
6807 LaVaque Jct. Rd.
Duluth, MN 55811

Dynatec Mining Ltd.
P. O. Box 267
Richmond Hill, Ontario L4C 4Y2

Ecological Analysts, Inc.
Suite 306
1535 Lake Cook Road
Northbrook, IL 60062

Foth & Van Dyke and Associates
1737 South Ridge Road
P. O. Box 3000
Green Bay, WI 54303

Geoterrex Ltd.
Suite 101
12860 West Cedar Drive
Lakewood, CO 80228

Golder Associates, Inc.
5125 Peachtree Road
Atlanta, GA 30341

Great Lakes Archaeological Research Center, Inc.
P. O. Box 1304
Waukesha, WI 53187

Hazen Research
4601 Indiana Street
Golden, CO 80401

INDECO
Tyrol West Building
1500 South Lilac Drive
Minneapolis, MN 55416

Inman-Foltz & Associates, Inc.
P. O. Box U
Minocqua, WI 54548

Interdisciplinary Environmental Planning
534 Boston Post Road
Wayland, MA 01778

Joy Industrial
621 S. Sierra Madre
P. O. Box 340
Colorado Springs, CO 80901

Raymond Kaiser Engineers Inc.
300 Lakside Drive
P.O. Box 23210
Oakland, California 94623-2321

Knight and Piesold, Ltd.
1250-409 Granville Street
Vancouver, British Columbia V6C 1T2

Lakefield Research of Canada Ltd.
P. O. Box 430
Lakefield, Ontario K0L 2H0

R. F. Lonsdale & Associates Ltd.
362 Blythewood Road
Burlington, Ontario L7L 2G8

Klohn Leonoff
3000 Youngfield Street #344
Wheat Ridge, CO 80215

MacDonald & Mack Partnership
750 Grain Exchange Building
Minneapolis, MN 55415

Mine Waste Reclamation Ltd.
565 Massey Road
Guelph, Ontario N1H 6R1

MPSI
240 Arch Street,
York, PA 17405

Normandeau Associates, Inc.
25 Nashau Road
Bedford, NH 03102

Northern Lake Service
400 North Lake Avenue
Crandon, WI 54520

Table 1.1-1 (continued)

Owen Ayres & Associates, Inc. (Ayres Associates)
1300 West Clairemont Avenue
P. O. Box 1590
Eau Claire, WI 54702

The Ralph M. Parsons Company
100 West Walnut Street
Pasadena, CA 91124

Pipeline Systems, Inc.
61 Avenida De Orinda
Orinda, CA 94563

Thomas A. Prickett & Associates
8 Montclair Road
Urbana, IL 60801

Thomas L. Coefield Associates
P. O. Box 1404
Rhinelander, WI 54501

J. S. Redpath Limited
Bond Street North
P.O. Box 810
North Bay, Ontario P1B 8K1

Residuals Management Technology, Inc.
Suite 124
1406 East Washington Avenue
P. O. Box 672
Madison, WI 53703

RPC, Inc.
1705 Guadalupe
Austin, TX 78701

Dr. Robert J. Salzer
Logan Museum of Anthropology
Beloit College
Beloit, WI 53511

The Sanborn Group, Inc.
Mansion Hill
531 No. Pinckney Street
Madison, WI 53703

Schreiber/Anderson Associates
923 Williamson Street
Madison, WI 53703

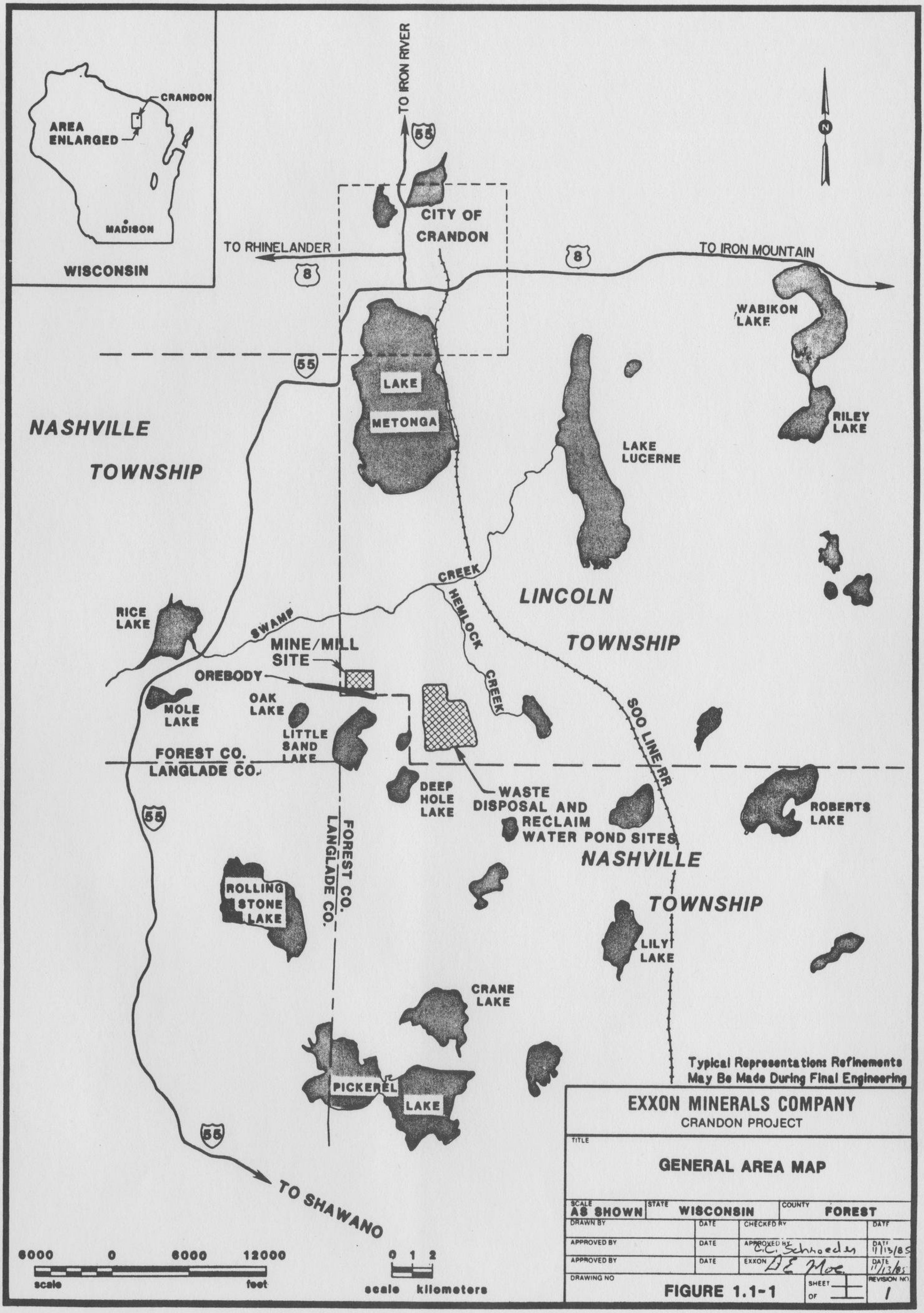
Skyline Labs
1700 West Grant Road
P. O. Box 50106
Tucson, AZ 85703

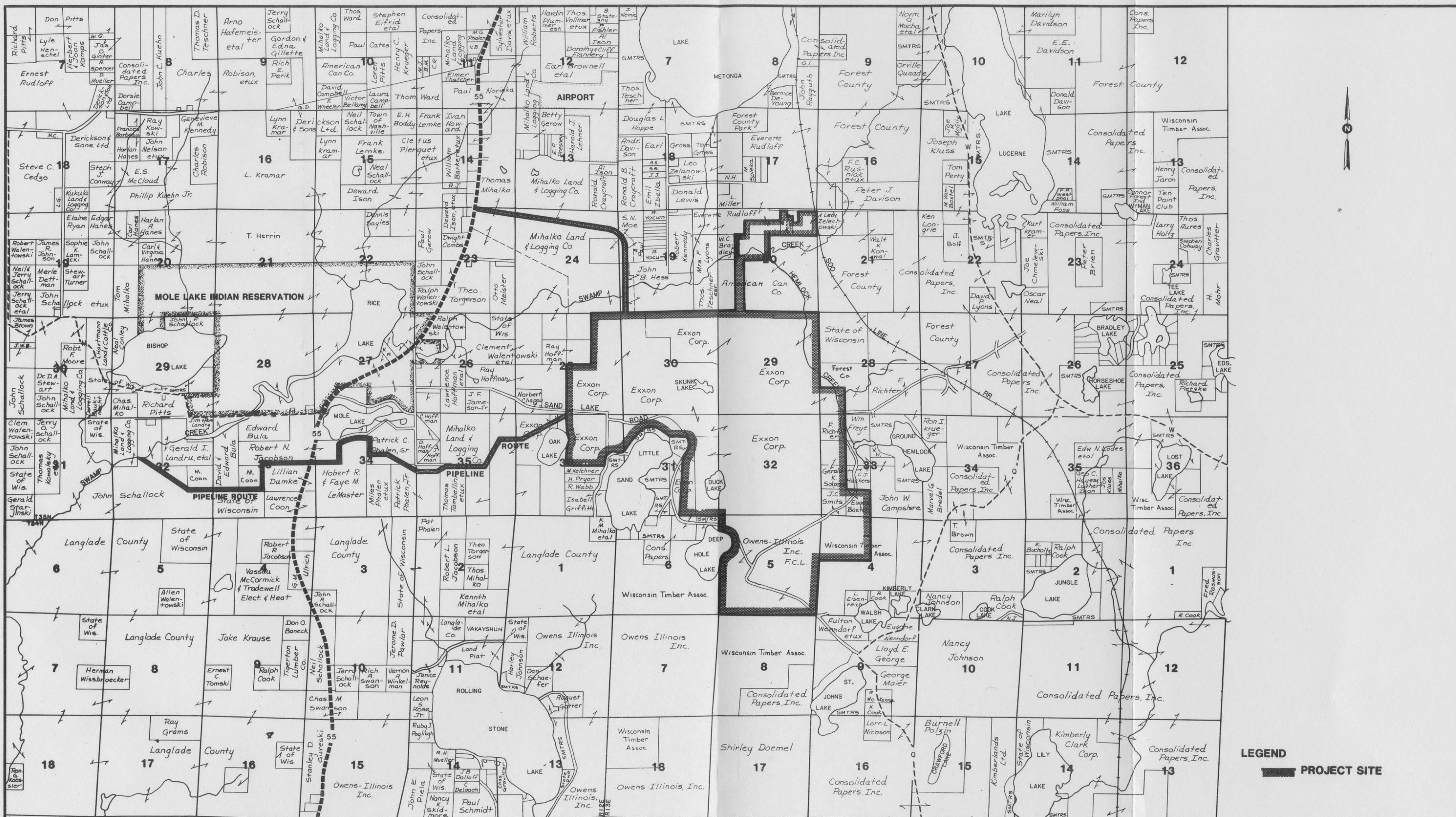
John D. Smith Engineering
  Associates, Inc.
110 Lakeshore Boulevard
Kingston, Ontario K7M 6R5

Soil Testing Services of Wisconsin
540 Lambeau Street
Green Bay, WI 54303

Edward F. Steigerwaldt & Sons, Inc.
Route 5
Tomahawk, WI 54487

G. L. Tiley & Associates
445 Dumas Street West
Hamilton, Ontario L9J 1B3


WISCONSIN
CRANDON
AREA ENLARGED
MADISON
TO IRON RIVER
55
N
CITY OF CRANDON
TO RHINELANDER
8
8
TO IRON MOUNTAIN
WABIKON LAKE
55
LAKE METONGA
RILEY LAKE
NASHVILLE TOWNSHIP
LAKE LUCERNE
CREEK
HEMLOCK
LINCOLN TOWNSHIP
RICE LAKE
SWAMP
MINE/MILL SITE
OREBODY
CREEK
MOLE LAKE
OAK LAKE
LITTLE SAND LAKE
SOO LINE RR
FOREST CO.
LANGLADE CO.
DEEP HOLE LAKE
WASTE DISPOSAL AND RECLAIM WATER POND SITES
ROBERTS LAKE
55
NASHVILLE TOWNSHIP
FOREST CO.
LANGLADE CO.
ROLLING STONE LAKE
LILY LAKE
CRANE LAKE
PICKEREL LAKE
55
TO SHAWANO
Typical Representations Refinements May Be Made During Final Engineering
6000 0 6000 12000
scale feet
0 1 2
scale kilometers
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 1.1-1
SHEET OF
REVISION NO. 1



2	10-17-85	DRS	Updated Land Ownership
1	4-10-84	DRS	Change Pipeline Route
REVISED	DATE	BY	DESCRIPTION

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 [signature] | DATE 11/29/85
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 1.1-2 | SHEET OF | REVISION NO. 2

GBB 5/1981

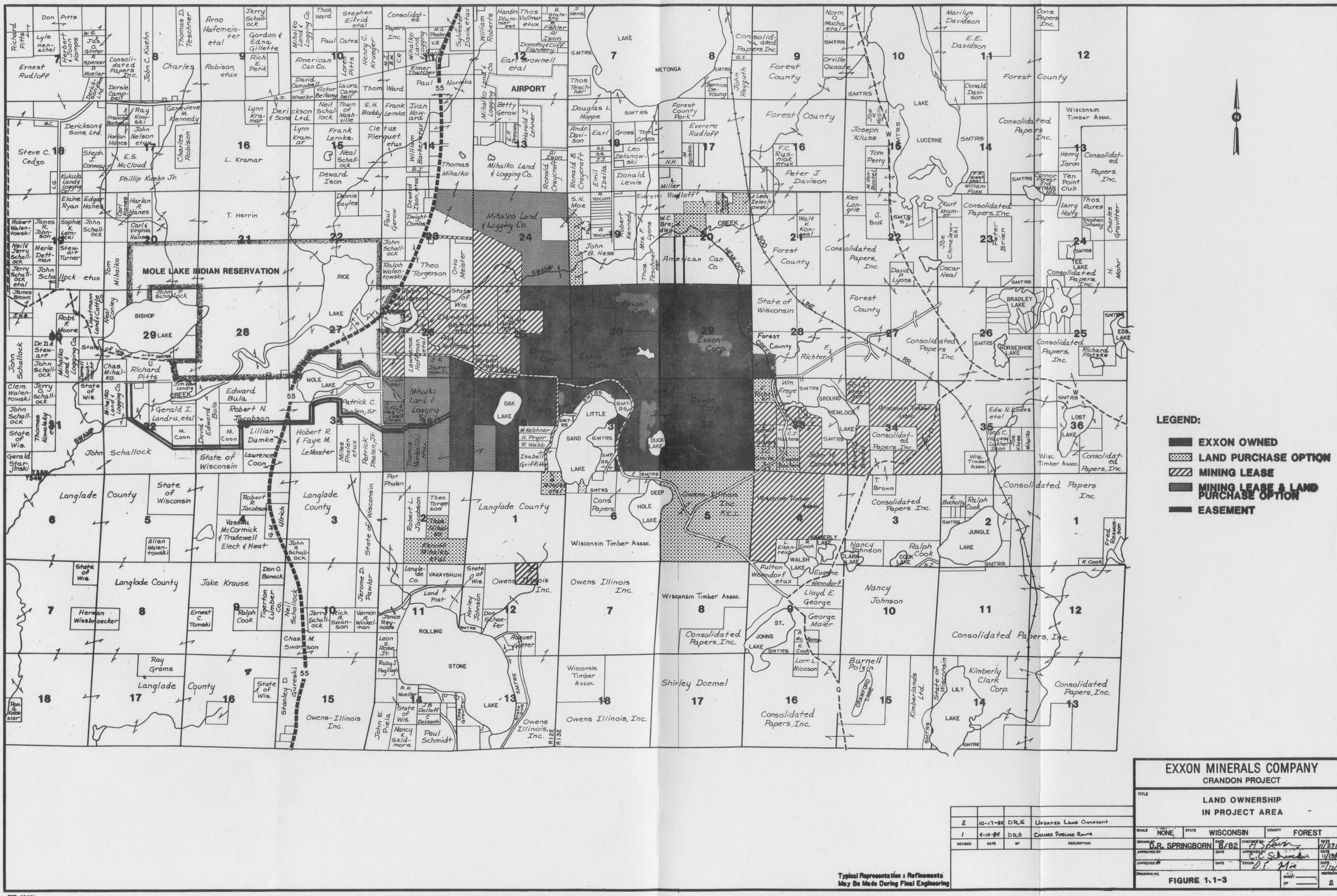
North, Range 13 East; Sections 23, 24, 25, 26, 32, 33, 34, 35 and 36, Township 35 North, Range 12 East; Sections 4, 5, and 6, Township 34 North, Range 13 East; and Sections 1, 2 and 12, Township 34 North, Range 12 East. The status of the specific parcels of land within the Project area is shown on Figure 1.1-3.

Exxon has under lease and option several parcels of land within Wisconsin. The EIR clearly identifies the lands within the Project site boundary and their ownership status. Typically, during exploration and project development, more land is leased and optioned than ultimately is used for the project in operation. After the Crandon Project is in operation, parcels of land under lease or option will be reevaluated as to their continued use and/or disposition.

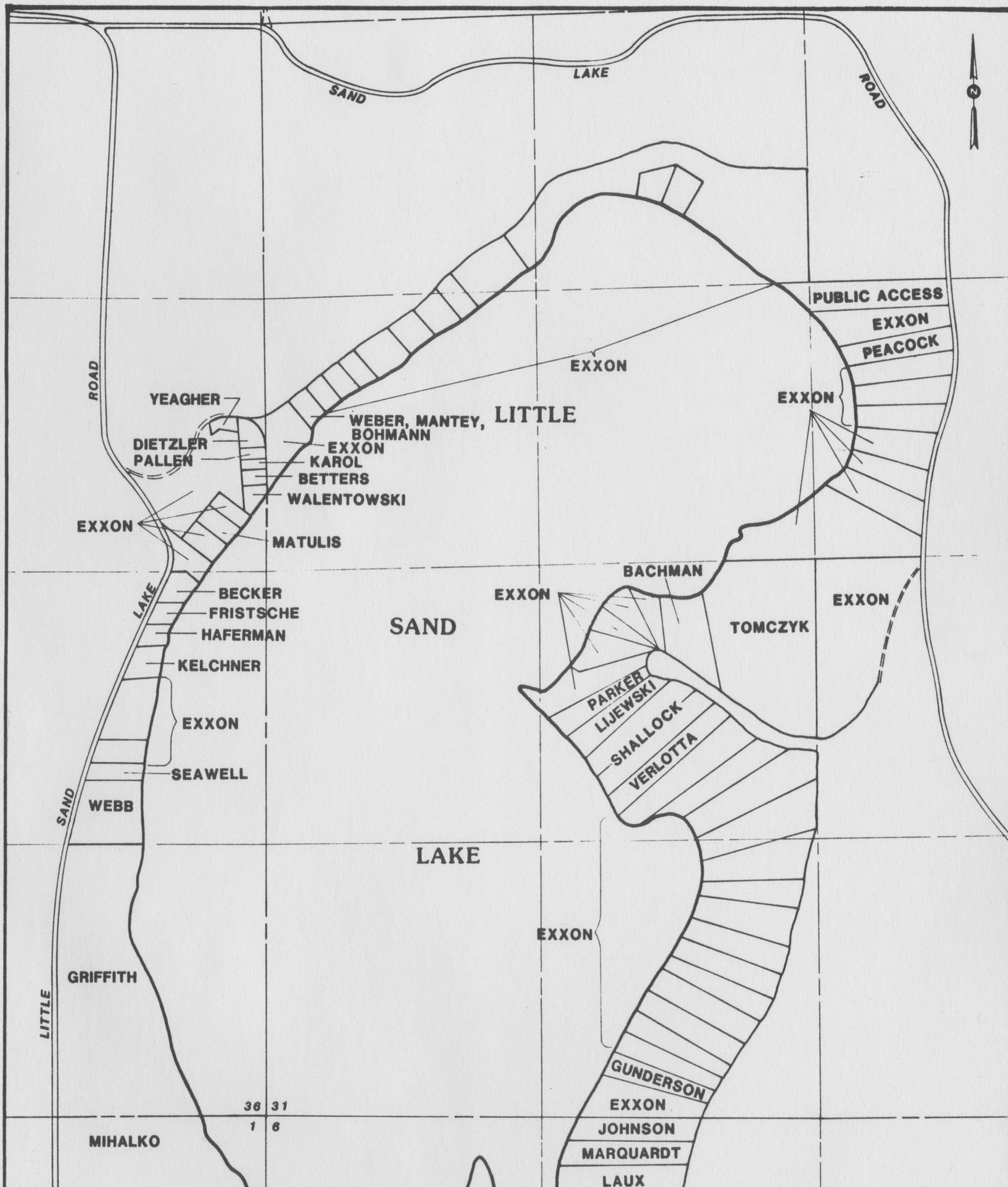
Exxon currently owns approximately 3,228 acres in the Project area (Figure 1.1-3). The remaining approximately 4,711 acres are controlled through land purchase options, mining leases, a combination of the two, or easement. The Exxon controlled acreages are summarized below:

Type of Control	Acres
Exxon Owned	3,228
Land Purchase Option/Mining Leases	4,711
Easement	21
Total	7,960

Figures 1.1-4 and 1.1-5 show the small tract owners surrounding Little Sand and Deep Hole lakes, respectively. Exxon currently owns all land surrounding Duck, Oak and Skunk lakes.



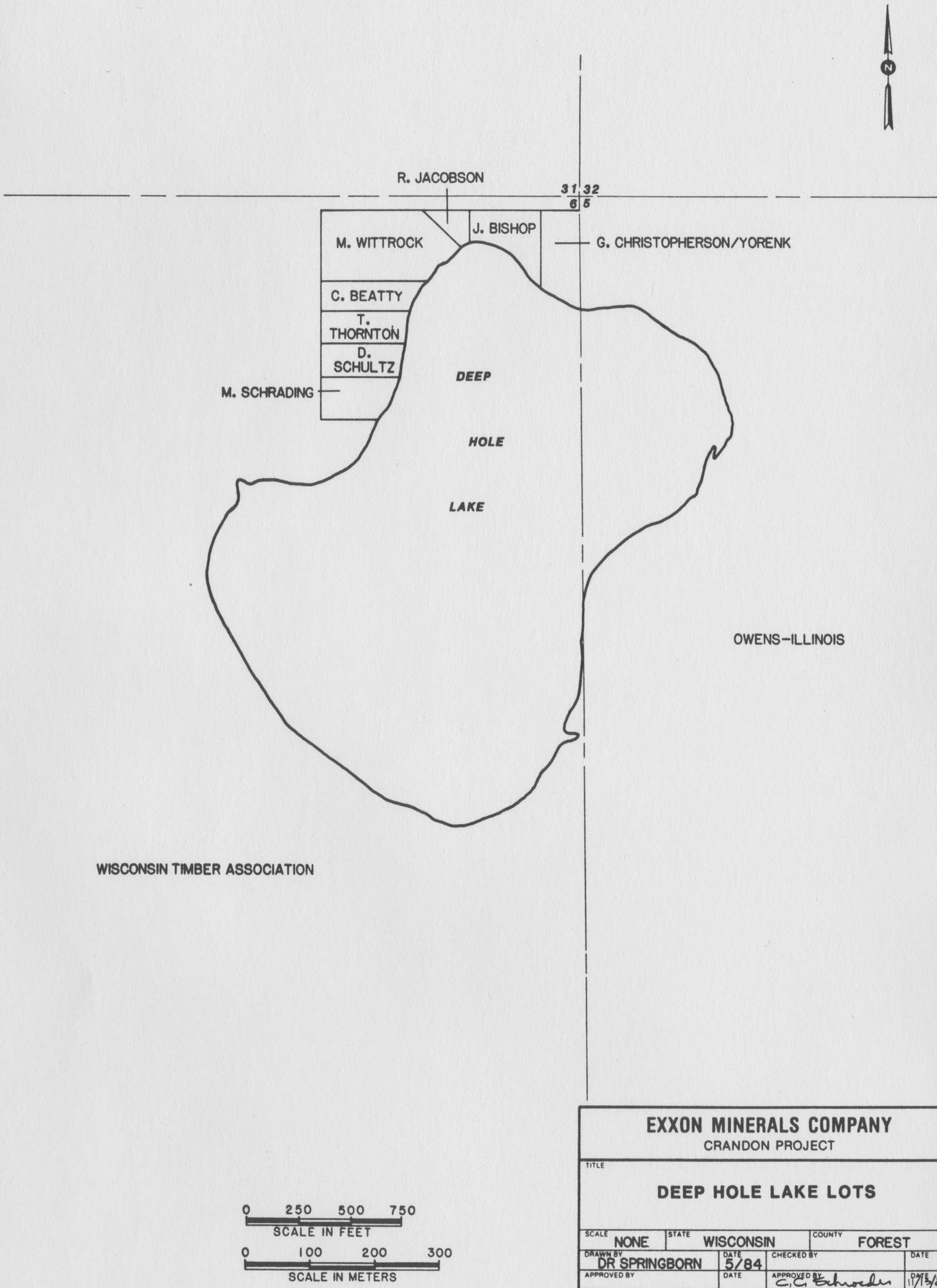
MOLE LAKE INDIAN RESERVATION
LEGEND:
EXXON OWNED
LAND PURCHASE OPTION
MINING LEASE
MINING LEASE & LAND PURCHASE OPTION
EASEMENT
Typical Representation : Refinements May Be Made During Final Engineering
EXXON MINERALS COMPANY
CRANDON PROJECT
LAND OWNERSHIP IN PROJECT AREA
SCALE NONE
STATE WISCONSIN
COUNTY FOREST
DRAWN BY D.R. SPRINGBORN 8/82
2 10-17-85 DRE UPDATES LAND OWNERSHIP
1 4-10-84 DRS CHANGE PIPELINE ROUTE
FIGURE 1.1-3
REVISION NO. 2



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
LITTLE SAND LAKE PROPERTY OWNERS

SCALE SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 3/84	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Sch...	DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. ...	DATE ...
DRAWING NO **FIGURE 1.1-4**		SHEET ___ OF ___	REVISION NO 1



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
DEEP HOLE LAKE LOTS

SCALE NONE	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 5/84	CHECKED BY		DATE
APPROVED BY	DATE	APPROVED BY C. C. Schroeder		DATE 11/13/85
APPROVED BY	DATE	EXXON D. E. M—		DATE 11/13/85
DRAWING NO **FIGURE 1.1-5**			SHEET ___ OF ___	REVISION NO.

1.1.3 History and Background of Proposed Action

Background

Exxon initiated an exploration program in Wisconsin in late 1969. Favorable areas based on literature searches were selected for reconnaissance, magnetic surveys, and airborne electromagnetic surveys.

From 1970 to 1975, Exxon continued to define favorable geologic areas, initiate geologic and geophysical mapping of individual prospects, began evaluation of prospects by diamond drill methods, and conducted detailed airborne electromagnetic survey exploration of the areas.

An airborne electromagnetic survey during the summer of 1974 identified an anomaly in the vicinity of Skunk Lake, Forest County, Wisconsin. The discovery hole was started on June 22, 1975. Massive sulfide mineralization was encountered on July 4, 1975. The discovery of the Crandon deposit was announced on May 13, 1976.

The Crandon Project team was formed and a Project office was opened in Crandon in May 1977. The primary responsibility of the team has been to conduct and complete on-site evaluations and intermediate stage feasibility studies. The evaluations and studies have continued through 1985 and are being used as the basis for permit applications and the EIR.

In early 1981, pilot plant studies of the ore treatment process were completed at Lakefield Research, Lakefield, Ontario, Canada.

During 1982, final work was initiated on the EIR and permit applications.

In the design of the Crandon Project, Exxon has utilized expert consultants and contractors in the areas of environmental studies, mine design, surface facilities design, metallurgical engineering, and all the areas involved in the evaluation of a complex mining project. All consultant and contractor work has been accomplished under the direction and review of Exxon. Exxon personnel have, in various areas, contributed directly and indirectly to the preparation of the proposed action. Of particular interest have been the efforts devoted to the siting and design of the waste disposal facilities, the water management and treatment system, and the effort devoted to the study of the socioeconomic aspects of the development of the Project.

DNR Coordination - In developing a Project plan which would be responsive to the DNR's regulatory mandate of review, developing an EIR, and seeking permits, Exxon has endeavored to involve and communicate with the DNR throughout the history of the Project. This effort has included numerous meetings with the DNR, Exxon, and Exxon consultants and contractors. It has also included public meetings, verification of environmental data gathering, and review of many specific scopes of work prior to and during accomplishment by Exxon's contractors. Toward this end, Exxon, by letter to the Secretary of the DNR dated March 7, 1980, and a Preapplication Services Agreement dated November 18, 1981, agreed to the early funding of DNR review under the mandate of Section 23.40 of the Wisconsin Statutes.

During the baseline studies and siting studies, DNR personnel participated in field activities, performed quality assurance audits of contractor work, and reviewed reports and frequently commented on siting activities.

Public hearings on the Project were held in Crandon and in Rhinelander, November 2, 1978, in response to a "Notice of Intent" to collect data in support of a mining permit. The "Notice of Intent" was submitted by Exxon in July of that year. These hearings gave the public the opportunity to comment on the environmental studies being undertaken by Exxon for the Project.

Early in 1980, Exxon submitted preliminary project plans for review by the DNR to ascertain the need for an EIS. In March of that year, the DNR notified Exxon that the Project was a major and significant action and would require preparation of an EIS.

In October 1980, Exxon submitted to the DNR, "Volume I, Preliminary Project Description," which described the Project as it was then conceived. A second public hearing was held on January 13, 1981, which allowed the public the opportunity to comment on the preliminary plans presented by Exxon. Public comments received at this hearing, as well as the result of other meetings and discussions, were taken into consideration by Exxon in the development of the Project plan and the execution of environmental, engineering, and socioeconomic studies.

"Volume II, Preliminary Project Description's Study Work" was submitted to the DNR on August 7, 1981. This volume contained detailed information regarding the environmental and technical studies being performed by Exxon in support of the Crandon Project plan. A listing of major documents submitted to the DNR is provided in Appendix 1.1A.

In early 1981, DNR staff members visited the laboratories of Lakefield Research, Lakefield, Ontario, to view and verify the pilot plant operations relating to the processing of the Crandon ores. This was part of a large and on-going program of data verification required by the Metallic Mining Reclamation Law, Wisconsin Statute, 144.80 et seq. In addition, DNR personnel have performed numerous field trips to the Project site and offices, inspected drilling sites and geotechnical samples, and have inspected the facilities and records of technical consultants to Exxon.

Technical Update - The information presented in EIR Chapters 1 and 3 has been revised and updated since the original filing with the DNR on December 22, 1982. Two major events have occurred subsequent to the December 1982 filing that have prompted the submittal of this revised EIR:

1) The DNR has subjected the EIR to an intense review and in the process has submitted to Exxon Minerals Company more than 600 comments contained in four letters, requesting additional information and clarification on various topics addressed in the EIR.

2) Exxon has completed additional engineering to further define and refine the project description and alternatives presented in Chapters 1 and 3, respectively.

The results to date of these two processes have been incorporated into Chapters 1 and 3. The answers to appropriate DNR comments contained in letters on the EIR and permit applications have been integrated into the appropriate sections of these chapters.

The additional engineering has resulted in the elimination of some facilities and downsizing of others and modifications to the Project schedule and manpower requirements. For example, the waste rock storage area in the mine waste disposal facility (MWDF) area and a separate intake air shaft for the mine have been eliminated from the Project design. Examples of new facilities that have been added or significantly modified include the addition of an on-site mine refuse disposal facility (MRDF) and the replacement of the septic tank and soil absorption field for treatment of sanitary wastes with a factory manufactured package treatment plant. Other facilities such as the mill and MWDF have been reduced in size.

The Project schedule has been revised to a 30-month construction period, 29 years of operation, and 4 years for closure and final reclamation. The work force required during the 29-year operations period will be approximately 620 employees. Also, the plan for mining the ore has been altered from simultaneous development of both massive (zinc) and stringer (copper) ores to a phased mine development with sequential extraction of first massive and then stringer ore. These changes, all of which in large measure will help minimize the overall environmental impact of the Crandon Project, have also been incorporated into Chapters 1 and 3.

Community Affairs - Since the establishment of the Crandon Project, Exxon has devoted a considerable effort toward communicating its plans to the public and soliciting the opinions, advice, and guidance of its neighbors in Wisconsin.

The Town of Lincoln passed a drilling ordinance on April 15, 1977. This ordinance represented the first local jurisdiction to request information in an attempt to involve local citizens. Exxon complied with this request for information and initiated informational meetings. Subsequently, the Exxon Crandon Project team began a dialog with local impact committees for the purpose of obtaining local input into community environmental sensitivies and development objectives. This active dialog has continued to the present.

Since the establishment of this open communication and planning dialog, approximately 20 groups have participated on a continuing or intermittent basis. The groups include local governments, Indian tribes, and lake or property owner associations.

The public input received from the formal meetings with these groups and with other citizens groups, including the forums sponsored by Nicolet College and Technical Institute, has proven valuable to Exxon in defining and responding to the concerns of the community while developing the Project plan.

1.1.3.1 Need for the Proposed Project

1.1.3.1.1 National Benefits

Each of the economically recoverable metals in the Crandon ore is important to the economic viability of the Project. The metals, in order of importance, are zinc, copper, silver, gold, and lead. The following subsections include a discussion of the benefits of recovery of each of the metals mentioned above. Production rates and statistics in the following text apply to the massive ore mining period and the stringer ore mining period, Years 1 through 16 and Years 17 through 29, respectively. The estimated annual metal production for the Crandon Project versus actual United States and world production in 1983 is presented in Table 1.1-2. The primary sources of information on world and U.S. metal consumptions were Minerals Facts and Problems (Bureau of Mines, 1980) and the 1983 Minerals Yearbook (Bureau of Mines, 1984).

Zinc - Among nonferrous metals, zinc ranks third in domestic tonnage consumed, behind aluminum and copper. Its physical properties of corrosion resistance, machineability, relatively low melting point, and solubility in copper make it an important industrial metal for a number of applications. The primary markets for zinc and zinc components are in galvanizing, brass hardware, die cast components for autos and appliances, batteries, and tire manufacture.

According to the latest available data of the U. S. Bureau of Mines, world zinc mine production in 1983 was 13,800 million pounds (Table 1.1-2). Mine production in the U.S. was 606 million pounds, some 4.3 percent of the total. The Crandon Project is expected to produce about 420 million pounds per year of zinc metal in concentrate form, making it one of the world's 10 largest mines in terms of annual zinc metal production. On world standards, however, the mine represents only a 3 percent expansion of production.

The U.S. mine production of zinc provides only 25 percent of total U.S. demand (Table 1.1-2). The remainder is covered by imports of zinc metal and concentrate, primarily from Canada, but also from Europe, Mexico and South America. The Crandon Project would directly or indirectly displace some of these imports, and thereby reduce U.S. foreign dependence for this important metal.

TABLE 1.1-2

ESTIMATED ANNUAL METAL PRODUCTION FOR THE CRANDON PROJECT VERSUS ACTUAL UNITED STATES AND WORLD PRODUCTION IN 1983

Metal	Estimated Annual Contained Metal Production Crandon Project		Annual Production (1983)	
	Years 1-16	Years 17-29	United States (% of U.S. Demand)	World
Zinc (M lb)	420	23	606 (25)	13,800
Copper (M lb)	31	68	3,740 (59)	17,600
Lead (M lb)	19	-	990 (39)	7,200
Silver* (K troy ounces)	3,600	415	43,000 (36)	390,000
Gold* (K troy ounces)	60	11	2,000 (64)	445,000

*These metals are contained in the zinc, copper and lead concentrate and will be recovered in the smelting and refining process.

The U.S. Bureau of Mines projects that U.S. demand for primary zinc will grow at a rate of about 1.6 percent per year through the year 2000. Such a growth rate would bring the demand to a level of 3,640 million pounds per year by the year 2000. At such a level, the Crandon Project would supply about 11 percent of total U.S. demand. Even though the U.S. zinc supply is substantial, there is a need for development of additional zinc mines in the U.S. to meet current and future needs.

Copper - Copper's physical properties, high electric and thermal conductivity, ability to be drawn into fine wire, malleability, high corrosion resistance, and appearance make it an important industrial metal. The principal end uses of copper are in electric wiring, telecommunications, plumbing and heating tubes, automotive radiators, valves and fittings, and household appliance components.

According to the U.S. Bureau of Mines, world mine production of copper in 1983 was approximately 17,600 million pounds (Table 1.1-2). The U.S. produced about 13 percent of the total, or 3,740 million pounds. The Crandon Project is estimated to produce about 31 million pounds per year of copper metal when full production is achieved during operation Years 1-16. As such, it represents about 1.5 percent of U.S. supplies and less than 0.5 percent of total world supply. During operation Years 17 through 29, annual production of copper is estimated to be 68 million pounds. While copper is an important source of revenue to the Project, the effect of the Project on the world market will be far smaller than for zinc.

According to the U. S. Bureau of Mines, in 1983 the U.S. imported about 25 percent of its primary copper needs in the form of metal or concentrates. The Project will help reduce this import dependence, directly or indirectly. While the tonnage impact is not large during the first 16 years of Project life, the impact will be significantly more favorable in later years.

The U.S. Bureau of Mines estimates that the demand for primary copper will grow at the rate of 2.4 percent per year through the year 2000. By then, demand should be 70 percent higher than in 1978. Clearly, considerable additional U.S. production capacity will have to be added if the country is to avoid increased dependence on imports of this important industrial commodity.

Silver - The pattern of consumptive use of silver has changed drastically since World War II. Whereas consumption for coinage has declined, the use of silver as an industrial commodity has increased. Silver continues to maintain its position as a precious metal used in jewelry and silverware. Progressively, silver has become a useful, if not critical, industrial product with the principal uses being in the electrical and electronics industries as a conductor, as a widely used constituent of brazing alloys in general industry, and as the basic chemical in photographic film.

Over half of world silver output is produced as a by-product of copper, lead, and zinc mining, with the remainder attributable to mines which principally produce silver metal. Total free world industrial consumption of silver in recent years has been 350 to 370 million troy ounces per year, with corresponding production being 340 to 390 million troy ounces. Accordingly, world consumption and supply are approximately in balance.

Mine production in the U.S. represents about 11 percent of western world consumption. In a typical year during the massive ore mining period, the Crandon Project would produce approximately 3.6 million troy ounces of silver in all concentrates (Table 1.1-2), most of which is ultimately recovered in smelting and refining.

Crandon represents an important source of newly mined silver in the U.S., amounting to about 8 percent of 1983 domestic mine production. Demand in the U.S. for primary silver according to the U.S. Bureau of Mines may more than double by the year 2000. Accordingly, the U.S. can support increases in silver production.

Lead - The major applications for lead are storage batteries, pigments and chemicals, an anti-knock additive to gasoline (still widely used outside the U.S.), cable sheathing, and in materials for the construction and metal working industries.

According to the U.S. Bureau of Mines, world mine production of lead in 1983 was approximately 7,200 million pounds (Table 1.1-2). The U.S. produced about 13 percent of this total, or 990 million pounds. The Project's anticipated lead production of 19 million pounds per year during operation Years 1 through 16 represents an increase of about 2 percent in U.S. mine production and far less than 0.5 percent in total world production. Lead does, however, contribute to Project economics.

Gold - The Crandon Project expects to produce in all concentrates about 3.0 percent of U.S. mine production of gold and less than 0.2 percent of world-wide mine production.

World mine production of gold in 1983 was approximately 44.5 million troy ounces (Table 1.1-2). According to U.S. Bureau of Mines' figures, U.S. demand for fabricated gold has varied in recent years from 3.1 to 4.8 million troy ounces. In 1983, demand was 3.1 million troy ounces. United States mine production was about 1.0 million troy ounces annually between 1979 and 1980, then increased to 2.0 million troy ounces in 1983. The U.S. Bureau of Mines forecasts that demand will grow by about 75 percent by the year 2000, indicating that there is a need for major increases in U.S. gold production capacity.

There are no other identified and marketable metal by-products besides silver and gold. The ore does not contain economic quantities of minor metals as is characteristic of some other base metal ores produced in the world.

Table 1.1-3 shows the relative abundance and economic worth of the metals from the Crandon Project during the initial 16 years of operation when a high zinc content massive ore is mined and during the last 13 years of Project life when a high copper content stringer ore is mined. The market price does not reflect costs of producing the products or any of the smelting and refining charges. These values do not in any way represent profit or profitability to the Project.

Crandon Project production is expected to help meet an increase in U.S. demand for zinc when the Project begins operation. Since the U.S. is a net importer of a major portion of its zinc

TABLE 1.1-3

RELATIVE ECONOMIC IMPORTANCE OF METALS RECOVERED IN THE CRANDON CONCENTRATES[a] (Typical Year of Operation)

Basis: Initial 16 years: 2,655 K tons per year ore milled
Last 13 years: 2,060 K tons per year ore milled

Metal	Amount of Metal Recovered Per Year: Initial 16 Years	Amount of Metal Recovered Per Year: Last 13 Years	1983 Price Ranges[b]
Zinc (M lb)	420	23	0.378 - 0.490 $/lb
Copper (M lb)	31	68	0.614 - 0.809 $/lb
Lead (M lb)	19	-	0.190 - 0.262 $/lb
Silver[c] (K troy oz)	3,600	415	8.44 - 14.08 $/tr oz
Gold[c] (K troy oz)	60	11	375.50 - 505.30 $/tr oz

a Data in table do not account for losses at smelter nor do they include smelting charges.

b Average weekly metal prices for 1983 as published by Metals Week.

c These metals are contained in the zinc, copper and lead concentrate and will be recovered in the smelting and refining process.

requirements, any incremental production will potentially reduce the dependence on imports. A marginal U.S. producer will survive or fail depending on its ability to compete in a world market rather than with any particular increment of production such as from the Crandon Project.

Crandon concentrates will compete with other concentrates for existing North American and European smelter capacity on a ton for ton basis. Whereas there is no assurance that a specific U.S. zinc smelter will remain operating by the year 1990, it is reasonable to assume that the following plants will continue in operation:

Company	Zinc Refinery Location
AMAX	Illinois
Jersey-Miniere	Tennessee
St. Joe	Pennsylvania
	Oklahoma

If the above refineries were to be operative and if other U.S. mines have not significantly increased their concentrate production from the average over the last 3 years, then there would be sufficient U.S. facilities to treat Crandon concentrates, as well as that from other U.S. producers, without a negative effect upon existing marginal U.S. production.

The future production status of the mines and smelters owned by other companies is speculative and beyond the knowledge, control or influence of the Project. For these reasons, the Crandon Project may use a variety of transportation routes, both domestic and overseas, in order to place concentrate output efficiently, economically, and with minimal disruption to existing marginal U.S. production.

1.1.3.2 Statutory Obligations

A summary of the permits required to begin construction of the Project is presented in Table 1.1-4. The Applicant submitted the Mining Permit Application, Air Permit Application, and the MWDF Feasibility Report in December 1982. All other permit applications were submitted to DNR in 1983.

1.1.3.3 Project Schedules and Manpower Requirements

A mine/mill facility of the type and size of the Crandon Project requires about 3 years to construct and start initial production of metal concentrates. Approximately 1 year is subsequently required to reach full production. Based on estimated ore reserves, the production life of the Project will be about 29 years. When the orebody is depleted and production ceases, approximately 4 years will be required for closure and reclamation of the facilities. A condensed schedule for the Crandon Project is presented on Figure 1.1-6 and shows the time durations and relationships of major Project activities. Also shown on Figure 1.1-6 is the estimated manpower for the various phases of the Project. Further details for employment needs are presented in subsections 1.3.3.1 and 1.4.2. The schedule shown on Figure 1.1-6 represents practical and achievable dates. However, the actual start date depends heavily on permitting and metal marketing factors and on Exxon's corporate decision process which includes an analysis of permit conditions and economic factors.

Planned Project activities during the pre-construction, construction, production, and closure phases are described under the following headings.

TABLE 1.1-4

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 (40 CFR 112.7)	Have plan on file before operations begin
49 U.S.C. 1348	FAA	Registration with FAA of all structures that will exceed 200 feet above ground level	Determine that head-frame is not an air navigational obstruction
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.

TABLE 1.1-4 (continued)

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

TABLE 1.1-4 (continued)

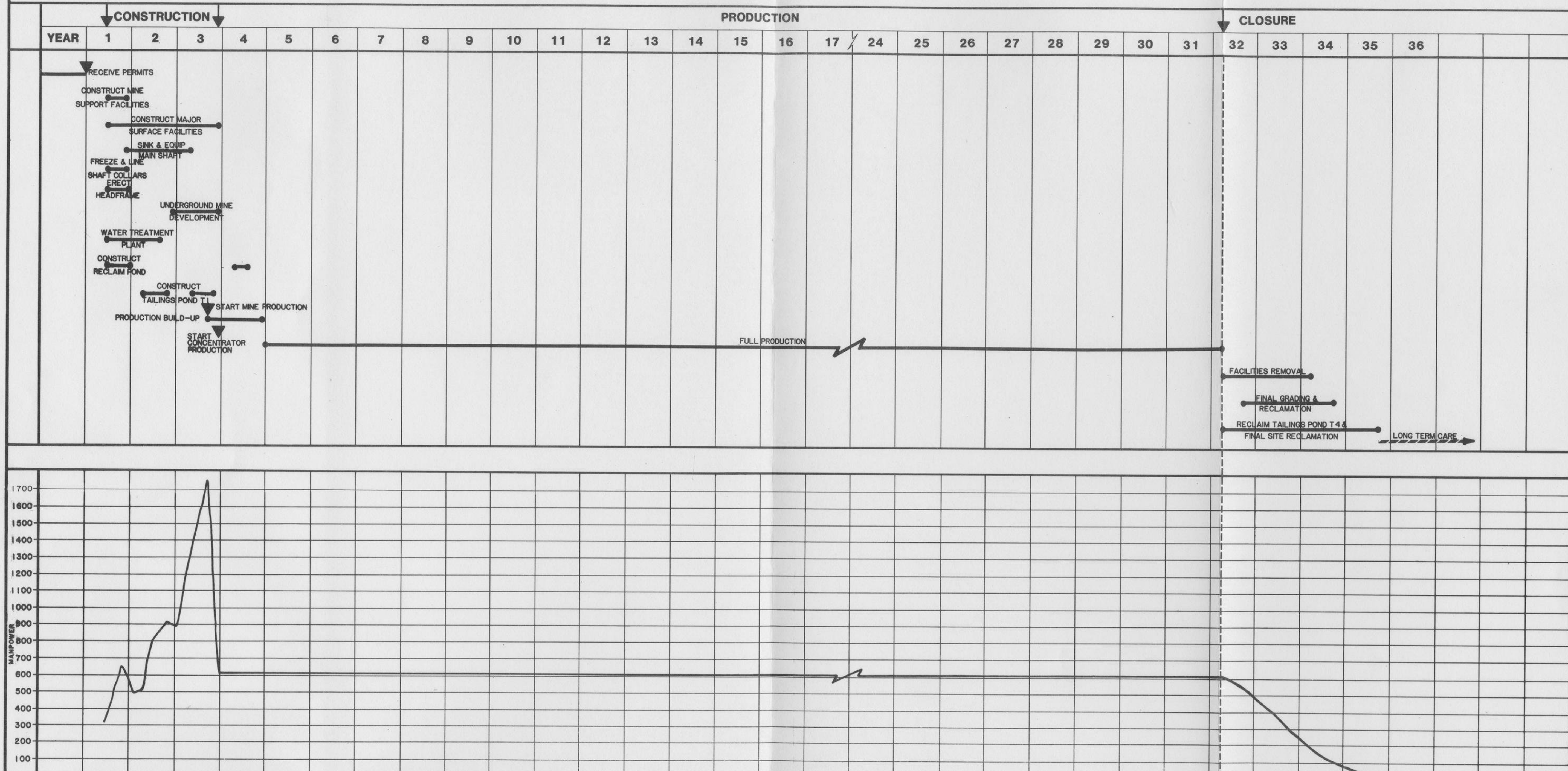
Statutory Obligation	Administering Agency	Activity	Action
Wis. Stat. 101.12	DILHR	Surface building plans, blasting procedures	Review and approve applicable construction procedures and building plans and issue applicable permits
Wis. Stat. 145.02	DILHR	Plumbing and fire protection	Review and approve plans 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. 145.19, 145.20, 147.02	DILHR, Forest County and DNR	Private sewage septic system*	Permit issuance (county); permit issuance (DNR) and review and approve final plans (DILHR)
Wis. Stat. 144.392, 144.391	DNR	Air emissions	Permit issuance
Wis. Stat. 144.44, 144.46	DNR	Mine Waste Feasibility Report, Plan of Operation	Report and plan; approval and license
Wis. Stat. 144.85	DNR	Mining	Permit issuance
Wis. Stat. 144.86	DNR	Bonding	Authorize Commencement of mining

*Ei[illegible]r a sewage package treatment plant or a septic s[illegible]em will be finally proposed.

TABLE 1.1-4 (continued)

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

EXXON MINERALS COMPANY
CRANDON PROJECT
SCHEDULE



YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	24	25	26	27	28	29	30	31	32	33	34	35	36			
PEAK	640*	909*	1734*	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	490	250	80	1	1	1	1
AVG.	550**	723	1340	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	580	325	165	55	1	1	1	1

NOTES:

1) CONSTRUCTION OF TAILINGS POND T2, T3 & T4 WILL BE DONE AS REQUIRED DURING PRODUCTION. RECLAMATION OF TAILINGS POND T1, T2 & T3 WILL BE DONE DURING PRODUCTION.

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

* CONSTRUCTION MANPOWER INCLUDES 20% CONTINGENCY.

** 7 MONTH AVERAGE

REVISED	DATE	BY	DESCRIPTION
4	8-14-85	DRS	Updated To Reflect Mine Changes
3	1-28-85	DRS	Gen Revision
2	4-23-84	DRS	Gen Revision

Typical Representation: Refinements May Be Made During Final Enginering. Final Estimate Expected To Be Within ±15% Of This Estimate.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **PROJECT SCHEDULE**

SCALE: NONE | STATE: WISCONSIN | COUNTY: FOREST

DRAWN BY: DR SPRINGBORN | DATE: 4/84 | 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 1.1-6 | SHEET ___ OF ___ | REVISION NO. 4

GBB 5/1981

Pre-construction - A discussion of the monitoring programs for ground water, surface water, aquatic ecology, air quality, and terrestial ecology is presented in the Mining Permit Application. The schedule for implementing the monitoring programs during pre-construction, construction, operation and reclamation (closure), the frequency of sampling, and locations to be sampled are also discussed in greater detail in the Monitoring and Quality Assurance Plan (Monitoring Plan). The Monitoring Plan developed for the Crandon Project is responsive to NR 132 and NR 182. It is designed to provide data for evaluation of construction, operations, and reclamation activities at the mine, mill, reclaim pond, MRDF, MWDF, other associated activities and their environs. The monitoring programs for the above items will be initiated 6 to 12 months prior to construction.

Construction - The Project construction phase is planned to begin after Exxon receives all required government permits and internal and corporate approval to commence construction. When it begins, duration for construction of the mine/mill facilities, or the schedule critical path, will be determined by the time required to sink the underground mine main shaft, erect the hoist headframe, and complete underground mine development.

The time required for construction of the mine/mill surface facilities will be less than that required to complete the underground mine and associated facilities. As a result, the sequence for construction of the surface facilities will initially be governed by the need to provide, in a timely manner, the surface facilities required for support of the mine shaft sinking and underground mine development.

Construction of the major surface facilities will begin in the first year of the construction phase and will be completed to meet the production start date.

It is anticipated that the construction phase of the Project will be performed utilizing three shifts per day working throughout the 24-hour period, 7 days per week for the development of underground mine and associated facilities. Work on the surface facilities will normally be performed by 1 to 2 shifts working up to 16 hours per day, 5 days per week.

Production - The production phase of the Project will normally be performed as presented below:

	Shifts/Day	Hours/Shift	Days/Week
Mine Stope Production and Development	3	8	7
Primary Crushing and Ore and Waste Hoisting	3	8	7
Mine Backfilling	3	8	7
Concentrator	3	8	7
Waste Disposal and Water Treatment	3	8	7

Closure - When the orebody is depleted and production ceases, approximately 4 years will be required for closure of the facilities and reclamation. The closure will involve conversion of facilities to other possible uses, the removal of the remaining facilities, and reclaiming the sites. In the event no other use can be found for a facility, it will be removed and its site reclaimed. Detailed scheduling of closure activities can only be developed as the production phase of the Project draws to a close.

Manpower Requirements - Tables 1.1-5 and 1.1-6 summarize the current estimates of employees that will be required for construction and operation of the Crandon Project. The 4-digit Standard Occupational Classification Code (SOC) from the U.S. Department of Commerce has been listed for each job category along with the number of employees, general educational level required and an indication of whether the position requires previous experience. The job category identifies the general skills necessary for the employees (i.e., cement mason) expected to be hired.

These tables represent only general guidelines for education and experience. The hiring and job interview process will balance the education and experience levels. In actual practice some deviation from the education and experience requirements, as indicated in the attached tables, will probably occur through the employment process.

To the extent allowed by the state and federal anti-discrimination laws, Exxon has an announced policy of preferentially hiring qualified local people during the construction and operation phase of the Crandon Project. As presently interpreted, the state and federal anti-discrimination laws do not prohibit the granting of local preferential treatment in the hiring decision provided the hiring is conducted in a nondiscriminatory manner within the local area. There are no existing or currently planned agreements with local governments or Indian tribes relating to proposed hiring practices.

Exxon will outline job skills required for various positions at the Crandon Project and review curricula developed by the local schools if requested. Exxon currently sees no need to support an organized van or bus system to encourage local hires.

TABLE 1.1-5

ESTIMATED CONTRACTOR CONSTRUCTION PHASE WORKFORCE

JOB CATEGORY	SOC[a]	NO. OF WORKERS[b]	EDUCATION[c]	EXPERIENCE[d]
		Shaft and Underground Facilities		
Pipefitters	6450	5	V	Y
Welders	7710	5	V	Y
Electricians	6430	10	V	Y
Millwrights	6178	10	V	Y
Mechanics	6140	15	H	Y
Equipment Operators	8310	10	H	Y
Ironworkers	6472 & 6473	15	V	Y
Carpenters	6420	10	H	Y
Laborers	8710	15	H	N-Y
Cement Masons	6463	10	H	Y
Shaft and Drift Miners/ Rock Drillers	6530	30	H	Y
Hoistmen	8314	10	H	Y
Surveyors	1640	5	V	Y
Supervisors	6310	10	H-C	Y
Engineers	162 & 163	5	C	Y
		Surface Facilities		
Boilermakers	6814	70	V	Y
Carpenters	6420	65	H	Y
Electricians	6430	195	V	Y
Laborers	8710	210	H	N-Y
Operating Engineers	8310	70	H	Y
Millwrights	6178	60	V	Y
Painters	6440	20	H	Y
Pipefitters	6450	160	V	Y
Ironworkers	6472 & 6473	70	V	Y
Drivers/Mechanics/Oilers	6140	70	H	Y
Cement Masons/Finishers	6463	5	H	Y
Surveyors (Rodmen)	1640	5	V	Y
Supervisors	6310	135	H-C	Y
Engineers	162 & 163	25	C	Y

[a] Standard Occupational Classification Code (SOC) - U.S. Department of Commerce.

[b] Numbers reflect maximum employment needs within job categories rounded to the nearest 5. Due to timing differences, totals may not agree with Project employment totals.

[c] Education: H - High School
V - Vocational Technology
C - College

[d] Y - yes; N - none required; N-Y - some employees will need prior experience and others will be trained on the job.

Note: Typical representation for the purpose of socioeconomic analysis. Refinements may be made during final engineering. Final estimate expected to be within ± 15% of this estimate.

TABLE 1.1-6

EMC PERSONNEL DURING OPERATIONS

JOB CATEGORY	SOC[a]	NO. OF EMP.[b]	EDUCATION[c]	EXPERIENCE[d]
	Administration	77		
Secretaries/Clerks	46-47	17	H	N-Y
Janitors	5240	7	H	N-Y
Security	5140	8	V	Y
Accountants	1412	2	C	Y
Warehouse	8724	9	H	N-Y
Purchasing	1449	2	H	Y
Paramedics	5236	4	V	Y
Employee Relations/ Safety/Training	1430	9	C	Y
Environmental	1849	5	C	N-Y
Supervision	12-13	8	C	Y
Engineers	162 & 163	4	C	Y
Public Affairs	3320	2	C	Y
	Mine Technical	26		
Supervisors/Engineers	162 & 163	6	C	N-Y
Geologists	1847	3	C	N-Y
Draftsmen	3720	2	V	N-Y
Engineers/Geology Technicians	3710	8	V	N-Y
Surveyors	1640	5	V	Y
Clerks	46-47	2	H	N-Y
	Mine Operations	267		
Secretaries/Clerks	46-47	4	H	N-Y
Miners	6530	80	H	N-Y
Equipment Operators	6540	88	H	N-Y
Laborers	6560	65	H	N
Supervisors	6320	26	V	Y
Hoistmen	8314	4	H	Y

a Standard Occupational Classification Code (SOC) - U.S. Department of Commerce.

b Numbers reflect employment needs within job categories. Due to timing differences, totals may not agree with Project employment totals.

c Education: H - High School
V - Vocational Technology
C - College

d Y - yes; N - none required; N-Y - some employees will need prior experience and others will be trained on the job.

Note: Typical representation for the purpose of socioeconomic analysis. Refinements may be made during final engineering. Final estimate expected to be within ± 15% of this estimate.

TABLE 1.1-6 (continued)

JOB CATEGORY	SOC[a]	NO. OF EMP.[b]	EDUCATION[c]	EXPERIENCE[d]
	Mine Maintenance	86		
Equipment Mechanics	6110	50	H	N-Y
Pump/Fan Mechanics	6130	1	H	Y
Welders	7710	4	V	Y
Electricians	6430	8	V	Y
Maintenance	6179	10	H	N-Y
Clerks	46-47	4	H	N-Y
Supervisors	6000	9	V	Y
	Mill Operations	57		
Secretaries/Clerks	46-47	2	H	N-Y
Mill Operators	6960	37	H	N-Y
Laborers	8650	11	H	N-Y
Supervisors	6320	7	H	Y
	Mill Technical	22		
Lab Technicians	3831	12	V	N-Y
Metallurgists/Chemists/ Engineers	162 & 163	7	C	N-Y
Technicians	3710	2	V	N-Y
Typist/Clerks	46-47	1	H	N-Y
	Mill Maintenance	28		
Supervisors	6000	2	V	Y
Mechanics/Oilers	6140	18	H	N-Y
Welders	7710	4	V	Y
Instrument Repairs	6170	4	V	Y
	Central Maintenance	57		
Supervisors	6000	6	V	Y
Machinists	6813	2	V	Y
Electricians	6430	13	V	N-Y
Mobile Equip Maintenance	6110	23	H	N-Y
Draftsmen	3720	1	V	N-Y
Welders/Fabricators	7710	6	V	Y
Carpenters	6420	1	H	Y
Secretaries/Clerks	46-47	2	H	N-Y
Maintenance Planners	4750	2	H	Y
Engineers	162 & 163	1	C	Y

1.1.3.4 Project Facilities and Equipment Costs

Expenditures on the Crandon Project from initial discovery of the orebody through construction are currently estimated to total $390 million in 1985 dollars (Table 1.1-7). Capital and reclamation expenditures during operations are estimated to total $144 million. Actual costs will reflect inflation and cost escalations between the reference year and the years of actual construction.

Expenditures are divided among three descriptive categories (Mine and Surface Facilities and Land; Pollution Control Facilities; and Reclamation) and two time periods (Construction and Operations). All expenditures indicated in Table 1.1-7 reflect current information and planning data. These numbers are expressed in 1985 dollars. Each type of expenditure category is defined below:

Expenditure Category	Definition
Land and Mine and Surface Facilities	Orebody delineation drilling, preliminary engineering, environmental studies and overhead expenditures, land, site preparation, construction of the mine, mill, major office building, roads, railways, original and replacement equipment, and all other surface facilities, excluding pollution control facilities.
Pollution Control Facilities	Water treatment, tailings disposal, and other pollution control facilities.
Reclamation	Facilities removal, grading and reclamation of the mine/mill site, waste disposal area, and ancillary facilities.

TABLE 1.1-7

ESTIMATED PROJECT FACILITIES AND EQUIPMENT COSTS IN 1985 DOLLARS

Description	Construction ($M)	Operations ($M)	Total
Mine and Surface Facilities and Land	340	66	406
Pollution Control Facilities			
Water Treatment	22	-	22
Tailings	28	43	71
Reclamation	-	35	35
TOTAL	390	144	534

NOTE: These values do not include anticipated escalation costs for the time period up to and through construction.

A definition of the time period for each of the major phases of Project development is presented below:

Time Period	Definition
Construction	Period from initial discovery in 1975 through beginning of operations.
Operations	Period from the start of production in Year 3 through the end of the Project life in Year 35. Period also includes reclamation and post-operations maintenance and monitoring.

At the present time it is anticipated that funds for the Project will be provided to Exxon Minerals Company from Exxon Corporation. Entry into the capital markets, whether by equity offering or bond issue, is currently not being considered for the Project alone. Rather, Exxon Corporation will fund this Project from resources generated to fund capital outlays for the entire Corporation. These resources could include internal cash generation, an equity issue, some type of indebtedness, or other means.

1.1.3.5 Related Governmental Plans and Goals

The related governmental plans and goals described in this subsection were identified as a result of contacts with various agencies and a review of local community development literature. The North Central Wisconsin Regional Planning Commission (NCWRPC), the Wisconsin Department of Transportation, and representatives from the Nicolet National Forest, Nicolet College and Technical Institute, Forest County, Langlade County and Oneida County were contacted to provide the required data. Major goals of these agencies are identified below.

At the county level, Forest, Langlade, and Oneida counties have completed Agricultural Land Preservation plans, which allow participants to receive a state income tax credit for setting aside lands identified as suitable for preservation of agricultural purposes (Jopek, 1982). The access road from State Highway 55 to the mine/mill site and parts of the railroad access proposed by Exxon in its applications cross acreage which is or has been agricultural. However, the lands were not included in the preservation plans.

1.1.3.5.1 Forest County

The Forest County Development Plan (NCWRPC, 1980a) and the City of Crandon Comprehensive Plan contain general statements of goals, policies, and objectives regarding the proposed Project (NCWRPC, 1981). In the Forest County Development Plan, the Zoning Committee adopted the position that local jurisdictions should allow metallic mining operations as long as those operations do not negatively affect neighboring property owners or degrade the natural environment. Similarly, the City of Crandon in its Comprehensive Plan, adopted the position that the proposed mine/mill complex offers great potential for new employment opportunities and that the City should promote diversification of industry and business and the development of new jobs.

Discussions with local governmental agencies have identified the following developments or planned developments:

Recreation - Improvements at the Forest County park on the South end of Lake Metonga and the City of Crandon beach area on Lake Metonga are planned as an on-going program. The Forest County

Fairgrounds in the City of Crandon have seen buildings constructed or remodeled in the past few years and the Fair committee has long-range goals for additional improvements.

Transportation - In the Crandon Comprehensive Plan (NCWRPC, 1981) the proposed U.S. Highway 8 bypass was identified as the only major transportation change under current consideration. The bypass would probably direct some Project-related traffic away from the downtown area and tend to decrease the level of traffic congestion in this area. The bypass is a long range project and is not expected to occur during the next decade.

Resources - Timber resources have historically been the basis of the county economy. Approximately 87 percent of the total land area of the county is classified as commercial forest land (NCWRPC, 1981). The Nicolet National Forest occupies approximately 333,000 acres of land of which 310,100 acres is commercial forest land. State ownership of 23,000 acres (with 21,400 acres classed as commercial forest land) is confined to Trust Fund Land. The county holds title to approximately 13,000 acres and manages more than 80 percent of it under the Forest Crop Law. About 37 percent of the commercial forest land is in private ownership (NCWRPC, 1981).

State, county, city, town or village public lands in the environmental study area are shown on Figure 2.9-7 in Section 2.9. Lands in the environmental study area entered into the Woodland Tax Law and the Forest Crop Law programs are identified in Section 2.9, Figure 2.9-2. County Forest lands associated with Project facilities will be acquired by Exxon by exercising a land purchase option covering lands in Sections 29 and 30, T35N, R13E (Figure 1.1-3).

Lands entered under the Forest Crop Law that were purchased by Exxon have been withdrawn from the provisions of this law. Any additional lands under Forest Crop Law contract that are acquired by Exxon for the Project will be removed from the provisions of this contract. This includes the Forest County lands in Sections 29 and 30, T35N, R13E which are under an Exxon land purchase option (Figure 1.1-3).

There are no Woodland Tax Law lands associated with the proposed Project facilities.

In the process of identifying related governmental plans or goals in the resource area for Forest County, the Nicolet National Forest was examined. The Draft Land Use Management Plan for the Nicolet National Forest has been completed and public input is being solicited. Even though final details are not available at this time, the plan is not expected to include any expansion of the current boundaries of Nicolet National Forest (Moore, 1983). Since the mine/mill site is over 5 miles from the nearest boundary, the development of the Crandon Project would not directly affect physical planning activities except an estimate will be needed for additional use of public facilities within the Forest created by Project-related growth.

Education - The Crandon School District currently plans a multi-year improvement of the physical plants at all elementary schools.

Native American Communities - The two Native American communities in the Project area have each submitted OEDP plans and annual updates. Discussions with the two communities do not indicate major developments during the short-term. The Mole Lake Chippewa

Community continues to develop a shopping complex and community building on the reservation and the Forest County Potawatomi recently received approval to develop a heavy construction trades program for their community.

1.1.3.5.2 Langlade County

The Langlade County plans and the City of Antigo Comprehensive Plan (NCWRPC, 1983) contain statements regarding the proposed Project. Discussion with local governmental agencies indicates the following developments or development plans:

Recreation - Langlade County has a 5-year recreational program. This program is currently devoted to improvement of the Langlade County Fairgrounds. Outdoor recreational activities are being evaluated and expanded as necessary through local governments in cooperation with the private sector (Given, 1983).

Transportation - County Trunk Highway A, the main route from Antigo to State Highway 55 near the Project, will be maintained and reconstructed during the next few years. State Highway 55 is considered a "scenic route" through Langlade County and the Wisconsin Department of Transportation indicates that this road will not be rebuilt or upgraded until demand exists (Given, 1983).

The Langlade County Airport is in a 6-year development plan. Currently the Airport Commission is attempting to acquire land for a cross-wind runway extension of an existing runway. Construction will not be considered until needs justify the expansion (Given, 1983).

The recently abandoned Chicago and Northwestern Railroad right-of-way is under study for potential use as a long-term utility development corridor by the City of Antigo (Given, 1983).

Resources - Langlade County and Antigo are in a reforestation program to estabish 7,500 trees on a 10-acre tract on the site of the former landfill.

The Antigo Waste Processing and Recycling Center is now completed and accepting waste products from Langlade and parts of Shawano and Marathon counties.

Education - The Antigo Board of Education Capital Improvement Plan includes the construction of a high school auditorium on school acreage followed by a multi-year program which includes complete remodeling of the existing high school facilities.

1.1.3.5.3 Oneida County

The revised Oneida County Long-Range Plan (NCWRPC, in preparation), the Rhinelander Comprehensive Development Plan (Rhinelander Mining Impact Committee, in preparation), and the Downtown Rhinelander Improvement Association Development Plan (Allen, in preparation) each present goals related to the proposed Project:

Recreation - The Oneida County Forestry and Outdoor Recreation Committee has developed long-range plans which include expansion of outdoor recreational activities on Oneida County Forest lands.

The Wisconsin Northwoods Tourism Region 2 recently established an annual Snowmobile Festival to be held in January of each year.

Transportation - The downtown Rhinelander traffic pattern has been improved by the development of the abandoned Chicago and Northwestern Railway corridor which was purchased by the City of Rhinelander.

A long-range proposal to provide a U.S. Highway 8 by-pass around Rhinelander will ultimately affect traffic in the Rhinelander-southern Oneida County area.

Current plans are to improve the taxiway at the Rhinelander-Oneida County Airport.

Resources - The Oneida County Forestry and Outdoor Recreation Committee long-range plans include timber sales and reforestation for total resource management. The same type of long-range management plan is in effect for the Northern Highland and American Legion forests in Oneida County.

Education - The Rhinelander K-12 School District has developed a 5-year capital expenditure plan which provides improvement to all schools in the district including the construction of a double K-6 school in the Town of Pelican and an addition to the West Elementary School. The proposed new construction has not been approved in two recent referrenda offered to the electors.

Nicolet College and Technical Institute, located in Rhinelander, is currently investigating the development of a curriculum for mining technicians (Travis, 1982). Graduates from this program could provide a work force for mining projects at any location including Wisconsin. It is also possible for additional training programs to be established by Nicolet College either for direct mining-related employment or for industrial development indirectly associated with mining.

Both North Central Technical Institute in Antigo and Nicolet College and Technical Institute have trades programs available for many of the skills required by mining construction and development.

Recreation - A review of the 1981 State Comprehensive Outdoor Recreation Plan supply-demand-needs assessment for outdoor recreational activities indicates that for all activities, only a minor percentage of the state-wide need occurs in Region 2. Data developed in the course of preparing the Exxon Minerals' Socioeconomic Report entitled, "Current Conditions Report," confirm the basic needs assessment for outdoor activities identified in the 1981 State plan. Discussions with the Forest, Langlade and Oneida County Chambers of Commerce indicate that the responsibility for meeting the recreational needs has been a primary function of each local governmental jurisdiction in cooperation with the local private sector. Also, in Region 2 many outdoor recreational activities are preferred to be in undeveloped or in the lesser developed areas.

Tourism goals and objectives have been established for Region 2 by the Wisconsin Department of Development (Wisconsin Tourism Industry Study, 1983) and the Governor's Blue Ribbon Task Force on Tourism (1982). These studies are more recent than the 1981 Comprehensive Outdoor Recreational Plan. Recommendations based on the Wisconsin Tourism Industry Study by the Department of Development apply equally to

Region 2. The study contained recommended action on several levels:

1) Information: Facilities availability; sight-seeing opportunities;

2) Lake Access: Better public access for water related activities;

3) Financing: State funding availability to local tourism areas;

4) Marketing: Maintenance of existing markets and attraction of untapped markets; and

5) Education: Providing operators with information on which to make decisions related to facilities improvement.

The above information and recommendations will provide adequate background for planning of tourism-based growth with and without mining-related development.

1.1.3.6 Requirements for Governmental Services

In the operation of the Crandon Project mine/mill facilities, it is anticipated that requirements for governmental services will be minimal, as most services will be provided on-site or contracted to a private contractor. The projected off-site requirements for governmental services to accommodate Project personnel during construction and operation are presented in subsection 4.2.10, Socioeconomics.

Potable water facilities will be provided on-site to satisfy Project needs. Also, sanitary sewage handling and treating facilities will be provided on-site. The sewage treatment system will be handled by a package wastewater treatment plant requiring approximately 0.1 acre within the mine/mill complex.

The wastewater loading for the package treatment plant is based on a waste generation rate of 35 gallons per day per person as stated in subsection 1.2.4.6, and an estimate of 650 people. Using this waste generation rate and adding 750 gallons per day of base flow (per code), the average wastewater flow and effluent discharge is estimated to be 16 gallons per minute. The package treatment plant will require a surface water discharge which will be included in the excess water discharge to Swamp Creek. Sludge from the package treatment plant will be accumulated in a tank adjacent to the plant and removed by a contractor at an estimated rate of 5,000 - 6,000 gallons every 2 months. More detail on the sanitary waste facilities is provided in subsections 1.2.4.6 and 1.4.8.2.

Fire protection will be provided from facilities on-site which will be capable of handling most fires that might occur. Part of the work force will be trained in fire fighting by MSHA-approved instructors qualified to teach fire fighting methods in accordance with an approved MSHA training plan. It is anticipated that only in the event of an unusually large or major fire would assistance of outside fire fighting equipment and personnel be requested.

Fire protection will be provided to meet all pertinent codes and regulations. The degree of protection provided in any facility area will be based on its occupancy and its content of combustibles. Individual systems design and the selection of specific equipment items will be addressed during the detailed engineering phase.

The preliminary design provides for a fire-water tank with a capacity of 500,000 gallons. This tank will be located on the north side of the mine/mill site approximately 650 feet east of the mill building. The water source for the fire-water system is assumed to be either treated water from the treatment plant, uncontaminated mine water or well water. The fire-water tank will be full at all times. An alternative source using the 3.4 million gallon excess discharge water lagoons in lieu of the fire water tank is presented in subsection 3.5.7.3

Two fire-water pumps (one electric and one emergency diesel) for supply and a jockey-pressuring pump will be provided to distribute fire water through a pipe loop. This loop will pass in close proximity to all principal surface facilities. A second, subsidiary loop will surround the concentrator building. Fire hydrants will be provided at close intervals, either mounted directly on the loop or on short branch lines. The emergency diesel pump will be activated in the event of a power outage at the pump station.

Automatic fire and/or smoke detection and alarm equipment will be installed in all facilities where appropriate. A fire truck will be garaged in the northwest corner of the services building. Hand-held and Halon 1211-type fire extinguishers will be located where needed. Every vehicle will carry at least one dry chemical unit.

Apart from the handling of flammable fuels and certain reagents, the operations of crushing, concentrating and product load-out are not potential fire risks. This is particularly true in the concentrator building where all processes are wet.

Information on fire protection capability of nearby municipalities is presented in subsection 2.10.4.2. More detailed information on fire protection facilities, equipment and vehicles, number of firemen, salary and operating expenditures, key fire insurance ratings, service area and planned modifications for the local cities and service centers, where available, is given in Appendix 2.10A, Table 2.10A-5.

The frequency of rail traffic on the existing main rail line is not expected to increase. The only additional rail traffic will be from the main track to the mine/mill site. Therefore, the potential for fires along rail lines should not increase as a result of Project activity.

Security will be provided on-site by specially trained personnel. It is anticipated that outside law enforcement assistance would not be required.

A fully equipped emergency medical vehicle will be stationed on-site and will be capable of transporting injured personnel to outside medical facilities. Project personnel will be trained to man this vehicle and to supply emergency treatment. It is anticipated that only in the event of a major accident involving a number of people would a request be made for outside medical assistance and transportation.

Project road maintenance and snow removal will be performed by the work force or by contractors. The construction schedule indicates completion of the access road within the first 15 months of construction. The railroad will be completed within 19 months from start of construction so that heavy loads can be delivered by rail. Exxon plans to maintain and use Sand Lake Road during the construction period.

Plans for the disposal of solid waste refuse from the Crandon Project provide for the construction and operation of an on-site MRDF for all non-hazardous wastes. The annual waste volume is estimated to be 1,625 tons or approximately 50,000 tons over the 32-year estimated life of the MRDF.

The disposal facility will be developed in three stages, each with a 40,000 cubic yard volume capacity and a 10 - 11 year life. This facility will be located in the MWDF area. More detail on the MRDF is provided in subsections 1.2.4.18 and 1.4.8.3.

Slash and unmerchantable timber will be burned or disposed at an on-site or off-site landfill facility.

Refuse generated during operation is characterized in subsection 1.4.8.3, under the heading "Refuse." Estimates of the percentage of various waste categories are as follows:

Waste Type	Volume Percentage
Paper and garbage	75
Plastic	5
Wood	5
Metal	10
Miscellaneous	5
	100

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 would be approximately 1,625 tons.

At the State level, governmental service requirements in the areas of facility inspection (Department of Industry, Labor and Human Relations, Department of Health and Social Services, Department of

Natural Resources) and environmental inspections (DNR) will be increased to the extent required to meet current laws and administrative regulations. However, it is anticipated that the types of inspections necessary will not increase the overall workload or require additional staff.

The decision to treat the Project property as "Manufacturing" for assessment purposes has not required the Department of Revenue's Bureau of Property Tax to increase the manpower required for proper evaluation and tax computation. Under current conditions, any anticipated workload increase should not have a major effect on the overall manpower of the Bureau of Property Tax. Other Department of Revenue Bureaus may also experience brief increases in administrative effort due to the Project; however, no shift in the total workload is expected.

State planning agencies (i.e., Department of Education, Department of Administration and Department of Revenue) have had to consider the potential of mining in the development of near-term and long-range plans. Because these plans were being developed for numerous other purposes, the mining aspects have added only minimal amounts of effort. If the Project proceeds into the construction phase, State agencies may be required to provide a limited short-term increase in manpower assigned to the planning effort for the Crandon Project and its effect on the long-range plans.

The Mining Investment and Local Impact Fund Board, created as a result of the 1977 tax laws, has continued to require one full time staff person. Manpower levels for planning administrative requirements should not increase as a result of the development of the Project, according to discussions with Elizabeth Kohl (1983).

According to Eugene Voss (1983), Director of the Job Service Office in Rhinelander, current administrative functions utilizing computerized data availability will enable the Job Service to handle any Project development with a minimal increase of staff time.

With the exception of possible Department of Industry, Labor and Human Relations involvement on a minimal scale, governmental services for employee training will not be necessary under current plans. Exxon Minerals Company will conduct or retain outside contractors for all training required for permanent staff.

1.1.3.7 Proposed Changes in Land Classification

1.1.3.7.1 Proposed Changes in Zoning

No modifications to current zoning will be required for construction and operation of the Project mine and mill complex.

A summary is presented below of current zoning ordinances and proposed changes in zoning in the area of the mine/mill complex and the implications of these changes on the Crandon Project.

Forest County - In June 1980, the Forest County Board of Supervisors approved and adopted a revised zoning ordinance prepared by the NCWRPC, (1980b). The new ordinance has not been accepted by any of the towns in Forest County. However, any town zoning ordinances must be submitted to, and approved by, the Forest County Board. The ordinance cannot be less restrictive than that currently in force for the County without specific County Board approval. In the ordinance there are no sections or requirements which would prohibit or unduly restrict the construction or operation of the Crandon Project.

Forest County administers a shoreland zoning ordinance. Conditional use permit applications for the proposed access road and railroad crossings, the discharge structure, and other facilities located within 1,000 feet of a lake's ordinary high water mark and 300 feet of the high water mark of navigable streams have been submitted to the Forest County Zoning Administrator along with all pertinent plans.

Town of Lincoln - The Town of Lincoln Board of Supervisors has adopted a zoning ordinance under the "Village Powers" granted at the 1981 Annual Town Meeting (Town of Lincoln, 1982). The ordinance was adopted by the Town in September 1982 and approved by the County Board in November 1982. Amendments to the ordinance were approved by the County Board in November 1984.

The Town of Lincoln zoning ordinance is based on the County ordinance. The mining section of the ordinance is contained in Chapter 15 - Planned Development. The specific standards for a Metallic Mineral Mining and Prospecting Planned Development are described in Sections 15.29 through 15.33.

As written, the Town of Lincoln zoning ordinance contains no sections or requirements which would prohibit or unduly restrict the construction or operation of the Crandon Project.

Town of Nashville - At the 1982 Annual Meeting, Town of Nashville residents approved adoption of village powers. The Town Board has passed a zoning ordinance similar to that of the Town of Lincoln and it was approved by the Forest County Board in November 1984.

The mining section of the ordinance is in Chapter 15 - Planned Development. The specific standards for a metallic mineral mining and prospecting planned development for the Town of Nashville is described in sections 15.30 through 15.34.

As written, there are no town regulations which would prohibit or unduly restrict the construction or operation of the Crandon Project.

Langlade County - Langlade County has completed a comprehensive revision of the existing zoning ordinance (Langlade County, 1985). The revised ordinance will be submitted to each Langlade County town for adoption. The proposed ordinance could affect the operation of the Crandon Project only if any segment should be located within Langlade County.

Under current plans, none of the Crandon Project mine/mill facilities will be located in Langlade County.

Town of Ainsworth - The Langlade County Town of Ainsworth has not adopted current county zoning. However, village powers have been granted by the town's electorate (April, 1984) and local zoning may be implemented.

Proposed zoning would not have any impact on the construction or operation of the Crandon Project because no acreage in the Town of Ainsworth is involved.

City of Crandon - The Crandon Municipal Code contains only one section which could affect the construction and operation of the Crandon Project. The Municipal Airport Zoning Ordinance contains permit requirements and height restrictions for structures constructed within the approach zones and turning zones of the municipal airport. All structures associated with the Crandon Project and located within these zones will be below the allowable heights and will be permitted accordingly.

Town of Crandon - The Town of Crandon has not adopted Forest County zoning. However, village powers were recently granted by the town's electorate (April 1984) and local zoning may be implemented. Under current Exxon plans, construction or operation of the Crandon Project will not involve any acreage in the Town of Crandon.

1.1.3.7.2 Proposed Changes in Political Boundaries and Annexations

There are currently no proposed changes to political boundaries or annexations which would have any effect on the construction and operation of the Crandon Project.

1.1.3.8 Relationship of the Proposed Project to Other Similar Projects

The Crandon Project will be the first massive sulfide mine developed in Wisconsin under the existing state regulations. The Project is not dependent upon or related to any other similar project in Wisconsin. As is discussed in Chapter 3, Alternatives to the Proposed Action, Sections 3.2 and 3.3, the size of the mineral deposit that forms the basis for the Project is sufficient to justify processing facilities dedicated to the treatment of Crandon ores.

Exxon intends to design the Crandon Project to mine and to treat the ores contained within the Crandon deposit. The capacity of the facilities will be sized to match the ore deposit.

1.1.4 References Cited

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Wisconsin Department of Development, 1983, Wisconsin Tourism Industry Study: Madison, Wisconsin.

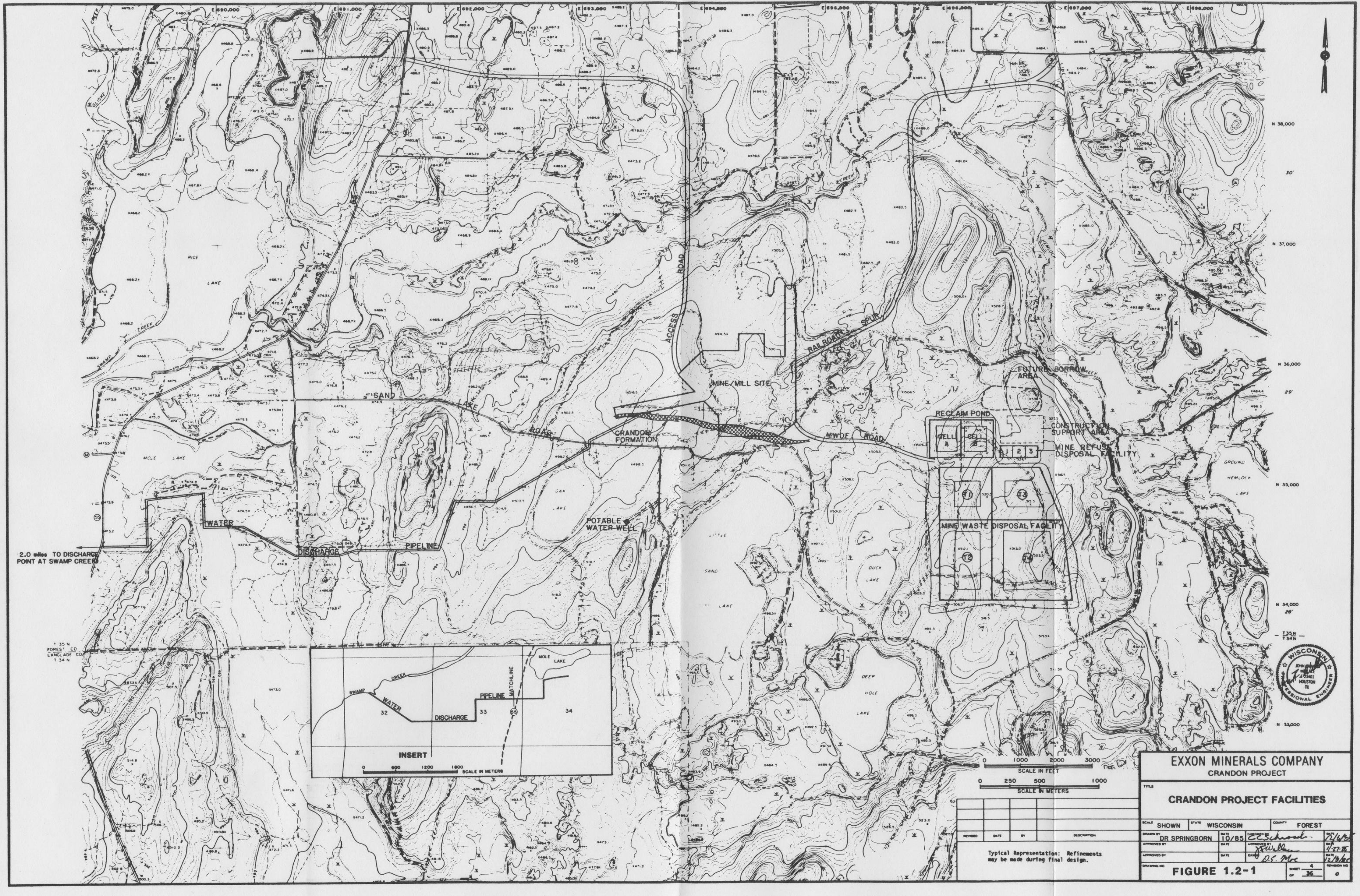
1.2 DESCRIPTION OF FACILITIES

The facilities for the Crandon Project described herein will include an underground mine, a mill to process a total nominal 7,400 tons per day of ore, waste disposal, and ancillary facilities. Since the two types of ore (massive, a zinc-copper-lead ore with pyrite gangue and stringer, a copper-zinc ore in a quartz matrix) will require somewhat different processing, the facilities will be constructed to mine, handle, store, and process the ores sequentially. Massive ore will be mined and processed from Project Year 4 into Year 20 and stringer ore from Year 20 into Year 32. The facilities will be designed based on proven and established technology and consistent with all applicable environmental and regulatory requirements.

The locations of major Project facilities are shown on Figure 1.2-1. A more detailed view of the mine/mill surface facilities is shown on Figure 1.2-2. These facilities are described in the following subsections.

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. With the exception of the railroad spur and access road, 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.


EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
CRANDON PROJECT FACILITIES
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
DATE 10/85
CHECKED BY
APPROVED BY
DATE
DRAWING NO
FIGURE 1.2-1
SHEET 4 OF 36
REVISION NO 0
REVISED
DATE
BY
DESCRIPTION
Typical Representation: Refinements may be made during final design.
SCALE IN FEET
0 1000 2000 3000
SCALE IN METERS
0 250 500 1000
MINE/MILL SITE
ACCESS ROAD
RAILROAD SPUR
SAND LAKE ROAD
CRANDON FORMATION
MWDF ROAD
FUTURE BORROW AREA
RECLAIM POND
CELL A
CELL B
CONSTRUCTION SUPPORT AREA
MINE REFUSE DISPOSAL FACILITY
1 2 3
MINE WASTE DISPOSAL FACILITY
T1
T2
T3
T4
POTABLE WATER WELL
WATER DISCHARGE PIPELINE
2.0 miles TO DISCHARGE POINT AT SWAMP CREEK
RICE LAKE
MOLE LAKE
LITTLE SAND LAKE
DUCK LAKE
DEEP HOLE LAKE
GROUND HEMLOCK LAKE
SWAMP CREEK
T 35 N
FOREST CO
LANGLADE CO
T 34 N
T35N
T34N
N 38,000
N 37,000
N 36,000
N 35,000
N 34,000
N 33,000
E 690,000
E 691,000
E 692,000
E 693,000
E 694,000
E 695,000
E 696,000
E 697,000
E 698,000
INSERT
MOLE LAKE
SWAMP
CREEK
WATER
DISCHARGE
PIPELINE
MATCHLINE
32
33
34
35
SCALE IN METERS
0 600 1200 1800


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
EXPLOSIVE STORAGE
ACCESS ROAD
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
COVERED STORAGE
SANITARY WASTE TREATMENT PLANT
TIMBER & STEEL STORAGE
HAUL ROAD
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
WEST EXHAUST RAISE
BULK FUEL STORAGE
BACKFILL HOLE NO. 1
PARKING
BACKFILL HOLE NO. 2
FUEL TANKS
SURFACE DRAINAGE BASIN NO. 1
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
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
APPROVED BY
EXXON
DRAWING NO.
FIGURE 1.2-2
SHEET OF
REVISION NO.
GBB 11/1981

A discussion of aesthetic features of the surface facilities is provided in subsection 4.2.9.2.

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 100-foot wide corridor containing the MWDF access road and the slurry and reclaim water pipelines. This corridor will be approximately 0.9 mile in length from the interface point at 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.

The land areas associated with the access road, railroad spur, and pipeline corridors are presented in Table 1.2-1.

TABLE 1.2-1

LAND AREAS FOR ACCESS ROAD, RAILROAD SPUR, AND PIPELINE CORRIDORS

	Construction Limits (Avg.) (Feet)	Construction Area (Acres)
Access Road	100	35
Railroad Spur	100	45
MWDF Access Road/Slurry Transport/Reclaim Water	100	10
Excess Water Discharge Line	50	35

1.2.1 Mine

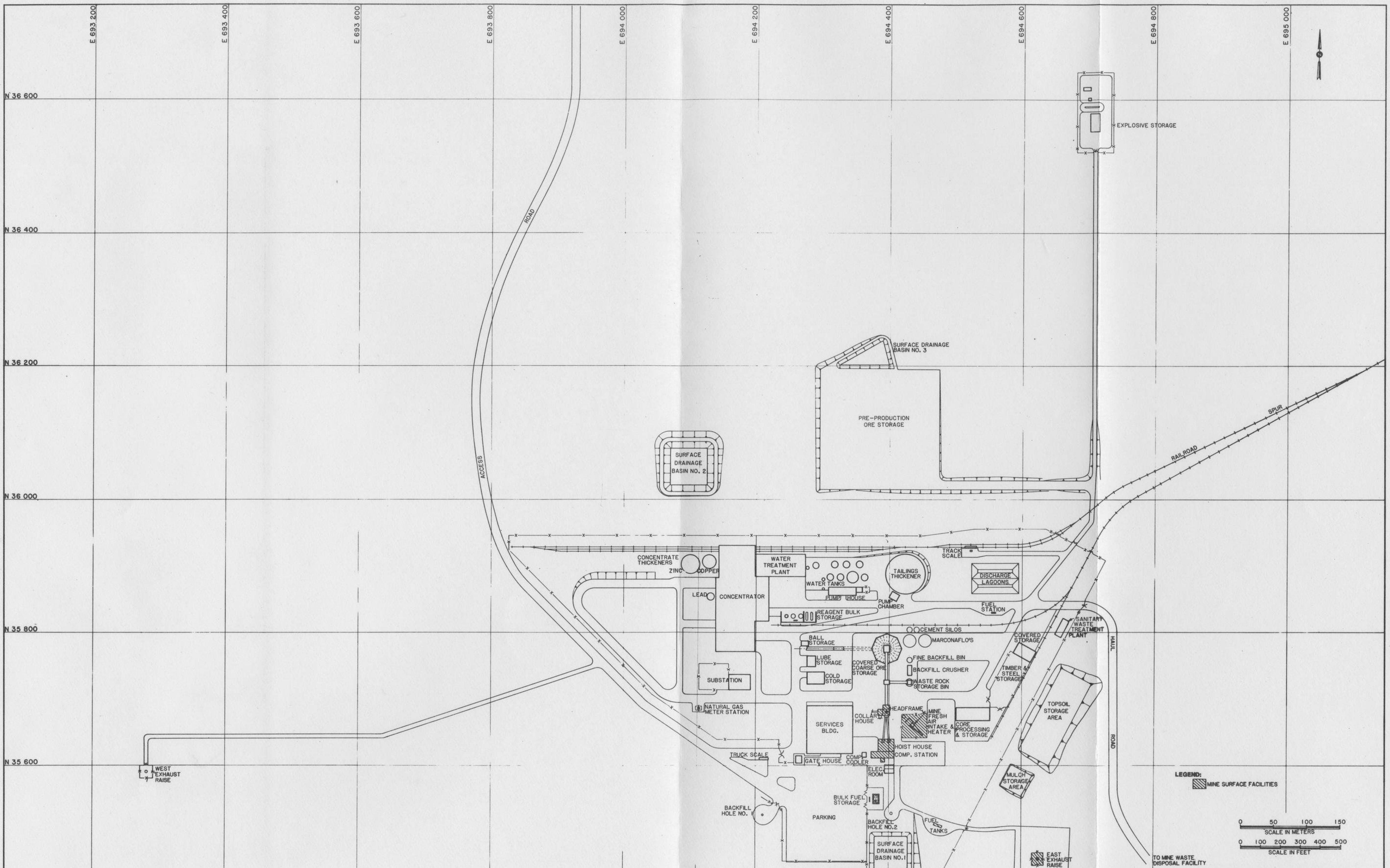
The mine will consist of the main shaft and ventilation shafts which will extend from the surface into the mine, and of underground levels developed to gain access to the ore. Ore will be blasted and extracted from stopes and the ore will be handled through a material handling and primary crushing system. 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, mine air heaters, backfill handling facilities, main mine exhaust fans, and diesel fuel tanks.

1.2.1.1 Mine Surface Facilities

The mine surface facilities are shown as shaded areas on Figure 1.2-3.

1.2.1.1.1 Headframe

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 1.2-4). This enclosed structure will be approximately 155 feet high with plan dimensions of about 32 x 36 feet. An additional 25 feet of headframe base and foundation structure will extend below the shaft collar surface elevation. 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.



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 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. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. Moe	DATE 11/13/85
DRAWING NO. FIGURE 1.2-3	SHEET __ OF __	REVISION NO.

Subsection 4.2.9.2 describes the aesthetics of the headframe's simple line and form. 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 rough textured to minimize structure reflectivity.

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.

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.

1.2.1.1.2 Hoist and Compressor House

Mine production and service hoisting equipment will be housed in a building directly south of the main shaft (Figure 1.2-3). 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 be a split single drum unit for the cage and counterweight. This hoist house structure will also contain the electric driven air compressors for supply of both mine and plant compressed air service. A general arrangement of the hoist and compressor house equipment is shown on Figure 1.2-5.

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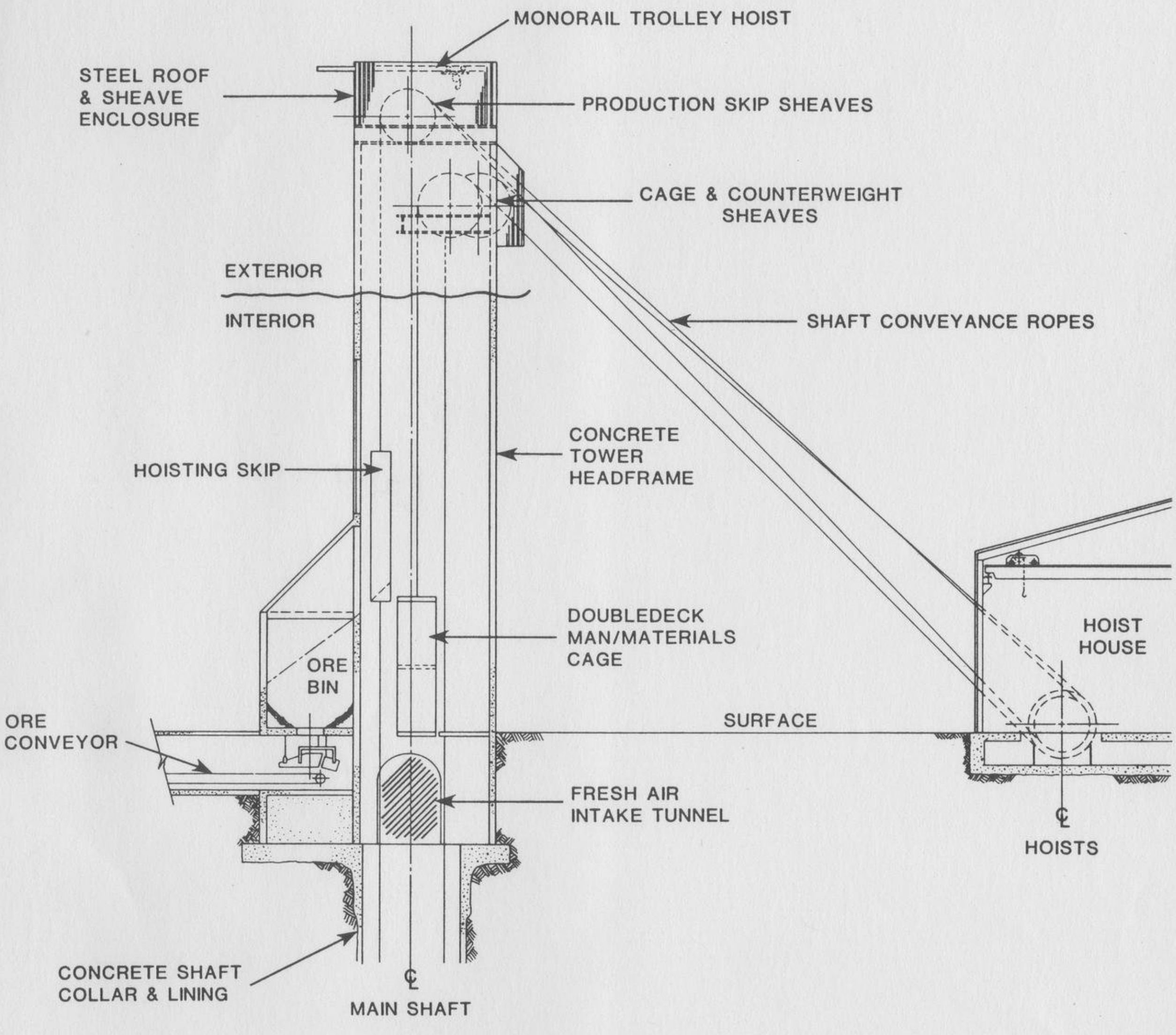
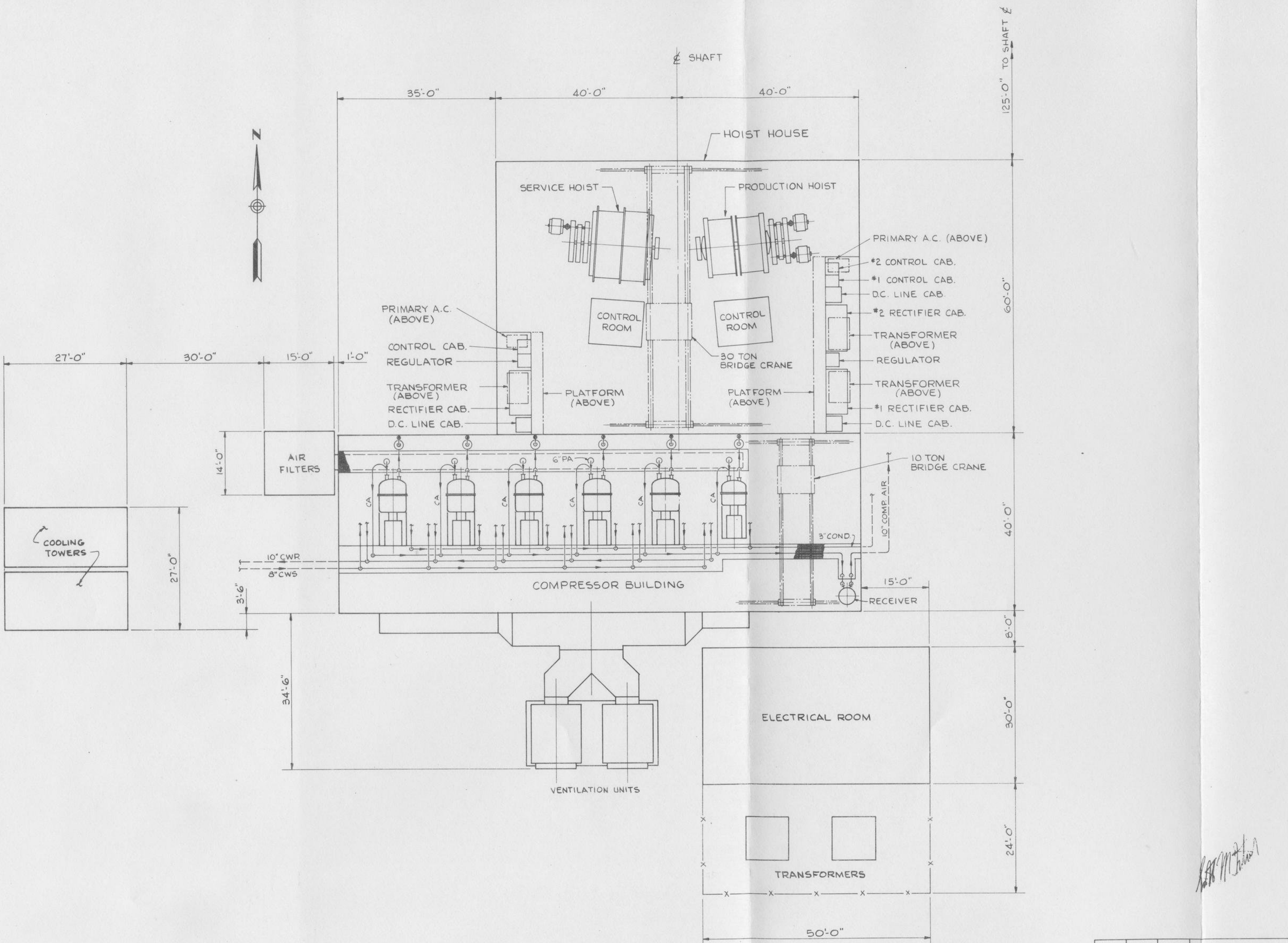


LOOKING EAST

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY CRANDON PROJECT			
TITLE MAIN SHAFT HEADFRAME/HOISTS			
SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY C. ADAMS	DATE 8/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	11/86
APPROVED BY	DATE	EXXON D.E. Moe	DATE 11/13/85
DRAWING NO FIGURE 1.2-4		SHEET ___ OF ___	REVISION NO



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

Typical Representations: Refinements May Be Made During Final Engineering

JSREDPATH CORPORATION
P.O. BOX 27329
TEMPE, ARIZONA 85283
TELEPHONE: 602-968-3192
TELEX 669447

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
HOIST HOUSE/COMPRESSOR BUILDING
GENERAL ARRANGEMENT

SCALE 1" = 10'	STATE		COUNTY
DRAWN BY JEB	DATE 7/28/85	CHECKED BY SLM	DATE 8/16/85
APPROVED BY	DATE	APPROVED BY SLM	DATE 8/16/85
APPROVED BY	DATE	EXXON D.F. Moe	DATE 11/13/85
DRAWING NO FIGURE 1.2-5		SHEET OF	REVISION NO

5316-13-G-06

1.2.1.1.3 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. The ambient air temperature in the underground mine workings will average about 55° F year round.

1.2.1.2 Mine Underground Facilities

Mine underground facilities are discussed in the following subsections. Table 1.2-2 shows the approximate dimensions of surface openings for the mine.

1.2.1.2.1 Main Shaft

Principal access to the mine will be via the main shaft shown on Figure 1.2-3. This major 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.

TABLE 1.2-2

APPROXIMATE DIMENSIONS OF SURFACE OPENINGS

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

Present plans call for a vertical shaft approximately 1,810 feet deep with a diameter of 22 to 24 feet. The main shaft collar will be underlain by approximately 110 feet of glacial overburden. The upper 25 feet will be incorporated into the base of the headframe structure. An additional 85 feet through glacial overburden and 30 feet into bedrock will be lined with a reinforced concrete collar. The base of this collar will be grouted into the bedrock to provide a watertight seal.

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.

1.2.1.2.2 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 orebody, exhaust air moved by surface mounted fans will reach the surface through exhaust ventilation shafts (Figure 1.2-3). These fans, with a total capacity of approximately 850,000 cubic feet per minute, 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 1.2-3.

1.2.1.2.3 Drifts

The nearly vertical Crandon 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. All 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 1.2-6. 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.

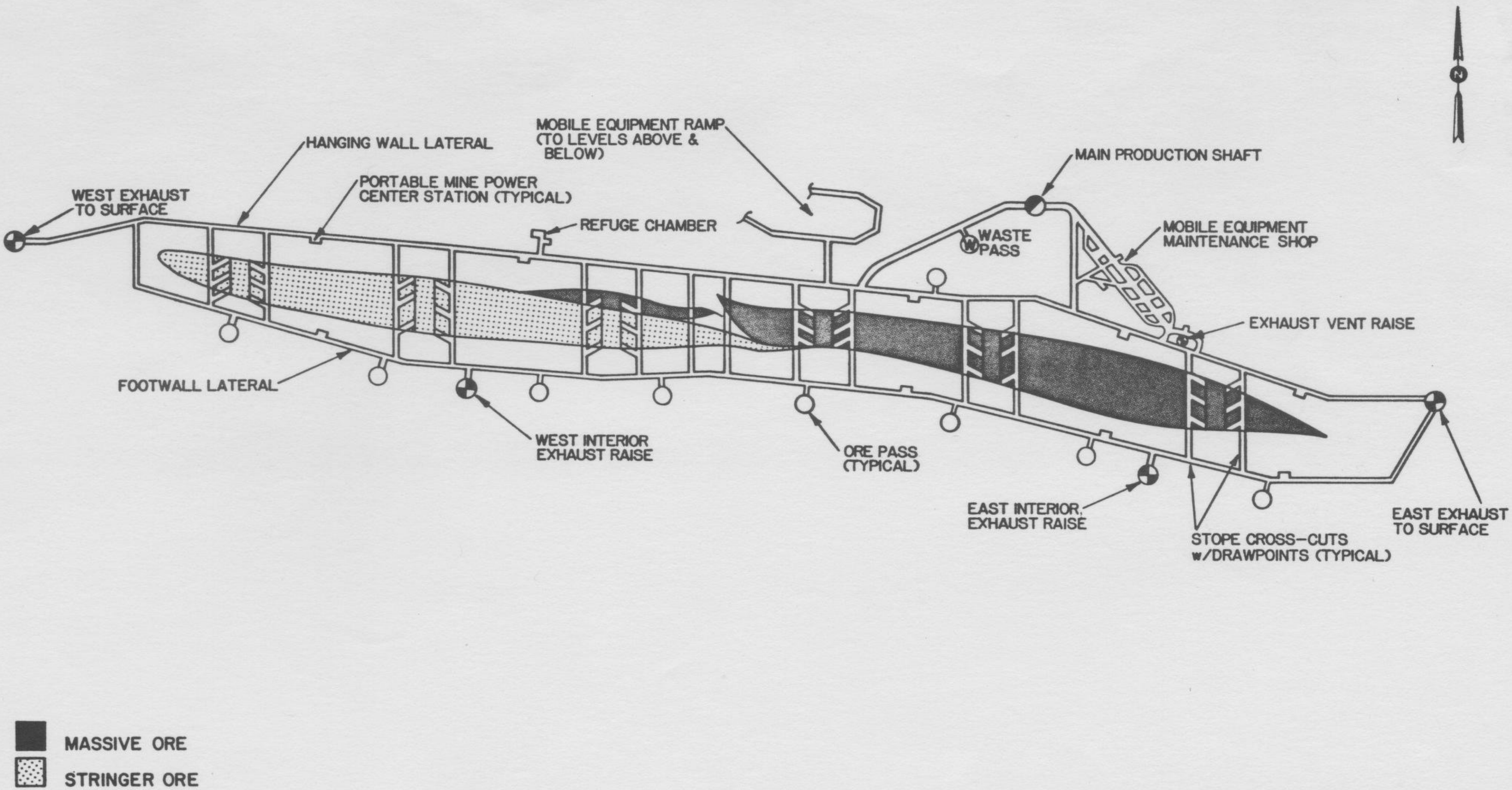
A ramp decline will connect all mine levels to allow movement of equipment, supplies, and personnel throughout the mine. This centrally located decline is shown on Figure 1.2-7.

1.2.1.2.4 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 1.2-8).

The mining methods and stope sequences planned for extraction of the Crandon 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 (subsection 1.4.2.1) provide for backfilling of stopes immediately following ore extraction. Mining of the zinc and copper ores will generally proceed from depth and the deposit extremities toward the surface, with mining directly below the permanent crown pillar planned for the final one-third of the orebody life. These practices, combined with the fact that approximately 10 percent of the potentially minable ore will be left in

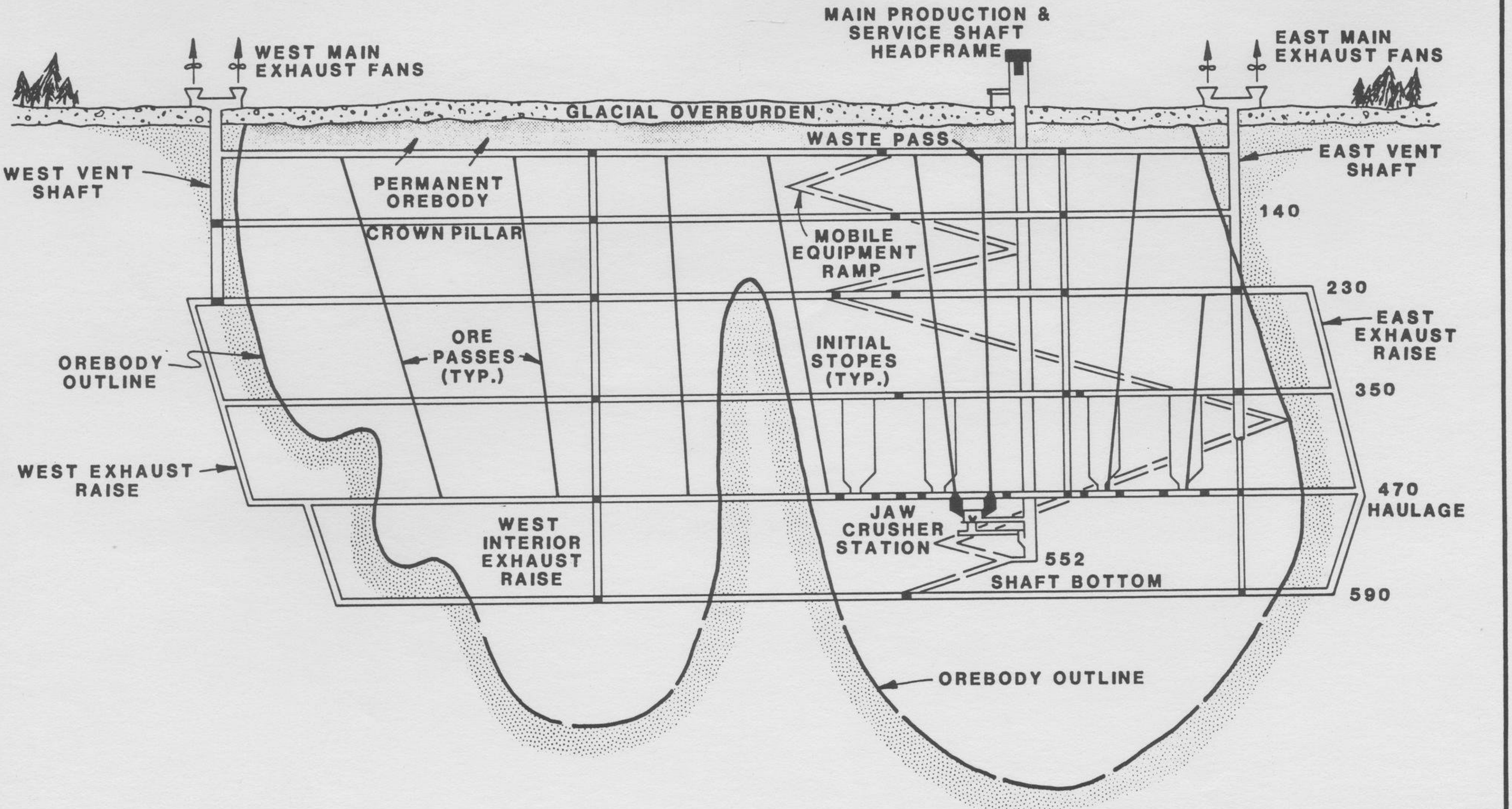


Typical Representations Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MAIN MINE LEVEL (350)
CONCEPTUAL PLAN

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY	DATE	CHECKED BY		DATE	
APPROVED BY	DATE	APPROVED BY		DATE 11/13/85	
APPROVED BY	DATE	EXXON		DATE 11/13/85	
DRAWING NO FIGURE 1.2-6		SHEET OF		REVISION NO 1	



Typical Representations: Refinements May Be Made During Final Engineering

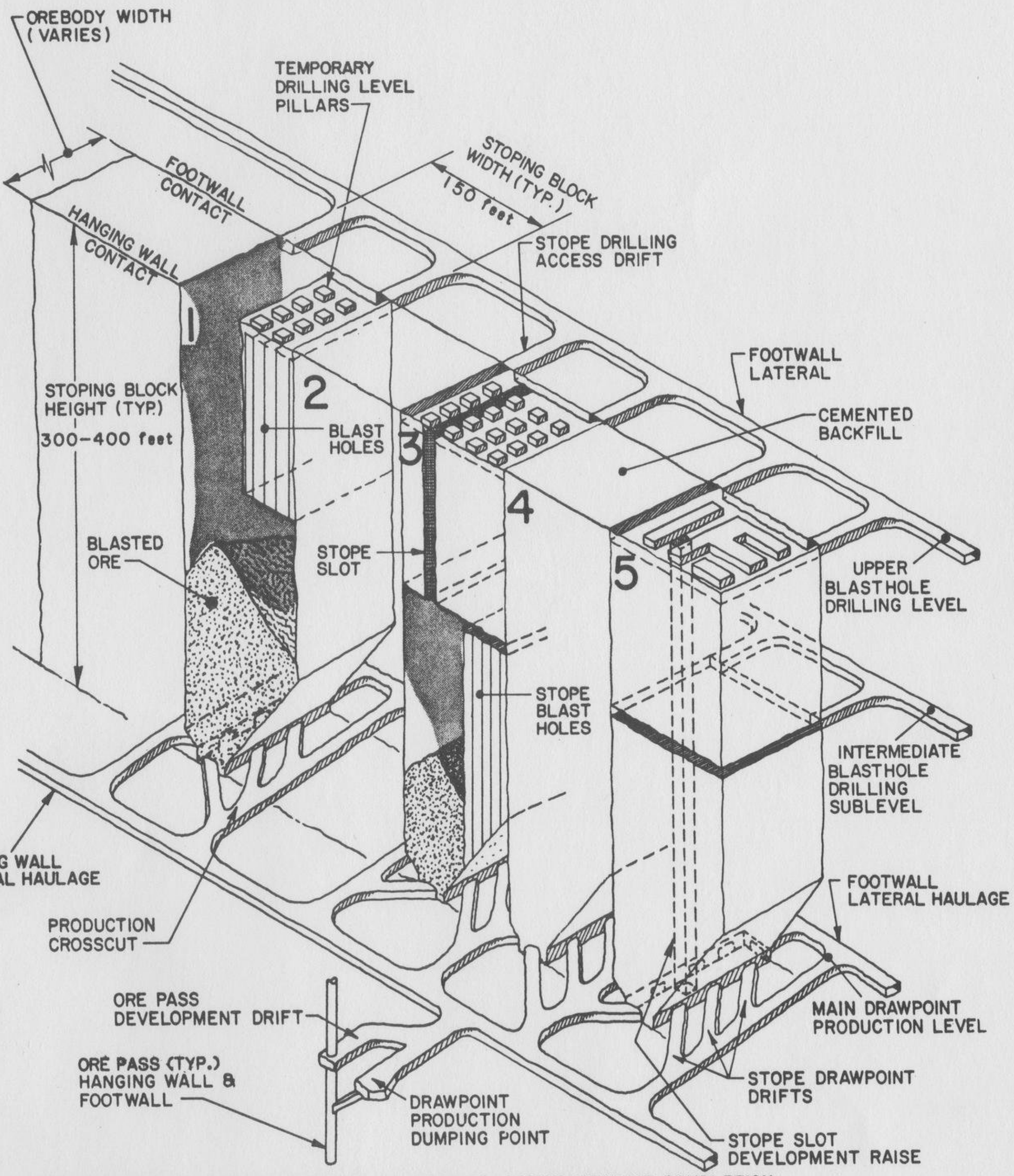
EXXON MINERALS COMPANY

CRANDON PROJECT

TITLE

UNDERGROUND MINE LONGITUDINAL SECTION SCHEMATIC (LOOKING NORTH)

SCALE NONE	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 D E Moe	DATE 11/13/85
DRAWING NO FIGURE 1.2-7		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 NONE	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY	DATE 7/82	CHECKED BY		DATE
APPROVED BY	DATE	APPROVED BY		DATE 11/13/85
APPROVED BY	DATE	EXXON		DATE 11/12/85
DRAWING NO FIGURE 1.2-8		SHEET 1 OF		REVISION NO 1

Typical Representation: Refinements May Be Made During Final Engineering

A ramp decline will connect all mine levels to allow movement of equipment, supplies, and personnel throughout the mine. This centrally located decline is shown on Figure 1.2-7.

1.2.1.2.4 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 1.2-8).

The mining methods and stope sequences planned for extraction of the Crandon 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.

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Support of the mine workings in the weathered zones is not expected to present any major problems. Rock strength in the weathered zones that will be mined is expected to be in the range of 5,000 to 10,000 psi. The planned mining methods for the upper portions of the mine (modified cut and fill) have been developed with the recognition of lower rock strength. These mining methods will maintain the overall rock mass integrity and prevent the collapse of the mine entries.

1.2.1.2.5 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 1.2-3 provides a representative list of major mine electrical equipment and estimated installed kilowatts and horsepower.

1.2.1.2.6 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.

1.2.1.2.7 Explosives

During operation of the mine, several days' supply of blasting materials (25,000-40,000 pounds) 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.

1.2.1.2.8 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 on the 350

TABLE 1.2-3

MAJOR MINE ELECTRICAL EQUIPMENT

EQUIPMENT	CONNECTED hp	CONNECTED kW	MAXIMUM kW DEMAND	AVERAGE kW DEMAND
Production Hoist	2,100	1,565	860	730
Cage Hoist	1,100	820	440	360
Escape Hoist	125	95	75	70
Main Fans	2,000	1,490	1,265	1,140
Crusher	200	150	105	95
Conveyors & Feeders	100	75	60	30
Booster Fans & Heaters	1,400	1,045	890	710
Main Pumps*	4,240	3,160	2,370	1,540
Electric/Hydraulic Drills	1,010	755	600	290
Booster Compressors	320	240	190	170
Surface Compressors	2,000	1,490	1,195	955
Raiseboring Machines	400	300	240	190
Miscellaneous	400	300	180	110
TOTAL	15,395	11,485	8,470	6,390

*Only one-half of the pumps will normally be operating.

Note: This is a typical representation for a mine of this design capacity. The actual horsepower of the installed equipment may vary.

level. This area will resemble a surface truck garage. All mobile and portable mining equipment will have access to the 350 level shop via the mine ramp or main shaft service cage.

1.2.1.2.9 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 machine and portable mine power centers. Major mobile and portable equipment projections are presented in Table 1.2-4.

All mine structural materials, machinery, and mobile equipment will 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 will be separated at the center articulation joint for transport underground.

1.2.1.2.10 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 470 level, LHDs and trucks will haul directly to the crusher coarse feed bins. Ore and waste from below the 470 level will be transported by truck haulage on the ramp. Typically, ore will be transported by an LHD

TABLE 1.2-4

ESTIMATED UNDERGROUND MOBILE EQUIPMENT REQUIREMENTS

DESCRIPTION	NO. REQUIRED*	HORSEPOWER (EACH)
Diesel Powered Rubber-tired Mobile Units		
Load-haul-dump (LHD) (8 to 13 yd^3)	15	270
Load-haul-dump (LHD) (5 yd^3)	3	180
Load-haul-dump (LHD) (2 yd^3)	1	140
Haulage Truck (26 to 40 ton)	8	270
Hydraulic Drill Jumbo - Twin Boom	4	140
Pneumatic Drill Jumbo - Triple Boom	1	140
Roofbolting Jumbo - Twin Boom	1	140
Fan Drill Jumbo - Twin Boom	1	140
Secondary Breakage Drawpoint Drill	2	50
Scissors Lift Service Truck	4	140
Utility Flatbed Truck	2	140
Explosives Transport/Loading Truck	7	140
Lubrication/Service Truck	1	140
Personnel Carrier (12 persons)	2	140
Utility Tractor	10	40
Ambulance/Emergency Vehicle	1	60
Utility End-loader (0.5 yd^3)	2	60
Forklift (3 to 6 ton)	3	60
Road Grader/Dozer	2	140
Concrete Delivery Truck	2	140
Portable Mining Equipment		
Crawler Mounted Stope Blasthole Drill	4	80
Booster Air Compressor (250 pounds/$inch^2$)	4	80
Electric/Hydraulic Diamond Core Drill	3	50
Raise Boring Machine (6 to 8 feet diameter)	1	200
Concrete/Shotcrete Mixer-Placer	3	20
Grout Pumping Unit	2	60
500kVA Mine Power Substation	12	---

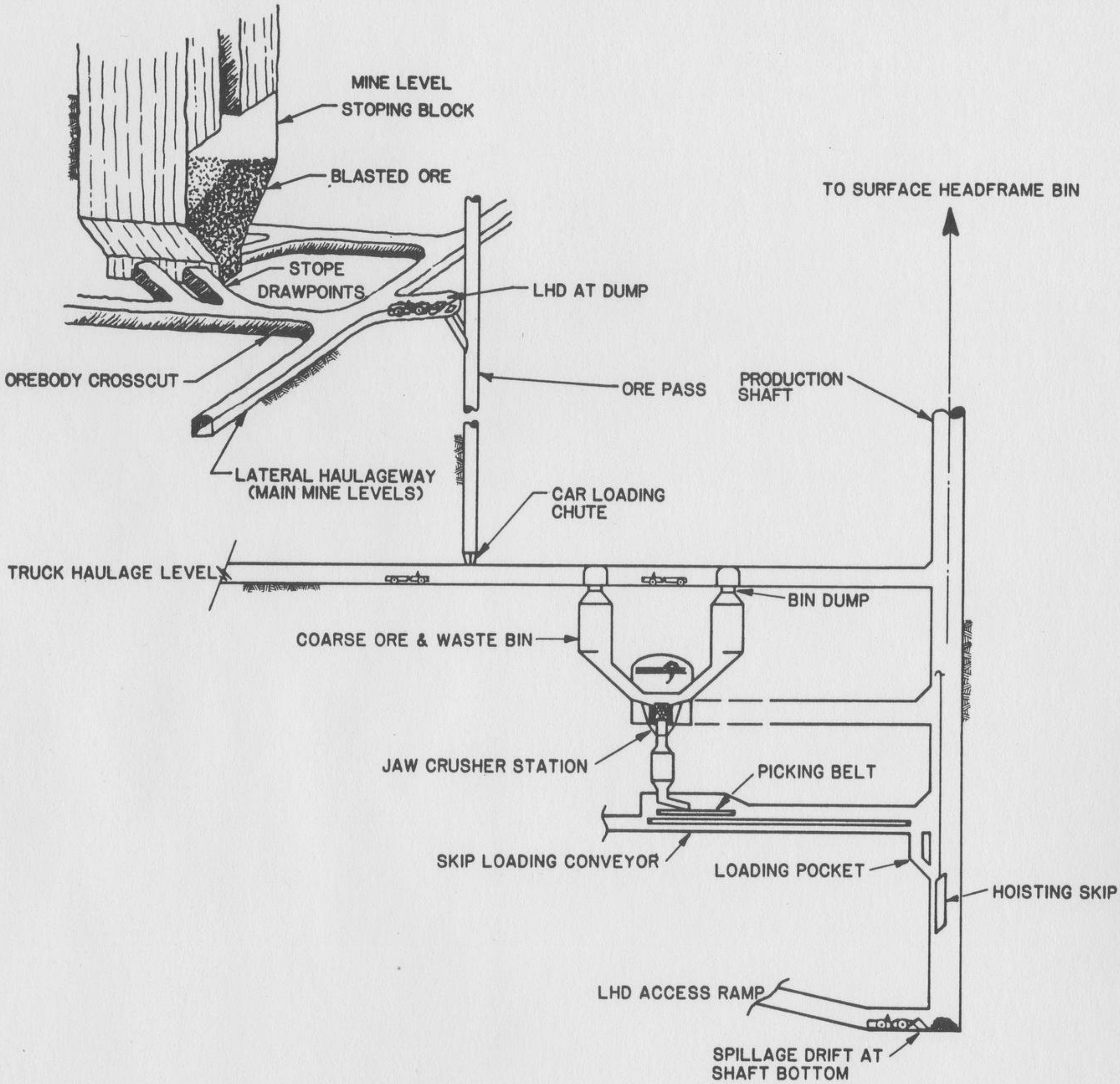
*Includes spare units in consideration of historical machine availability rates in the mining industry.

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

to steeply dipping ore passes leading down to the 470 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 1.2-9.

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. Crushed rock, minus 8 inches, will discharge to a surge bin of about 200 tons capacity immediately below the crusher. A discharge feeder will feed the crushed rock from the bin to a wide, slow-speed picking belt from which timber and steel trash can be removed. Fines from the surge bin discharge feeder will fall directly onto the main conveyor. This fine material will lessen the impact of the coarse material dropping off the picking belt onto the main conveyor. The main conveyor will move crushed rock horizontally to the loading pocket which will consist of two measuring flasks. Crushed rock will flow into one of the flasks until either a pre-set weight or a pre-set volume has been reached. When one of the skips is in position, the companion flask will discharge into it, and the rock will be hoisted to the surface. A diverter will cause crushed rock to flow to the other flask while the first is discharging.

A dust control system will be provided for the rock handling system underground. Dust from the primary crusher discharge will be collected in a 24-inch line running down an access raise to the dust collectors on the main conveyor level. Collection duct work from the



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
ORE TRANSPORT SYSTEM

SCALE NONE	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 1.2-9		SHEET OF	REVISION NO

Typical Representation: Refinements
May Be Made During Final Engineering

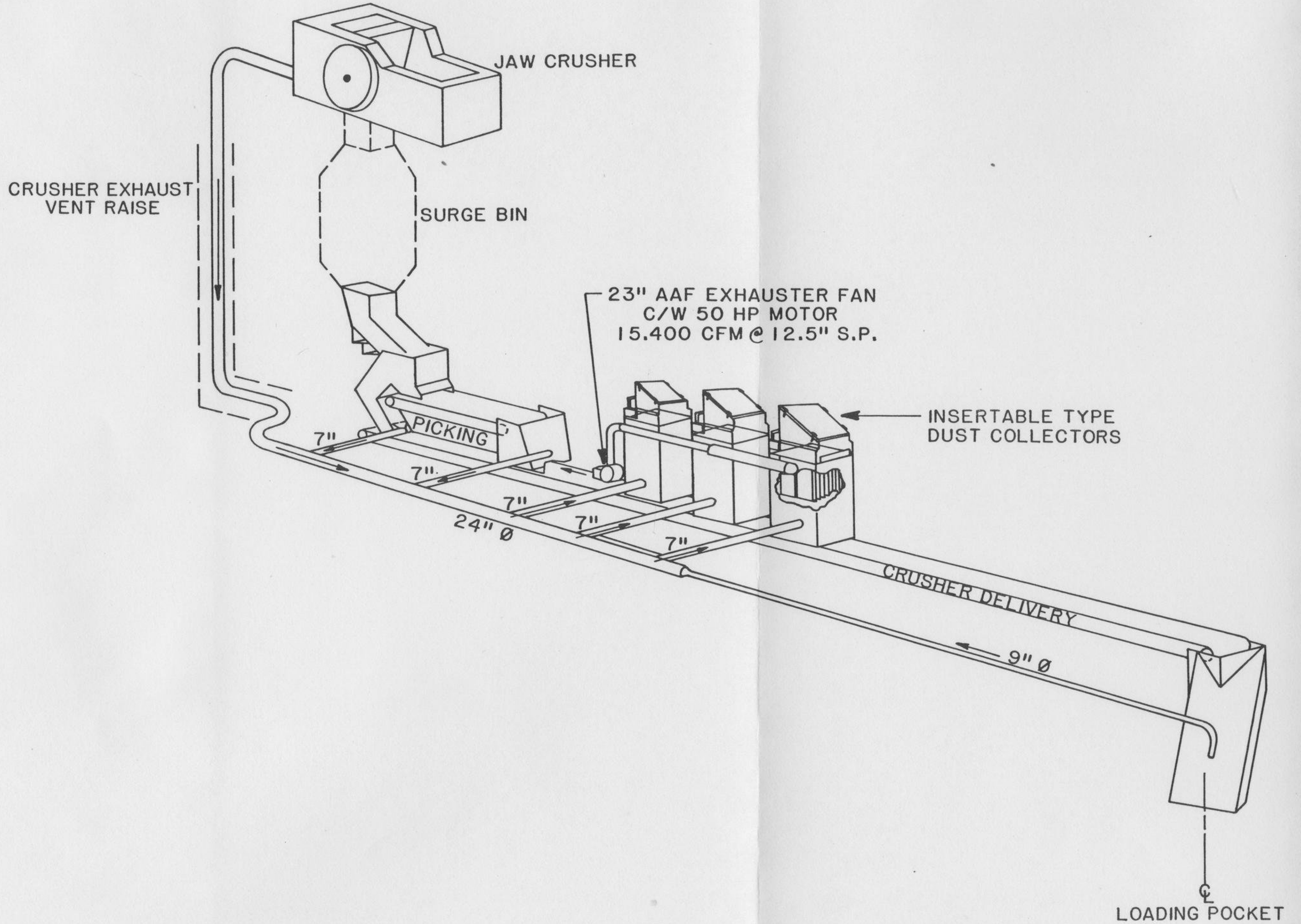
surge bin feeder and picking belt will be manifolded into a dust collector similar to those used for insertable collector installations modified to include a lower airlock. Dust collected in this system will be discharged onto the main conveyor. Dust suppression at the skip loading station will be accomplished using water sprays. Figure 1.2-10 depicts the planned dust control system.

1.2.1.2.11 Underground Primary Crusher

A jaw crusher will be installed below the main haulage level (Figure 1.2-9). 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 550 tons per hour. Crushed material will discharge to a surge bin of about 200 tons capacity immediately below the crusher.

1.2.1.2.12 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. Rock wall cut-outs in well ventilated drifts will be bulkheaded for privacy. Chemical toilets, typical of those used at surface construction sites or large public events, will be installed on a prepared floor. The sanitation stations will be equipped with permanent lighting and required supplies.



NOTE:
ALL DUCT SIZES SHOWN IN INCHES DIA.

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY CRANDON PROJECT			
TITLE CRUSHER-CONVEYOR DUST SUPRESSION SYSTEM			
SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 9/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
APPROVED BY	DATE	EXXON	DATE
DRAWING NO FIGURE 1.2-10		SHEET ___ OF ___	REVISION NO

Sanitation units will be serviced as demanded by local use frequency. Containerized waste will be transported to surface in the mine cage for disposal in the sanitary waste package plant. The formaldehyde and perfume used in the chemical toilet control solutions will be in dilute concentrations compatible with the plant sanitary waste treatment system.

1.2.1.2.13 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. Nominal consumption of potable water in the mine is estimated to be 5 gallons per minute.

Mine utility and tool water will be recycled from the mine drainage system (see subsection 1.2.1.2.16).

1.2.1.2.14 Fuel Handling and Storage

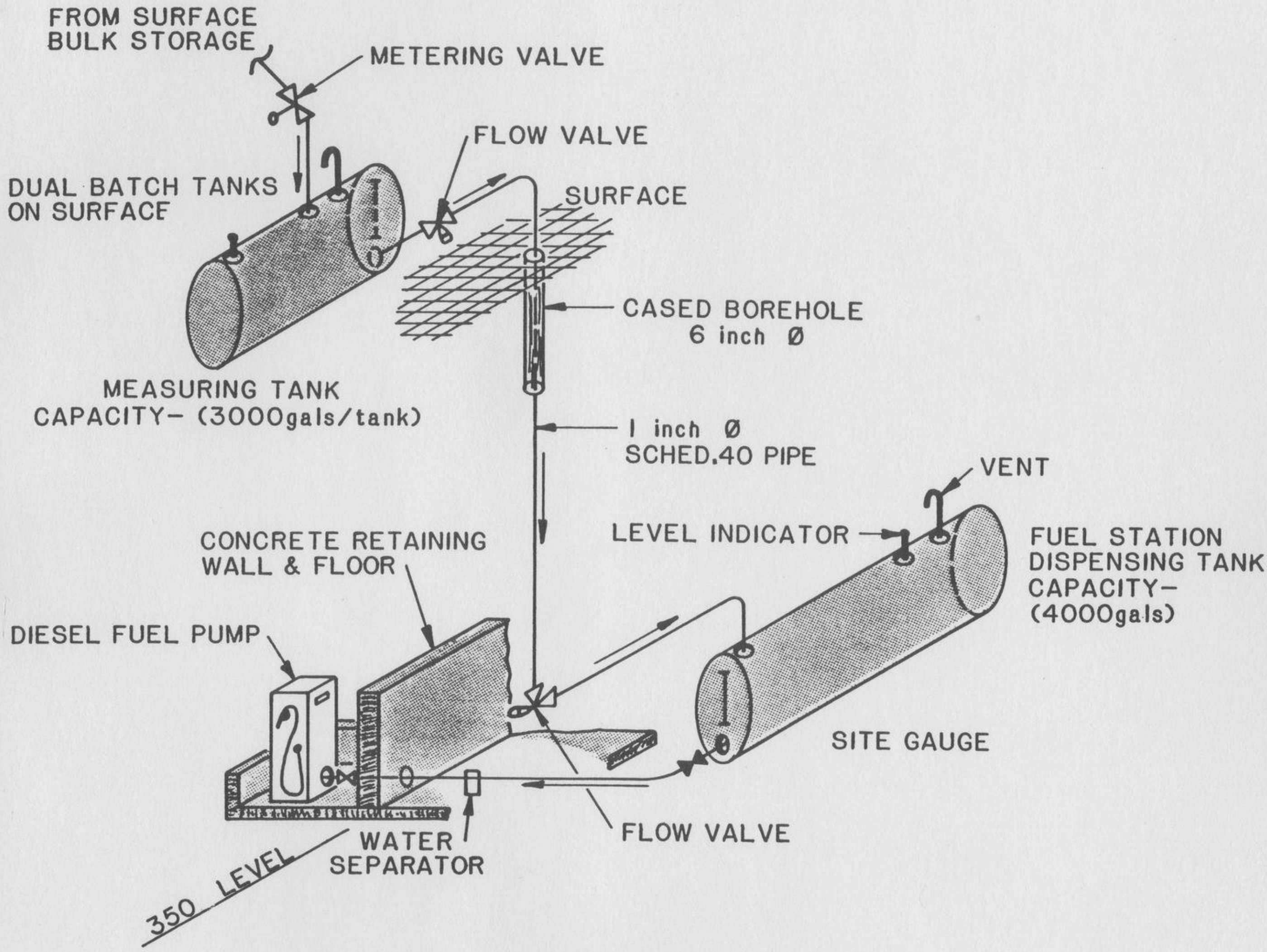
Diesel fuel oil to supply the needs of surface and underground vehicles, the emergency power generators, and other plant equipment will be delivered to the mine/mill site by tank truck. Fuel will be off-loaded through a pumphouse adjacent to the two 15,000-gallon bulk fuel oil storage tanks. These tanks 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.

The system for delivering and distributing diesel fuel to underground locations is presented on Figure 1.2-11. 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 two 3,000-gallon capacity 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 on the 350 level near the mobile equipment shop. Its tank will have a capacity of 4,000 gallons and 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 the 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.



Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
UNDERGROUND DIESEL FUEL DELIVERY - SCHEMATIC

SCALE NONE	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 D. E. [illegible]	DATE 11/13/85
DRAWING NO **FIGURE 1.2-11**		SHEET ___ OF ___	REVISION NO

1.2.1.2.15 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 may 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.

1.2.1.2.16 Mine Drainage

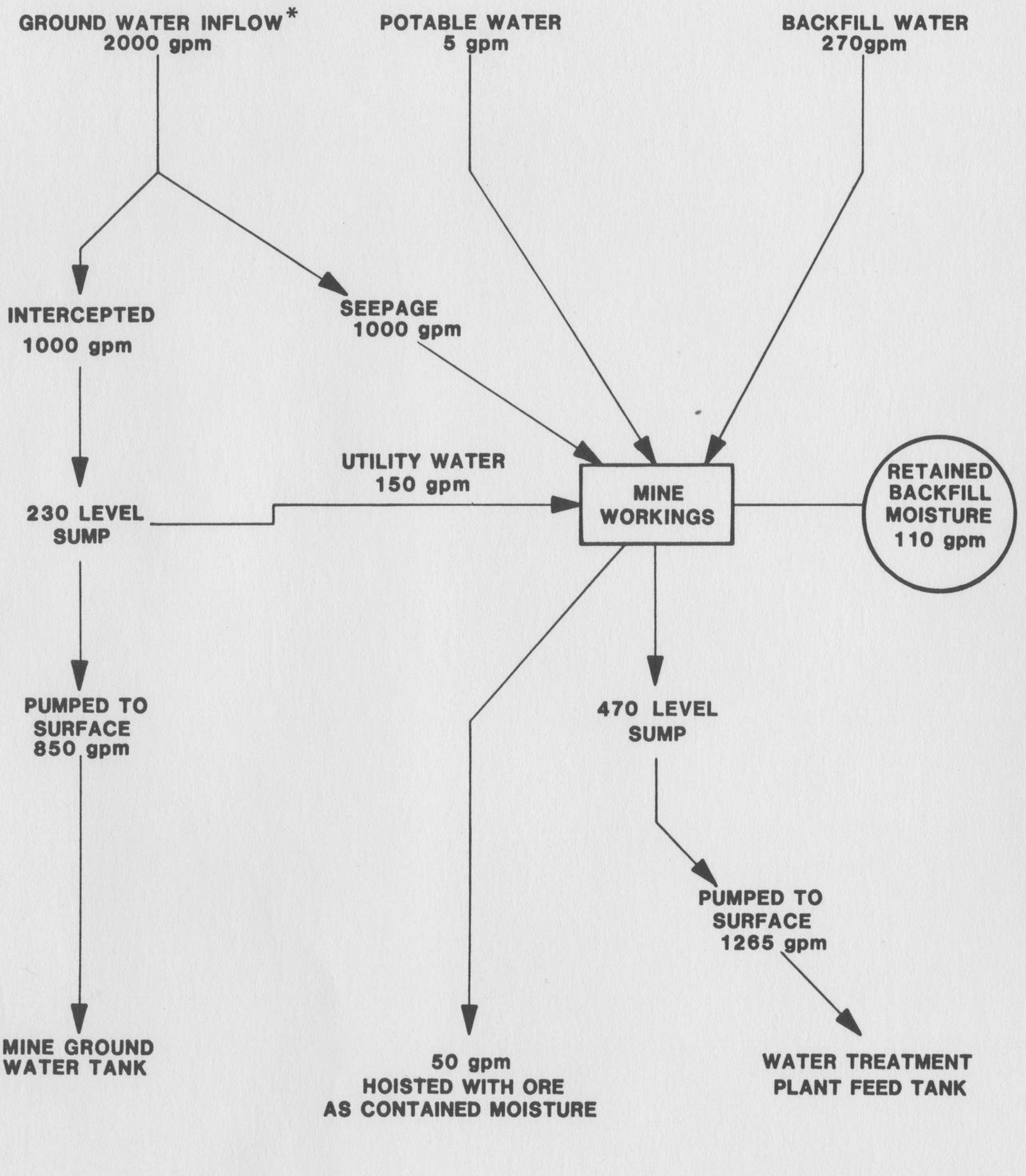
The predicted steady state rate of ground water inflow to the mine ranges from approximately 935 to 1,590 gallons per minute. This range represents the potential variation from ground water recharge to the main glacial aquifer over the mine site area. The expected mine inflow rate is about 1,270 gallons per minute and is based on the approximate average annual recharge rate. These mine inflow rates are documented in "Predictive Ground Water Inflow Modeling and Sensitivity Analysis for the Proposed Crandon Mine," by Prickett & Associates (1984). For purposes of designing the underground mine water handling systems, an inflow rate of 2,000 gallons per minute was used. During mine development and operation, all practical efforts will be made to control and reduce the rate of ground water inflow. Therefore, it is highly unlikely that total inflow to the mine in excess of 2,000 gallons per minute will ever be experienced.

In the absence of pumping stress, the bedrock is functionally excluded from the local site area ground water system. Development of the mine will, however, induce flow from the overburden aquifer through weathered bedrock courses not throttled by less permeable materials (basal till and clays from bedrock weathering) at the orebody subcrop.

The design basis for the Crandon mine water inflow is depicted on Figure 1.2-12. This assumes no surface control of water entering the mine and that the full assumed design inflow of 2,000 gallons per minute will be handled by underground means.

Ground water inflow to the proposed Crandon mine will 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 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 350 to 470 stope interval which is 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 and less practical to attempt segregation, collection and pumping of uncontaminated ground water. At steady state inflow rates less than



*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**

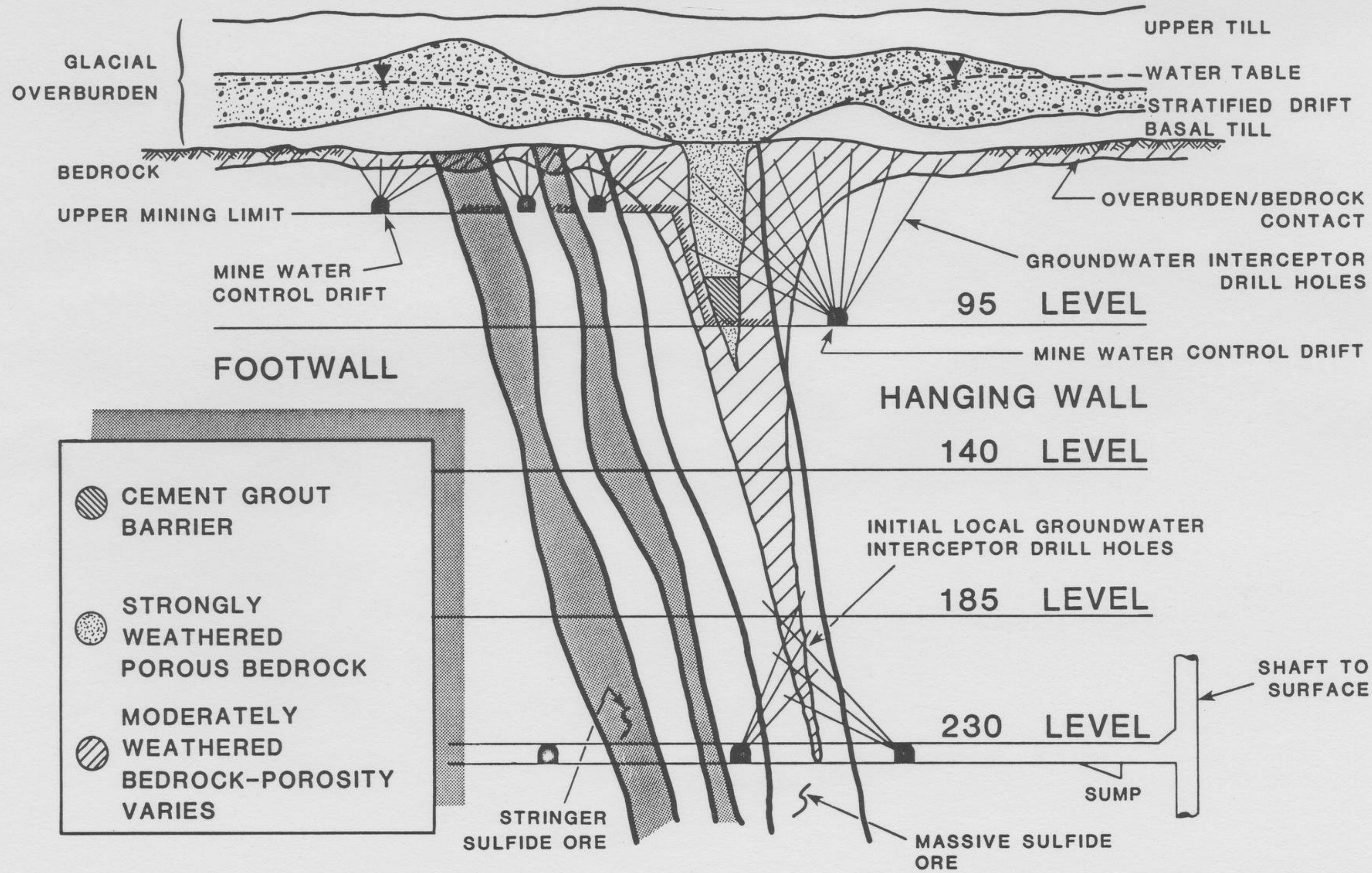
SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY DR SPRINGBORN	DATE 9/83	CHECKED BY			DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder			DATE 11/86
APPROVED BY	DATE	EXXON D.E. Moe			DATE 11/13/8?
DRAWING NO FIGURE 1.2-12		SHEET ____ OF ____			REVISION NO 2

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.

Exploratory diamond drilling techniques will be used to identify active water courses prior to advance of the mine face. Flows encountered on the uppermost mine levels will be captured in the interceptor drill holes and contained to avoid contamination by mining operations on levels below. This interceptor system is shown on Figure 1.2-13. Mine water control drifts will be developed ahead of production entry in the upper mine areas to maintain the ability to intercept uncontaminated ground water. Rock grouting techniques may also be used for local inflow control or diversion underground.

As the mine progresses upward from the initial level entry position, the required mine water control drifts will simply be normal production access drifts that will be developed prematurely and dedicated for exploration and interception of ground water. The orebody exploration diamond drill holes will become part of the ground water interception system. As is common practice in other mines, the diamond drill hole collars will be packed and fitted with pipe connections.

Ground water collected from exploration drilling or other drillholes placed specifically for inflow interception will be piped directly to a clean water sump and pump station near the main shaft on an upper mine level (Figure 1.2-14). With the exception of water inflow diverted for mine utility use, water from the segregated ground water system will be pumped to the surface through a separate pipe column in the main shaft.



EXXON MINERALS COMPANY
CRANDON PROJECT

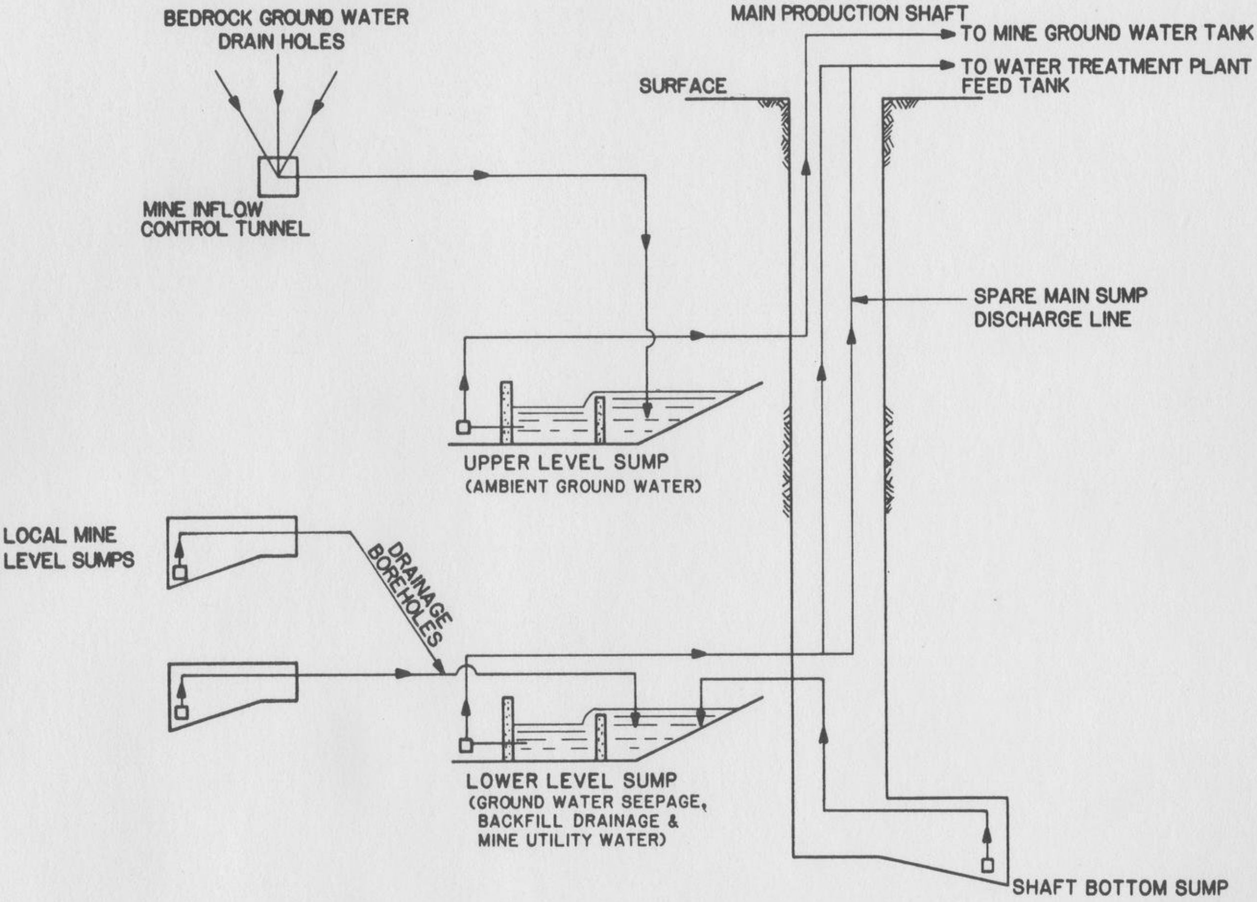
TITLE: MINE WATER INFLOW CONTROL METHODS

SCALE: NONE | STATE: WISCONSIN | COUNTY: FOREST

DRAWN BY: RGH

Typical Representation; Refinements May Be Made During Final Engineering

FIGURE 1.2-13



Typical Representation: Refinements
May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MINE WATER DRAINAGE SCHEMATIC SUMP SYSTEM

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY DR SPRINGBORN	DATE 10/83	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 1.2-14		SHEET ____ OF ____		REVISION NO 1	

Mine inflow intercepted, contained and pumped to the surface by this system is expected to remain near ambient ground water quality, except for possible transient effects during orebody storage depletion and initial flushing of pore volumes. In the steady state, partially saturated flow conditions will exist in the weathered bedrock courses. Some oxygen may then be introduced to this previously anaerobic environment, but its effects are expected to be minor. The oxidation and leaching potential of the water courses are already limited by the extensive preglaciation weathering, and the residence time for further ground water flow will be of short duration.

A second water handling system will be used for ground water seepage that is not contained by the interceptor system. This water will infiltrate the mine workings and ultimately be recovered in the local mine sumps on each level. The water will either be pumped or drained to the main mine water sumps and pump station located near the main shaft on a lower mine level. These sumps will also receive backfill seepage and used mine utility water. This system is shown on Figure 1.2-14.

Collection of unintercepted water will begin on each mine level where flows will be directed to small local sumps excavated in the drift wall. Decant water from the local mine level sumps will be piped or drained through boreholes to the main mine sumps. The main sumps will consist of downgrade excavations in the wall rock adjacent to the pump station. A bulkhead containing the pump station suction pipes will be constructed at the sump outlet.

Mine drainage system pumps will be specified for "dirty" water (i.e., containing particulates); therefore, the main level sumps will function primarily as pumping reservoirs. However, some settling of solids is expected in the local level and main mine drainage sumps. For this reason, pairs of sumps with front-end loader access will be provided at each mine level transfer point and at the main mine drainage facilities. One sump at each location will then be operated while the other is cleaned. Sump solids will be transported to mined stopes and combined with regular stope backfill.

In the event that additional settling capability is required, a segment of the mine area adjacent to the main mine drainage pump room will be reserved for excavation of a vertical cone settler. Solids discharged from the base of the conical settler would be transported to depleted stopes as backfill.

Discharge from the totally segregated ground water interceptor and mine operations drainage systems will exit the mine in separate main shaft pump columns. The intercepted ground water will be directed to a surface storage tank. From this tank it can be discharged, treated if necessary, or, if needed, used as mill process make-up water. Mine drainage effluent will be routed to the water treatment plant feed tank for treatment prior to discharge or re-use.

If mine inflow would ever exceed 2,000 gallons per minute, two mitigative actions could be taken. First, the excess inflow could potentially be controlled by surface source pumping or inflow path grouting as described by Klohn Leonoff (1982). Secondly, mine pumping systems have been designed for a conservative maximum inflow value of 2,000 gallons per minute, including pumps and shaft columns. In addition, each mine pump station will feature 100 percent spare pump and pipeline capacity. Surface surge storage capacity will exist in the reclaim and tailing ponds for temporary handling of excess inflow. The total available freeboard volume in the reclaim pond, for example, is 210 acre-feet with maintenance of a minimum 3-foot freeboard, or enough for an excess flow of 1,000 gallons per minute of mine pumpage for over one and one half months.

1.2.1.2.17 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.

1.2.2 Mill

The mill facilities will include all the equipment for handling, storing, grinding and classifying the ore hoisted to the surface and the concentrator where the valuable minerals will be recovered from the ores to produce finished concentrates (Figure 1.2-15).

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.


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
EXPLOSIVE STORAGE
SURFACE DRAINAGE BASIN NO. 3
PRE-PRODUCTION ORE STORAGE
SURFACE DRAINAGE BASIN NO. 2
ACCESS ROAD
RAILROAD SPUR
HAUL ROAD
TRACK SCALE
CONCENTRATE THICKENERS
ZINC
COPPER
LEAD
CONCENTRATOR
WATER TREATMENT PLANT
WATER TANKS
PUMP HOUSE
PUMP CHAMBER
TAILINGS THICKENER
DISCHARGE LAGOONS
FUEL STATION
REAGENT BULK STORAGE
CEMENT SILOS
MARCONAFLO'S
SANITARY WASTE TREATMENT PLANT
COVERED STORAGE
BALL STORAGE
LUBE STORAGE
COLD STORAGE
COVERED COARSE ORE STORAGE
FINE BACKFILL BIN
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN
TIMBER & STEEL STORAGE
TOPSOIL STORAGE AREA
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
MULCH STORAGE AREA
WEST EXHAUST RAISE
BULK FUEL STORAGE
BACKFILL HOLE NO. 1
PARKING
BACKFILL HOLE NO.2
FUEL TANKS
SURFACE DRAINAGE BASIN NO.1
EAST EXHAUST RAISE
TO MINE WASTE DISPOSAL FACILITY
LEGEND:
MILL SURFACE FACILITIES
0 50 100 150
SCALE IN METERS
0 100 200 300 400 500
SCALE IN FEET
0 10-31-85 New Dwg. Release
REVISED DATE BY DESCRIPTION
Typical Representations: Refinements
May Be Made During Final Engineering
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
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. Schroeder DATE 11/13/85
APPROVED BY DATE EXXON D.E. Moe DATE 11/13/85
DRAWING NO. FIGURE 1.2-15 SHEET OF REVISION NO.

These 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 1.2-5. The approximate sizes, dimensions, and capacities are described, as appropriate, for each of the major operations associated with processing.

1.2.2.1 Ore Handling

After coarse ore is hoisted to the surface, it will be conveyed to the covered coarse ore stockpile. The general arrangement plan and sections for the building are shown on Figure 1.2-16. The stockpile will hold approximately 16,500 tons (2 days) of massive ore or about 13,000 tons of stringer ore as live storage capacity. A concrete tunnel below the stockpiles will house feeders for reclaiming the ore. The feeders will transfer the coarse ore onto a belt conveyor which will transport the material in a tunnel and conveyor gallery to the semi-autogenous grinding (SAG) mill.

TABLE 1.2-5

MILL FACILITIES - TYPICAL EQUIPMENT LIST

Operation	Equipment Description	Size	Number of Units	Total Connected HP
Coarse Ore Handling Backfill Preparation	Conveyor to Coarse Ore Stockpile	36 in	1	150
	Coarse Ore Feeder Belts	48 in	3	75
	Conveyor Coarse Ore to SAG Mill	36 in	1	200
	Insertable Dust Collectors	2100 SCFM	3	15
	Miscellaneous	-	-	100
	TOTAL			540
Waste Rock Handling and Crushing	Fixed Tripper to Waste Rock Bin	36 in	1	50
	Feeder Waste Rock Bin to Crusher	18 in	1	5
	Primary Crusher - Waste Rock	12 in x 24 in	1	30
	Secondary Crusher - Waste Rock	30 in x 20 in	1	40
	Vibrating Screen Waste Rock	-	1	10
	Slurry Tank and Pumps	-	2	120
	Insertable Dust Collectors	1200 SCFM	4	12
	Insertable Dust Collectors	3500 SCFM	2	20
	Insertable Dust Collectors	1800 SCFM	2	10
	Miscellaneous	-	-	25
	TOTAL			322
Grinding and Regrinding	Recycle Conveyor (0' size to SAG)	30 in	1	50
	SAG Mill	26 x 10 ft	1	3500
	Ball Mill	16 x 27 ft	1	3500
	Vibrating Screens	10 x 20 ft	2	300
	Slurry Pump	-	-	450
	Cyclones (Primary)	-	-	-
	Regrind Tower Mill (Zinc)	450 kw	2	900
	Regrind Tower Mill (Copper/Lead)	450 kw	1	450
	Cyclones (Zinc Regrind)	20 in	12	-
	Cyclones (Copper Head Regrind)	10 in	6	-
	Regrind Pumps	-	-	300
	Miscellaneous	-	-	500
	TOTAL			9950

TABLE 1.2-5 (continued)

Operation	Equipment Description	Size	Number of Units	Total Connected HP
Backfill Preparation	Cyclones, Primary and Secondary	4 in	93	-
	Marconaflo High Pressure Pumps		2	200
	Slurry Pumps		2	100
	Feeders, Miscellaneous			200
	TOTAL			500
Flotation	Flotation Machines - Copper/Lead	1400 ft^3	10	750
	Flotation Machines - Copper/Lead	700 ft^3	3	150
	Flotation Machines - Lead	1400 ft^3(Column)	6	-
	Flotation Machines - Copper	1400 ft^3(Column)	4	-
	Flotation Machines - Zinc	1400 ft^3	14	1050
	Flotation Machines - Zinc	1400 ft^3(Column)	12	-
	Flotation Blower	2000 ft^3/min	4	3000
	Pumps, Conditioners, Overhead Cranes, and Miscellaneous	-	-	1000
	TOTAL			5950
Concentrate Thickening, Filtering, and Loadout	Thickener - Copper	50 ftØ	1	10
	Thickener - Lead	40 ftØ	1	1.5
	Thickener - Zinc	125 ftØ	1	15
	Filters	-	4	280
	Conveyors	48 in	4	40
	Thickener Underflow Pump - Copper	-	1	30
	Thickener Underflow Pump - Lead	-	1	25
	Thickener Underflow Pump - Zinc	-	1	40
	Thickener Overflow Pump - Copper	-	1	20
	Thickener Overflow Pump - Lead	-	1	15
	Thickener Overflow Pump - Zinc	-	1	125
	Filter Feed Pumps	-	6	90
	Filter Feed Pumps	-	1	25
	Miscellaneous	-	-	166
	TOTAL			883

TABLE 1.2-5 (continued)

Operation	Equipment Description	Size	Number of Units	Total Connected HP
Reagent Preparation and Distribution	Starch - Mixing Tank and Agitator	9.0 ftØ x 11.0 ft	1	3
	- Transfer Pump	--	1	15
	- Day Tank	10.0 ftØ x 10.0 ft	1	-
	- Metering Pump	--	1	0.75
	Sodium Dichromate - Bulk Storage Tank	13.0 ftØ x 13.0 ft	1	-
	- Transfer Pump	--	1	3
	- Mix Tank and Agitator	12.0 ftØ x 12.0 ft	1	3
	- Solution Pump	--	1	5
	- Day Tank	12.0 ftØ x 12.0 ft	1	-
	- Metering Pumps	--	2	1.5
	Depressant (Zinc, Sulfate, Lime, and Sodium Cyanide) - Mix Tank & Agitator	8.9 ftØ x 11.0 ft	1	3
	- Loop Pump	--	1	10
	- Metering Pump	--	3	0.75
	Sulfur Dioxide - Bulk Storage Tanks	7.5 ftØ x 27.0 ft	2	-
	- Transfer Pump	--	1	2
	Activated Carbon - Eductor System	--	1	-
	- Eductor Circulating Pump	--	1	15
	- Mix Tank and Agitator	12.0 ftØ x 12.0 ft	1	7.5
	- Transfer Pump	--	1	15
	- Day Tank & Agitator	12.0 ftØ x 12.0 ft	1	3
	- Metering Pump	--	1	0.25
	Sodium Cyanide - Mix Tank & Agitator	8.9 ftØ x 11.0 ft	1	3
	- Transfer Pump	--	1	5
	- Day Tank	6.0 ftØ x 7.2 ft	1	-
	- Metering Pumps	--	3	0.75

TABLE 1.2-5 (continued)

Operation	Equipment Description		Size	Number of Units	Total Connected HP
Reagent Preparation and Distribution	Dowfroth	- Bulk Storage Tank	9.8 ftØ x 11.2 ft	1	-
		- Transfer Pump	--	1	5
		- Mix Tank	5.9 ftØ x 7.2 ft	1	-
		- Transfer Pump	--	1	5
		- Day Tank	5.9 ftØ x 7.2 ft	1	-
		- Metering Pumps	--	4	1
	Sodium Sulfide	- Mix Tank and Agitator	11.8 ftØ x 11.8 ft	1	3
		- Solution Pump	--	1	5
		- Day Tank	9.8 ftØ x 10.2 ft	1	-
		- Metering Pumps	--	2	0.5
	Zinc Sulfate	- Mix Tank and Agitator	8.9 ftØ x 11.2 ft	1	3
		- Solution Pump	--	1	5
	Copper Sulfate	- De-lumper	--	1	10
		- Mix Tank & Agitator	13.8 ftØ x 13.8 ft	1	3
		- Solution Pump	--	1	3
		- Day Tank	13.8 ftØ x 13.8 ft	1	-
		- Metering Pumps	--	2	0.5
	Sodium Ethyl Xanthate	- Mix Tank	5.9 ftØ x 7.2 ft	1	-
		- Solution Pump	--	1	5
		- Day Tank	5.9 ftØ x 7.2 ft	1	-
		- Metering Pump	--	1	0.25
	Sodium Ethyl & Potassium Amyl Xanthates	- Mix Tank	5.9 ftØ x 7.2 ft	1	-
		- Solution Pump	--	1	5
		- Day Tank	5.9 ftØ x 7.2 ft	1	-
		- Metering Pumps	--	4	1

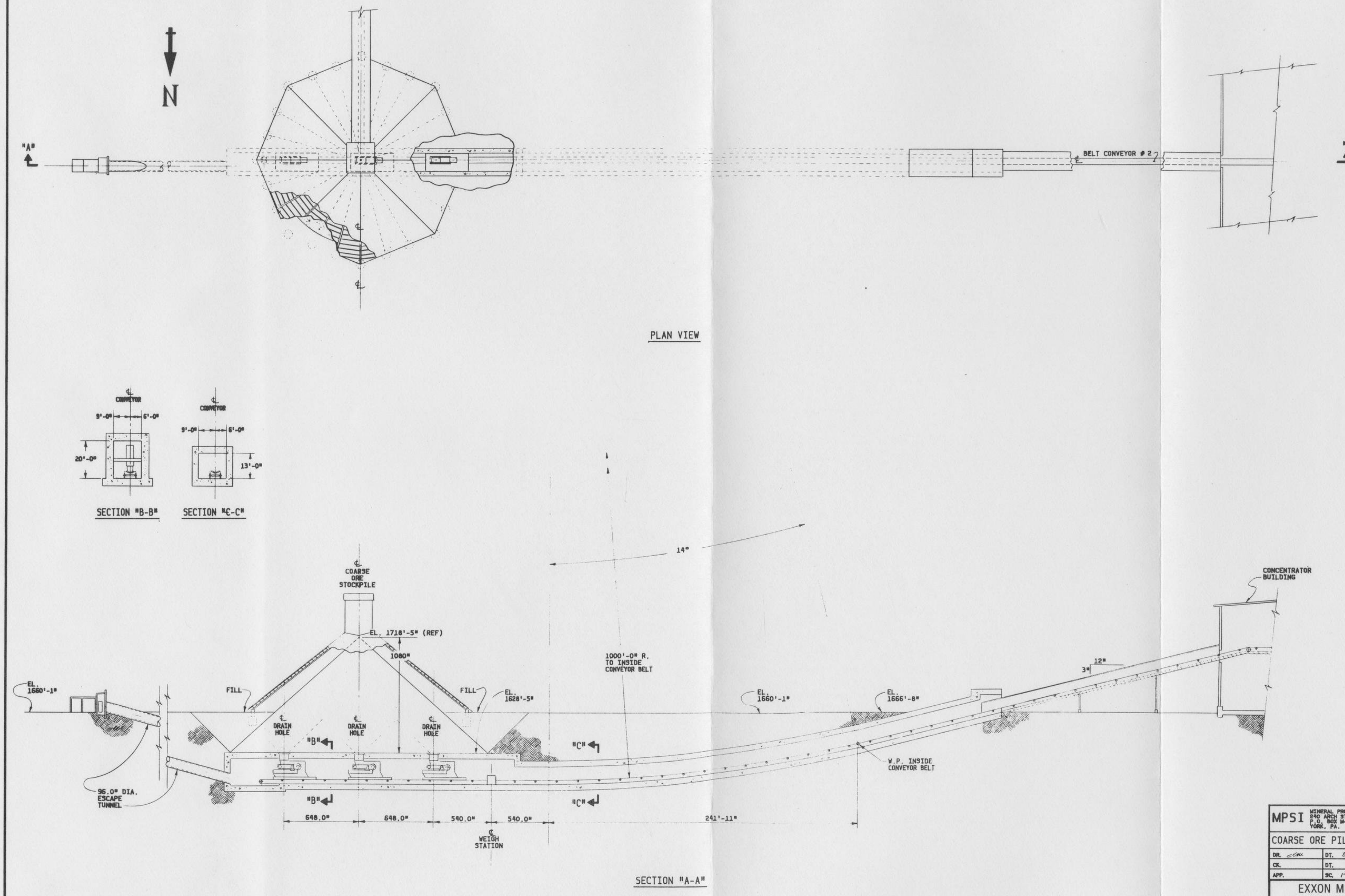
TABLE 1.2-5 (continued)

Operation	Equipment Description		Size	Number of Units	Total Connected HP
Reagent Preparation and Distribution	Sodium Isopropyl Xanthate				
		- Mix Tank	5.9 ftØ x 7.2 ft	1	-
		- Solution Pump	--	1	5
		- Day Tank	5.9 ftØ x 7.2 ft	1	-
		- Metering Pumps	--	2	0.5
	MIBC (Frother)	- Delivery Pump	--	1	5
		- Bulk Storage Tank	13.1 ftØ x 13.1 ft	1	-
		- Transfer Pump	--	1	5
		- Transfer Tank	3.9 ftØ x 3.9 ft	1	-
		- Transfer Pump	--	1	5
		- Day Tank	3.0 ftØ x 3.9 ft	1	-
		- Metering Pumps	--	6	1.5
	Sodium Silicate	- Delivery Pump	--	1	7.5
		- Bulk Storage	13.8 ftØ x 13.8 ft	1	-
		- Transfer Pump	--	1	1
		- Mix Tank & Agitator	13.8 ftØ x 13.8 ft	1	3
		- Solution Pump	--	1	10
		- Day Tank	13.8 ftØ x 13.8 ft	1	-
		- Metering Pumps	--	3	0.75
	Flocculant	- Storage Tank	8.5 ftØ x 9.8 ft	1	-
		- Transfer Pump	--	1	5
	Spare	- Mix Tank	5.9 ftØ x 7.2 ft	1	-
		- Transfer Pump	--	1	5
		- Day Tank	5.9 ftØ x 7.2 ft	1	-
		- Metering Pump	--	1	0.25
	Crane		2 ton	1	3
		TOTAL			209

TABLE 1.2-5 (continued)

Operation	Equipment Description		Size	Number of Units	Total Connected HP
Milk-of-lime and Soda Ash Preparation	Pneumatic Conveyor System			1	150
	Lime	- Rotary Air Lock Feeder	--	1	5
		- Storage Bin	600 ton	1	-
		- Insertable Dust Collector	1500 SCFM	1	4
		- Paste Slaker	3 ton/hr	1	6
		- Lime Slurry Pump	--	1	5
		- Slurry Tanks & Agitator	19.7 ft x 19.7 ft	2	20
		- Circulation Pump	--	1	20
		- Circulation Pump	--	1	100
	Soda Ash	- Rotary Air Lock Feeder	--	1	5
		- Soda Ash Storage Bin	310 ton	1	-
		- Insertable Dust Collector	1500 SCFM	1	4
		- Screw Conveyor	9 in	1	3
		- Mix Tank and Agitator	13.1 ft x 9.8 ft	1	3
		- Feed Pumps	--	2	10
	Crane		2 ton	1	3
	Vertical Floor Pump		--	1	2
		TOTAL			340
Tailings Thickening	Thickener		200 ft	1	
	Thickener Underflow Pumps		850 gpm	4	400
	Thickener Overflow Pumps		500 gpm	2	300
	Thickener Overflow Pump		3600 gpm	1	60
	Miscellaneous		--	-	5
		TOTAL			765
		GRAND TOTAL			19461 (14,512 kw)

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



Typical Representations: Refinements May Be Made During Final Engineering

MPSI	MINERAL PROCESSING SYSTEMS, INC 240 ARCH ST P.O. BOX M-312 YORK, PA. 17405	
COARSE ORE PILE TO CONCENTRATOR		
DR. clm	DT. 8-13-85	S05-004743
CK.	DT.	
APP.	SC. 1" = 27'-9"	

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
COARSE ORE PILE TO CONCENTRATOR

SCALE	STATE	COUNTY	
DRAWN BY	DATE	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED C.C. Schroedl	DATE 11/85
APPROVED BY	DATE	EXXON D.S. Moe	DATE 1/85

DRAWING NO **FIGURE 1.2-16** SHEET OF REVISION NO

REVISED	DATE	BY	DESCRIPTION

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

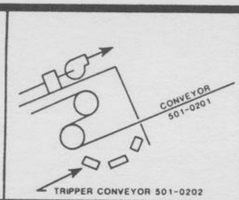
Insertable dust collectors will be used for dust control in the ore handling facility. A dust collector schedule for the ore handling facility and other surface facilities is shown on Figure 1.2-17.

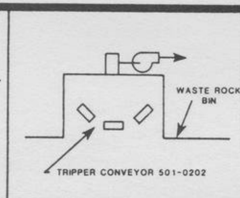
The entire ore handling facility from the mine headframe through coarse ore storage, waste rock crushing, and grinding will be completely covered. All conveyor galleries will be covered. There will be no contaminated water runoff from the ore handling facility. Any drainage water collected in the sumps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

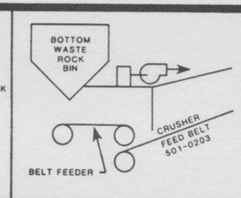
Preproduction ore and waste rock will be transported by truck from the headframe to a prepared laydown area north of the concentrator (Figure 1.2-15). This area will occupy 8 acres and will be lined with two 4-inch layers of compacted bentonite-modified soil. Approximately 12 inches of compacted random soil till will be placed on top of the clay/soil liner for protection. Drainage will be collected in surface drainage basin No. 3 and transported to the reclaim pond. Recovery of ore would be managed so that the protective cover will remain in place throughout the Project life. While this storage area is planned for preproduction ore, it could be maintained and reactivated for use as an ore surge area if needed.

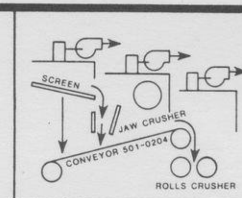
Surface runoff from the preproduction ore storage area will be collected in a lined 1,480,000 gallon sump surface drainage basin designed to accommodate the precipitation volume in the area from a

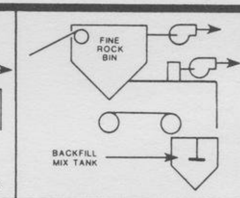
SYSTEM DIAGRAM

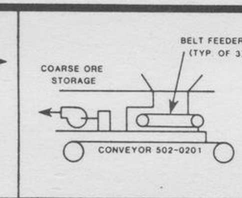


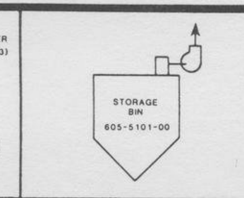






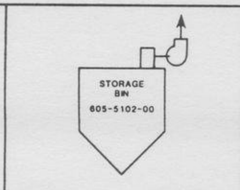


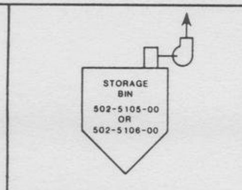




LOCATION/SYSTEM	WASTE ROCK TRIPPER	COARSE WASTE ROCK BIN	COARSE WASTE ROCK BIN	WASTE ROCK CRUSHER	FINE WASTE ROCK BIN	RECLAIM TUNNEL	STORAGE BIN - CONCENTRATOR
DUST COLLECTOR EQUIP. NO.	501-3101-00	501-3102-00	501-3103-00	(3 REQ'D) 501-3104-3106-00	(2 REQ'D) 501-3107&3108-00	(3 REQ'D) 501-3109-3111-00	605-3101-00
FAN EQUIPMENT NO.	—	—	—	—	—	—	—
MATERIAL	MASSIVE ORE/WASTE ROCK	WASTE ROCK	WASTE ROCK	WASTE ROCK	WASTE ROCK	MASSIVE ORE	BURNT LIME
SYSTEM VOLUME (CFM)	3500	3500	1200	1200	1800	2100	1500
FAN STATIC PRESS. LB/INCH^2	.26	.26	.26	.26	.26	.26	.26
FAN HORSEPOWER	10	10	3	3	5	5	5

SYSTEM DIAGRAM





LOCATION/SYSTEM	STORAGE BIN - CONCENTRATOR	STORAGE BIN - BACKFILL MIXING					
DUST COLLECTOR EQUIP. NO.	605-3102-00	(2 REQ'D) 502-3115&3116-00					
FAN EQUIPMENT NO.	—	—					
MATERIAL	SODA ASH	CEMENT					
SYSTEM VOLUME (CFM)	1500	3000					
FAN STATIC PRESS. LB/INCH^2	.26	.26					
FAN HORSEPOWER	5	7.5					

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
DUST COLLECTOR SCHEDULE

SCALE NONE	STATE		COUNTY	
DRAWN BY C. ADAMS	DATE 8/85	CHECKED BY		DATE
APPROVED BY	DATE	APPROVED BY		DATE
APPROVED BY	DATE	EXXON		DATE
DRAWING NO. FIGURE 1.2-17	SHEET 1 OF 1	REVISION NO.		

385-2C-219MA1

25-year, 24-hour storm event. This water will be pumped to the reclaim pond via the tailings thickener overflow.

A small bin on the east side of the coarse ore storage facility will be used to contain waste rock. Waste rock delivered to this bin will be crushed to minus 3/4 inch to supplement mine backfill. The facilities associated with backfill preparation are described in subsection 1.2.2.11.

1.2.2.2 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 on the north side of the coarse ore storage building such that the crushed material can be fed to the massive ore stockpile. A temporary opening will be provided in the building to allow transfer of ore to the stockpile.

The mobile crusher will be a jaw crusher which will operate no more than two shifts per day and will have a maximum capacity of 400 tons per hour. Three insertable dust collectors will be used on the crusher to control dust emissions.

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.

1.2.2.3 Concentrator

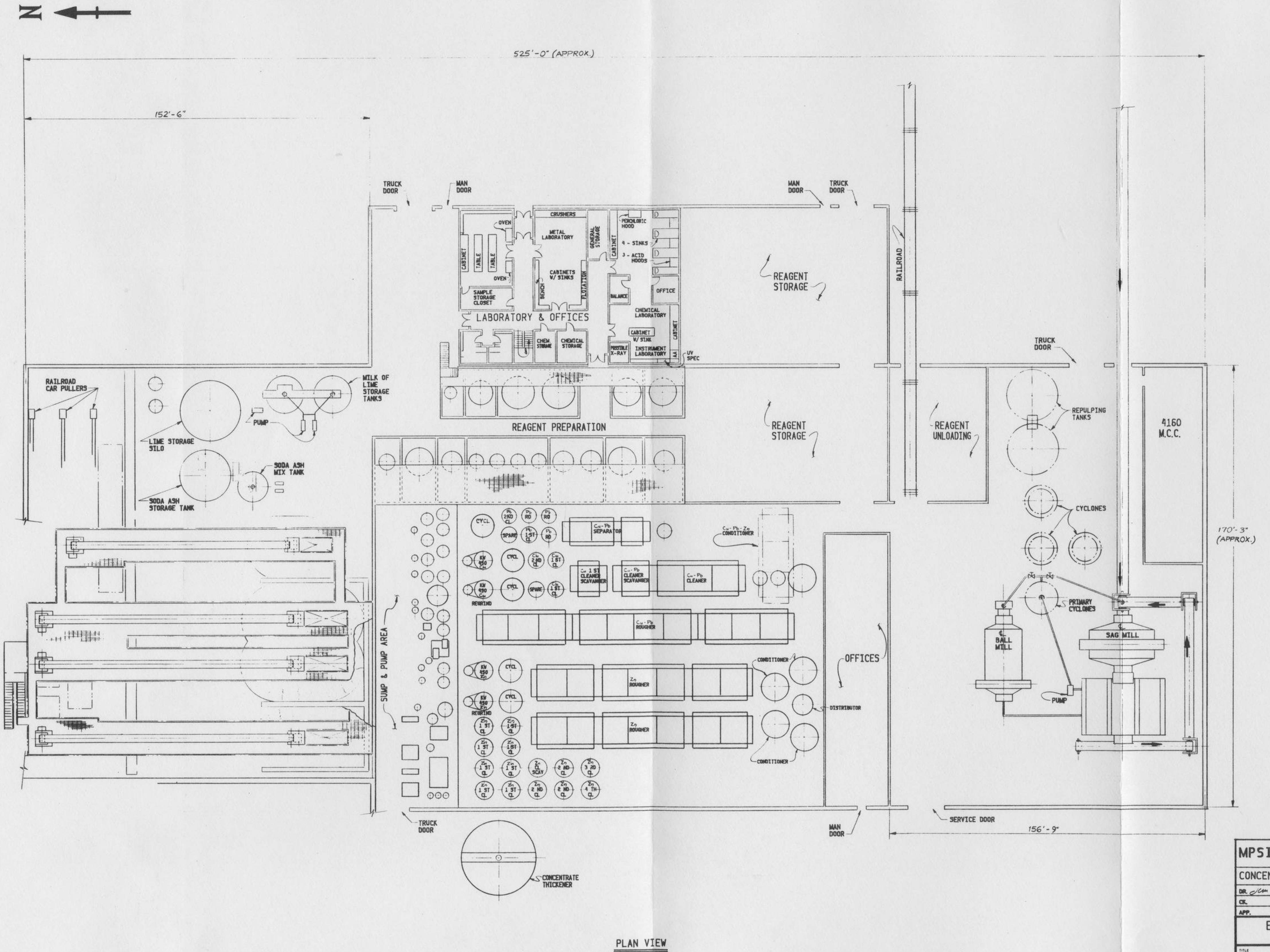
The recovery of concentrates from the ore will take place in a building located northwest of the mine production shaft (Figure 1.2-15). The equipment required for extracting the zinc, copper, and lead minerals from the coarse ore will be housed in this building. This equipment will be used for the following: grinding, flotation, thickening and dewatering, concentrate storage and loadout, and reagent preparation and storage.

The grinding and flotation sections will be on different elevations to allow for gravity flow in the process wherever practical. 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.

The building walls and roof will be insulated for fuel economy and will help to attenuate the noise emanating from the process equipment.

1.2.2.4 Ore Treatment

The facilities for recovering the valuable minerals from the ore will include the grinding and flotation circuits (Figure 1.2-18). 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.



MPSI MINERAL PROCESSING SYSTEMS, INC
240 ARCH ST.
P.O. BOX M-312
YORK, PA. 17405

CONCENTRATOR BUILDING

DR. JCM	DT. 8-8-85	S05-004729
CK.	DT.	
APP.	SC. 1:200	

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CONCENTRATOR BUILDING

SCALE	STATE	COUNTY	
DRAWN BY	DATE	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/85
APPROVED BY	DATE	EXXON D.E. [illegible]	DATE 11/85
DRAWING NO FIGURE 1.2-18	SHEET OF	REVISION NO	

REVISED	DATE	BY	DESCRIPTION

Typical Representations: Refinements May Be Made During Final Engineering

Grinding - Coarse ore will be conveyed from coarse ore stockpile directly to a SAG and ball mill grinding circuit. Here the ore will reduced in size by wet grinding. Ore and water will be fed to a SAG mill where the ore will be ground by a combination of grinding balls and the tumbling action of the ore itself. The slurry discharging from the SAG mill will flow across a vibrating wet screen. Ore collecting on the screen will be recirculated to the SAG mill; the finer material will be pumped to a classifier for further particle sizing. The slurry of classified coarse particles will flow by gravity to a ball mill for further grinding and will be returned to the classifiers. The slurry of fine particles from these classifiers 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.

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 tower 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. The tower mill is shown on Figure 1.4-4.

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. Overflow from the zinc concentrate thickener will be sent to a tank for direct recycle to zinc flotation. Overflow from the copper concentrate thickener will be sent to the reclaim pond. Overflow from the lead concentrate thickener will be sent to the tailing thickener to take advantage of the added lime for metal precipitation. 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 will not occur.

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.

1.2.2.5 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 and approximate quantities of reagents to be used in the mill are shown in Table 1.2-6. Lime, sodium carbonate (soda ash), and sodium sulfide required in the water treatment plant will also be supplied from this area.

Detail designs of the reagent storage and mixing areas will be completed during final engineering. Available designs for these facilities are shown on Figures 1.2-19 and 1.2-20.

Reagents will be received by either truck or railcar. Three unloading areas will be used:

1) Lime and sodium carbonate will be received on the inside plant track immediately north of the filter area (see Figure 1.2-18). Lime will be received as burnt pebble, and sodium carbonate will be received as a granular, free-flowing material.

2) Sulfur dioxide, sodium dichromate, and frothers will be received by truck and stored in the reagent bulk storage area just east of the concentrator building. Sulfur dioxide will be received in liquid form. Sodium dichromate will be received as a saturated solution. Inline heating will be provided to prevent freezing in winter. All of the receiving/storage tanks are contained in bermed areas with blind sumps. The bermed area will be designed to hold the contents of the tanks. Blind sumps can be used to return small spills to the respective tank.

3) Drums, bags, and returnable bins will be delivered by truck to the concentrator at the reagent unloading and storage area shown on Figure 1.2-18.

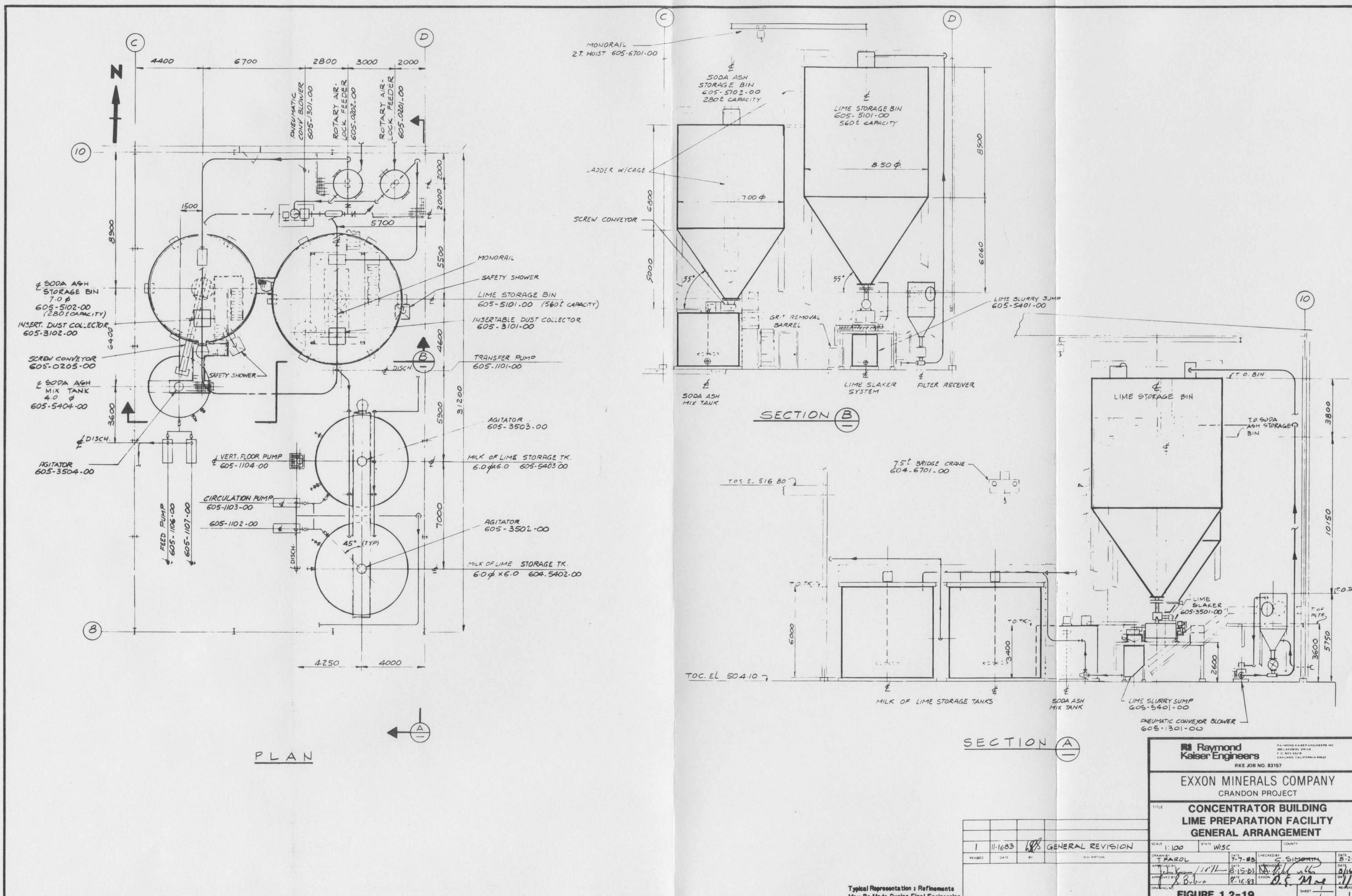
Facilities for handling lime and sodium carbonate are shown on Figure 1.2-19. Both materials will be pneumatically transported from

TABLE 1.2-6

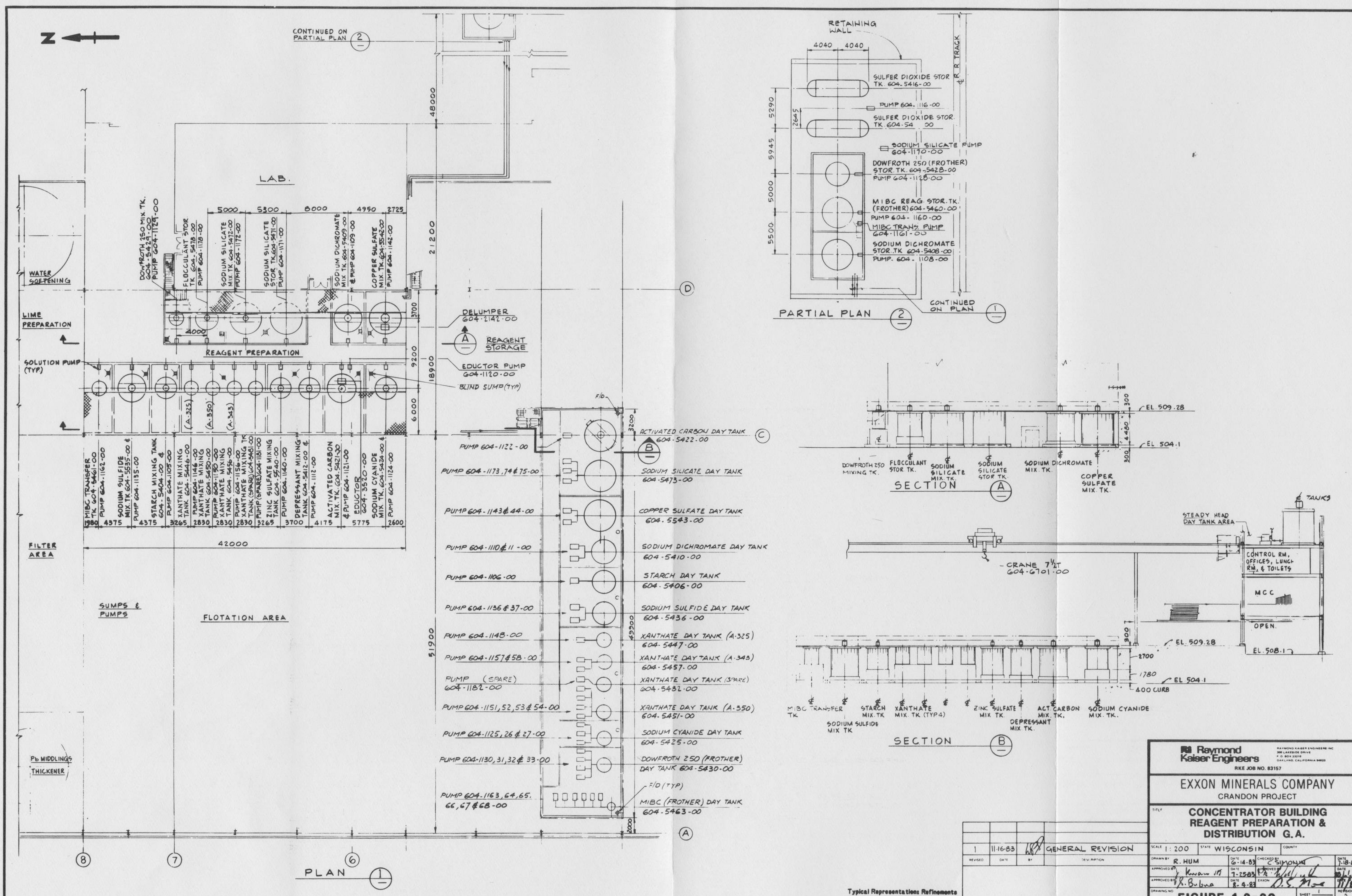
TYPICAL REAGENT DATA AND STORAGE CAPACITY

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

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



PLAN
SECTION B
SECTION A
MONORAIL
2T. HOIST 605-6701-00
SODA ASH STORAGE BIN 605-5102-00 280t CAPACITY
LIME STORAGE BIN 605-5101-00 560t CAPACITY
LADDER W/CAGE
SCREW CONVEYOR
GRIT REMOVAL BARREL
LIME SLURRY SUMP 605-5401-00
SODA ASH MIX TANK
LIME SLAKER SYSTEM
FILTER RECEIVER
PNEUMATIC CONV BLOWER 605-1301-00
ROTARY AIR-LOCK FEEDER 605-0202-00
ROTARY AIR-LOCK FEEDER 605-0201-00
SODA ASH STORAGE BIN 7.0 φ 605-5102-00 (280t CAPACITY)
INSERT. DUST COLLECTOR 605-3102-00
SCREW CONVEYOR 605-0205-00
SODA ASH MIX TANK 4.0 φ 605-5404-00
AGITATOR 605-3504-00
FEED PUMP 605-1106-00
605-1107-00
MONORAIL
SAFETY SHOWER
LIME STORAGE BIN 605-5101-00 (560t CAPACITY)
INSERTABLE DUST COLLECTOR 605-3101-00
TRANSFER PUMP 605-1101-00
AGITATOR 605-3503-00
MILK OF LIME STORAGE TK. 6.0φ×6.0 605-5403-00
VERT. FLOOR PUMP 605-1104-00
CIRCULATION PUMP 605-1103-00
605-1102-00
AGITATOR 605-3502-00
MILK OF LIME STORAGE TK. 6.0φ×6.0 604-5402-00
7.5t BRIDGE CRANE 604-6701-00
T.O.S. EL 516.80
TOC. EL 504.10
LIME STORAGE BIN
T.O. BIN
T.O. SODA ASH STORAGE BIN
LIME SLAKER 605-3501-00
T.O. TANK
T OF FLTR.
MILK OF LIME STORAGE TANKS
SODA ASH MIX TANK
LIME SLURRY SUMP 605-5401-00
PNEUMATIC CONVEYOR BLOWER 605-1301-00
Typical Representation : Refinements May Be Made During Final Engineering
Raymond Kaiser Engineers
RKE JOB NO. 83157
EXXON MINERALS COMPANY
CRANDON PROJECT
CONCENTRATOR BUILDING
LIME PREPARATION FACILITY
GENERAL ARRANGEMENT
SCALE 1:100
STATE WISC
DRAWN BY T. FAROL 7-7-83
CHECKED BY C. SIMONIN 8-2-83
1 11-16-83 GENERAL REVISION
FIGURE 1.2-19
051-6-G-008



CONTINUED ON PARTIAL PLAN 2
LAB.
DOWFROTH 250 MIX TK. 604-5429-00 PUMP 604-1129-00
FLOCCULANT STOR TK 604-5478-00 PUMP 604-1178-00
SODIUM SILICATE MIX TK 604-5472-00 PUMP 604-1172-00
SODIUM SILICATE STOR TK 604-5471-00 PUMP 604-1171-00
SODIUM DICHROMATE MIX TK 604-5409-00 & PUMP 604-1109-00
COPPER SULFATE MIX TK 604-5542-00 PUMP 604-1142-00
WATER SOFTENING
LIME PREPARATION
SOLUTION PUMP (TYP)
REAGENT PREPARATION
DELUMPER 604-2142-00
REAGENT STORAGE
EDUCTOR PUMP 604-1120-00
BLIND SUMP (TYP)
MIBC TRANSFER TK 604-5461-00 PUMP 604-1162-00
SODIUM SULFIDE MIX TK 604-5535-00 & PUMP 604-1135-00
STARCH MIXING TANK 604-5404-00 & PUMP 604-1105-00
XANTHATE MIXING TANK 604-5446-00
XANTHATE MIXING TANK 604-5450-00
XANTHATE MIXING TANK 604-5456-00
XANTHATE MIXING TANK (SPARE) 604-5481-00
ZINC SULFATE MIXING TANK 604-5440-00
DEPRESSANT MIXING TANK 604-5412-00 & PUMP 604-1112-00
ACTIVATED CARBON MIX TK 604-5421-00 & PUMP 604-1121-00
EDUCTOR 604-3520-00
SODIUM CYANIDE MIX TK 604-5424-00 & PUMP 604-1124-00
42000
FILTER AREA
SUMPS & PUMPS
FLOTATION AREA
Pb MIDDLINGS THICKENER
ACTIVATED CARBON DAY TANK 604-5422-00
PUMP 604-1122-00
PUMP 604-1173, 74 & 75-00 — SODIUM SILICATE DAY TANK 604-5473-00
PUMP 604-1143 & 44-00 — COPPER SULFATE DAY TANK 604-5543-00
PUMP 604-1110 & 11-00 — SODIUM DICHROMATE DAY TANK 604-5410-00
PUMP 604-1106-00 — STARCH DAY TANK 604-5406-00
PUMP 604-1136 & 37-00 — SODIUM SULFIDE DAY TANK 604-5436-00
PUMP 604-1148-00 — XANTHATE DAY TANK (A-325) 604-5447-00
PUMP 604-1157 & 58-00 — XANTHATE DAY TANK (A-343) 604-5457-00
PUMP (SPARE) 604-1182-00 — XANTHATE DAY TANK (SPARE) 604-5482-00
PUMP 604-1151, 52, 53 & 54-00 — XANTHATE DAY TANK (A-350) 604-5451-00
PUMP 604-1125, 26 & 27-00 — SODIUM CYANIDE DAY TANK 604-5425-00
PUMP 604-1130, 31, 32 & 33-00 — DOWFROTH 250 (FROTHER) DAY TANK 604-5430-00
F/D (TYP)
PUMP 604-1163, 64, 65, 66, 67 & 68-00 — MIBC (FROTHER) DAY TANK 604-5463-00
PLAN 1
RETAINING WALL
R.R. TRACK
SULFER DIOXIDE STOR TK. 604-5416-00
PUMP 604-1116-00
SULFER DIOXIDE STOR. TK. 604-54 00
SODIUM SILICATE PUMP 604-1170-00
DOWFROTH 250 (FROTHER) STOR. TK. 604-5428-00 PUMP 604-1128-00
MIBC REAG. STOR. TK. (FROTHER) 604-5460-00 PUMP 604-1160-00
MIBC TRANS PUMP 604-1161-00
SODIUM DICHROMATE STOR. TK 604-5408-00 PUMP 604-1108-00
CONTINUED ON PLAN 1
PARTIAL PLAN 2
EL 509.28
EL 504.1
DOWFROTH 250 MIXING TK.
FLOCCULANT STOR TK.
SODIUM SILICATE MIX TK.
SODIUM SILICATE STOR TK.
SODIUM DICHROMATE MIX TK.
COPPER SULFATE MIX TK.
SECTION A
TANKS
STEADY HEAD DAY TANK AREA
CONTROL RM, OFFICES, LUNCH RM, & TOILETS
CRANE 7 1/2 T 604-6701-00
MCC
OPEN.
EL 509.28
EL 508.1
EL 504.1
400 CURB
MIBC TRANSFER TK
SODIUM SULFIDE MIX TK
STARCH MIX TK
XANTHATE MIX TK (TYP 4)
ZINC SULFATE MIX TK
DEPRESSANT MIX TK.
ACT. CARBON MIX TK.
SODIUM CYANIDE MIX TK.
SECTION B
Raymond Kaiser Engineers
RKE JOB NO. 83157
EXXON MINERALS COMPANY
CRANDON PROJECT
CONCENTRATOR BUILDING REAGENT PREPARATION & DISTRIBUTION G.A.
SCALE 1:200
STATE WISCONSIN
DRAWN BY R. HUM
DATE 6-14-83
1 11-16-83 GENERAL REVISION
FIGURE 1.2-20
REVISION NO 2
SHEET 1 OF 1
Typical Representation: Refinements May Be Made During Final Engineering
051-6-G-009

the railcar into respective storage bins. Insertable dust collectors for this facility are shown on Figure 1.2-19 and are detailed in the dust collector schedule (Figure 1.2-17). An insertable dust collector also will be provided for the unloading and storage bins. Lime will be fed from the bottom of the storage bin to a slaking device. The slaked lime slurry from the slaker will be pumped to one of the two milk-of-lime agitated storage tanks. Water will be added to the pump sump beneath the slaker to dilute the lime slurry to the desired concentration. Milk-of-lime will be pumped from the storage tanks into slurry distribution loops; there will be one loop for the concentrator and one for the water treatment plant. These are continuous circulating loops that come back to the agitated mix tanks. Taps are provided at appropriate places in the loops at the reagent addition points. Any spills in the lime slaking area will be collected in a floor sump and pumped to the slaker discharge sump.

Sodium carbonate will be fed by a screw feeder to the mix tank. Mixed solution will be pumped to the solution holding tanks in the water treatment plant.

Sulfur dioxide will be fed directly to the necessary addition points from the outside storage tank with no intermediate storage of this reagent.

The frother, polypropylene glycol methylether (Dowfroth 250 or equivalent), will be pumped from the outside storage tank to the mix tank in the reagent preparation area. The diluted frother solution will be pumped to the reagent day tank for feeding to the necessary addition points in the process. The frother methyl isobutylcarbinol (MIBC) will be pumped from the outside storage tank to a small transfer tank and then to the day tank for use. This reagent will not be diluted prior to being used.

Concentrated sodium dichromate solution will be pumped from the outside storage tank to the mix tank via a heat-traced pipe. This reagent will be diluted with water and mixed with sodium silicate solution. The diluted solution of sodium dichromate and sodium silicate will be pumped to the day tank and used as the depressant for lead in the copper-lead separation process.

Sodium cyanide will be received in 3000-pound Flo-Bins™ which are returnable. These bins mount directly on top of the mixing tank. A mechanism beneath the bin allows the sodium cyanide briquettes to flow directly into the solution mix tank. Sodium hydroxide will be added to the water in the mix tank before adding the sodium cyanide. This will prevent the formation of hydrogen cyanide gas. Final pH of the solution should be about 12.

All other reagents will be transferred from either drums, bags, or small bins into mix tanks for agitation. Mixed reagent solutions will be pumped to the day tanks for distribution to the process addition points. Each day tank is sized to hold enough reagent for about 32 hours of continuous mill operation. Any solution overflowing the day tank will flow back to the mix tank.

The berms that are shown in the reagent mixing and day tank areas will isolate the reagents from each other. Equipment for mixing the three different xanthate reagents will be in the same bermed area because these reagents are chemically and functionally compatible. The berms will be designed to contain a total spill from a single tank. Blind sumps will be used to return spilled reagents to their respective tank.

Noncompatible reagents will be isolated spatially as well as with berms. For example, sodium cyanide will not be unloaded or stored near acids, nor will any acid be stored near strong caustics. The only strong acid, sulfuric acid, will be delivered directly to the water treatment plant.

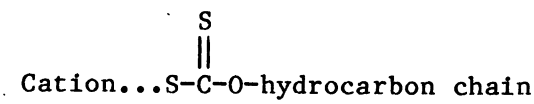
Dusts will be minimal in the reagent preparation area. Personal breathing protection will be provided as necessary for workers in these areas. Dusts encountered will be primarily in the lime and soda ash areas; dust collectors for these areas were discussed earlier in this subsection. Reagent mixing areas will be ventilated as part of the normal building ventilation system. The reagent preparation and day tank areas will be equipped with detectors for hydrogen sulfide and hydrogen cyanide.

Other design considerations for the reagent preparation facilities include:

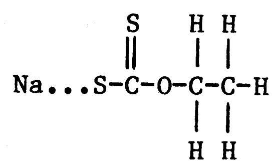
1) Explosion-proof motors, light fixtures, and conduit;
2) Emergency eye wash and shower facilities and necessary first aid equipment; and
3) Special consideration will be given to materials selection for each reagent system to guard against corrosion.

The reagents listed in Table 1.2-6 are essentially those that have been used in the process development testing for the Crandon Project. These reagents are "typical" in the sense that they are commonly used in the treatment of ores of this type. If pilot plant and actual plant testing shows other reagents to be more beneficial to the process, they might be incorporated into the process.

The xanthates are a group of flotation collectors which have the following general chemical structure:



For example, sodium ethyl xanthate is one of the xanthates used for Crandon ore:



Xanthates with different hydrocarbon chains that will be used include potassium amyl xanthate and sodium isopropyl xanthate. Other xanthates which have commonly been used in treating similar ores might be tested in the pilot plant and ultimately used in the flotation process.

Flocculants are generally organic polymers which are commonly used to agglomerate fine suspended ore particles so that they settle faster in thickeners and thus enhance clarity in the thickener overflow. They are generally used in extremely low dosages, typically 0.03 to 0.1 pound per ton of ore. Although a particular polymer has not been identified for use at Crandon, the polymer used would be one of the flocculants in general use by mining and other industries. A typical polymer is a polyacrylamide.

1.2.2.6 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.

1.2.2.7 Mechanical Equipment

The heating system for the concentrator building will consist 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.

1.2.2.8 Tailings Thickening

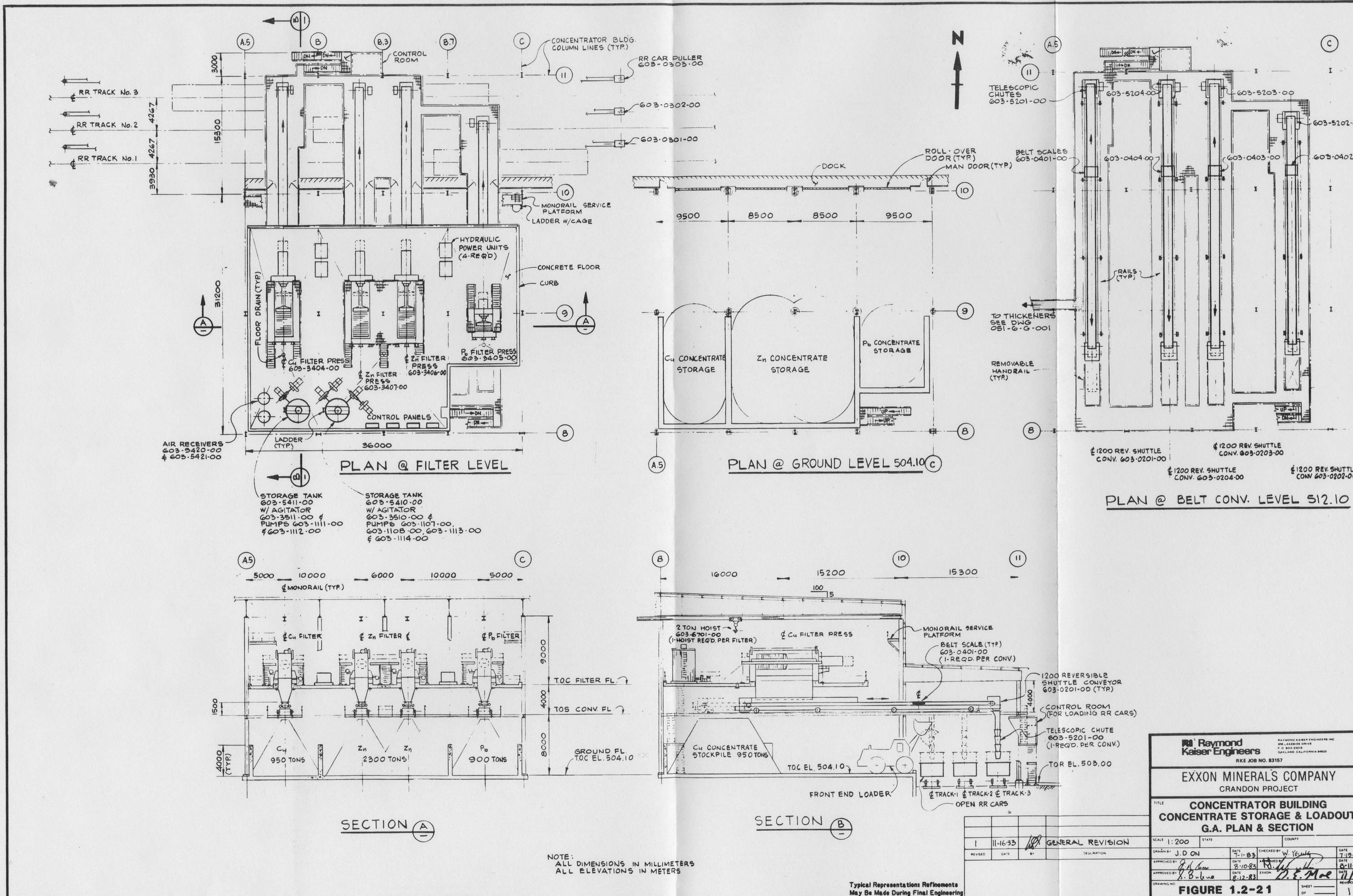
The tailings thickener will be 200 feet in diameter, uncovered and installed at grade level. The fine tailings from the backfill preparation facility (described in subsection 1.2.2.11) will be pumped to the thickener. A thickener is used to increase the density of a slurry. A dilute slurry is fed at the center feed well of a large circular vessel. The solids settle towards the bottom while clear solution overflows along the periphery of the vessel. The settled solids are withdrawn from the bottom of the vessel as a thick slurry. The feed rate, diameter of the vessel, and flocculants, if used, are all factors that affect the performance of the thickener.

For the Crandon Project, the feed stream will contain an average of approximately 3,000 tons per day of solids with a total pulp volume of 6,800 gallons per minute, including two small overflow streams from the lead feed thickener and lead concentrate 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 MWDF.

The thickener overflow at approximately 6,250 gallons per minute will contain a small amount of solids, approximately 100-1000 ppm. 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.

1.2.2.9 Concentrate Handling and Loadout

The concentrate handling and loadout facilities will be enclosed at the north end of the mill building (Figure 1.2-18). Available details for the facility are shown on Figure 1.2-21. The concentrates will normally be loaded directly into railcars. The



PLAN @ FILTER LEVEL
CONCENTRATOR BLDG. COLUMN LINES (TYP.)
CONTROL ROOM
RR CAR PULLER 603-0303-00
603-0302-00
603-0301-00
RR TRACK No. 3
RR TRACK No. 2
RR TRACK No. 1
MONORAIL SERVICE PLATFORM
LADDER W/CAGE
HYDRAULIC POWER UNITS (4-REQ'D)
CONCRETE FLOOR
CURB
FLOOR DRAIN (TYP)
℄ Cu FILTER PRESS 603-3404-00
℄ Zn FILTER PRESS 603-3407-00
℄ Zn FILTER PRESS 603-3406-00
Pb FILTER PRESS 603-3405-00
CONTROL PANELS
AIR RECEIVERS 603-5420-00 & 603-5421-00
LADDER (TYP)
36000
STORAGE TANK 603-5411-00 W/ AGITATOR 603-3511-00 & PUMPS 603-1111-00 & 603-1112-00
STORAGE TANK 603-5410-00 W/ AGITATOR 603-3510-00 & PUMPS 603-1107-00, 603-1108-00, 603-1113-00 & 603-1114-00
PLAN @ GROUND LEVEL 504.10
DOCK
ROLL-OVER DOOR (TYP.)
MAN DOOR (TYP)
9500
8500
8500
9500
Cu CONCENTRATE STORAGE
Zn CONCENTRATE STORAGE
Pb CONCENTRATE STORAGE
N
PLAN @ BELT CONV. LEVEL 512.10
TELESCOPIC CHUTES 603-5201-00
603-5204-00
603-5203-00
603-5202-00
BELT SCALES 603-0401-00
603-0404-00
603-0403-00
603-0402-00
RAILS (TYP)
TO THICKENERS SEE DWG 051-6-G-001
REMOVABLE HANDRAIL (TYP)
℄ 1200 REV. SHUTTLE CONV. 603-0201-00
℄ 1200 REV. SHUTTLE CONV. 603-0203-00
℄ 1200 REV. SHUTTLE CONV. 603-0204-00
℄ 1200 REV. SHUTTLE CONV 603-0202-00
SECTION A
℄ MONORAIL (TYP.)
℄ Cu FILTER
℄ Zn FILTER ℄
℄ Pb FILTER
TOC FILTER FL.
TOS CONV. FL.
GROUND FL. TOC EL. 504.10
Cu 950 TONS
Zn 2300 TONS Zn
Pb 900 TONS
SECTION B
2 TON HOIST 603-6701-00 (1-HOIST REQ'D. PER FILTER)
℄ Cu FILTER PRESS
MONORAIL SERVICE PLATFORM
BELT SCALE (TYP) 603-0401-00 (1-REQ'D. PER CONV.)
1200 REVERSIBLE SHUTTLE CONVEYOR 603-0201-00 (TYP)
CONTROL ROOM (FOR LOADING RR CARS)
TELESCOPIC CHUTE 603-5201-00 (1-REQ'D. PER CONV.)
Cu CONCENTRATE STOCKPILE 950 TONS
TOC EL. 504.10
TOR EL. 503.00
FRONT END LOADER
℄ TRACK-1 ℄ TRACK-2 ℄ TRACK-3
OPEN RR CARS
NOTE:
ALL DIMENSIONS IN MILLIMETERS
ALL ELEVATIONS IN METERS
Typical Representation: Refinements May Be Made During Final Engineering
1 11-16-83 GENERAL REVISION
Raymond Kaiser Engineers
RKE JOB NO. 83157
EXXON MINERALS COMPANY
CRANDON PROJECT
CONCENTRATOR BUILDING
CONCENTRATE STORAGE & LOADOUT
G.A. PLAN & SECTION
SCALE 1:200
DRAWN BY J. D ON 7-1-83
CHECKED BY W. YEUNG 7-19-83
FIGURE 1.2-21
051-6-G-011

railcars to be used to transport concentrate are open top, rectangular cars called gondola cars with 70 to 100-ton capacity. They have a steel bed and sides which will completely contain the concentrate without spillage. After loading, the cars will be covered with a tarpaulin type cover typically made of woven polyolefin fabric or a latex-based chemical spray coating and sealant. Trucks will not normally be used; however, if they are required, they probably would be 20-ton semi-trailer type dump trucks with a plastic cover or dust control spray over the concentrate.

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

Discussions with officials from the Soo Line Railroad indicate that the history of rail service in the area has been extremely reliable. Therefore, the probability of an extended transportation problem occurring is low. The storage capacity available for copper and zinc concentrates along with storage capacity in available railcars should be adequate to prevent shutdown of the plant during the day or two that the railroad cannot supply cars due to a weather-related problem. Currently, there is an oversupply of railcars and this situation is not expected to change in the near future.

Severe market problems or a lengthy rail strike would likely force a temporary shutdown of the Project regardless of the amount of storage capacity available.

If railcar availability were to become a problem and the planned concentrate storage capacity were inadequate, a modification to the existing permit would be requested to provide more storage area.

1.2.2.10 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 sump pumps used to handle any spills will also be used for general clean-up. Sumps have not been provided specifically for water; the building is designed to prevent entrance of precipitation. Spilled material can be recycled without any treatment; this is common practice in mineral processing plants.

There will be three process lines in the concentrator:

1) Grinding massive ore;

2) Copper-lead flotation; and

3) Zinc flotation.

The sump system is designed to keep potential spills in these areas separated. Allowing spills to mix would not be a safety hazard; however, from the standpoint of process control it is not desirable.

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 (see Figures 1.2-51 and 1.2-52). 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.

Provisions for handling reagent spills were discussed in subsection 1.2.2.5.

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.

1.2.2.11 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 1.2-15). 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.

1.2.2.12 Backfill Storage and Transport

Storage capacity for approximately 18,000 tons 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 minus 3/4 inch rock and cement as needed before transfer to the mine. The Marconaflo system can repulp at 70 percent solids and provides a close control of density.

1.2.2.13 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.

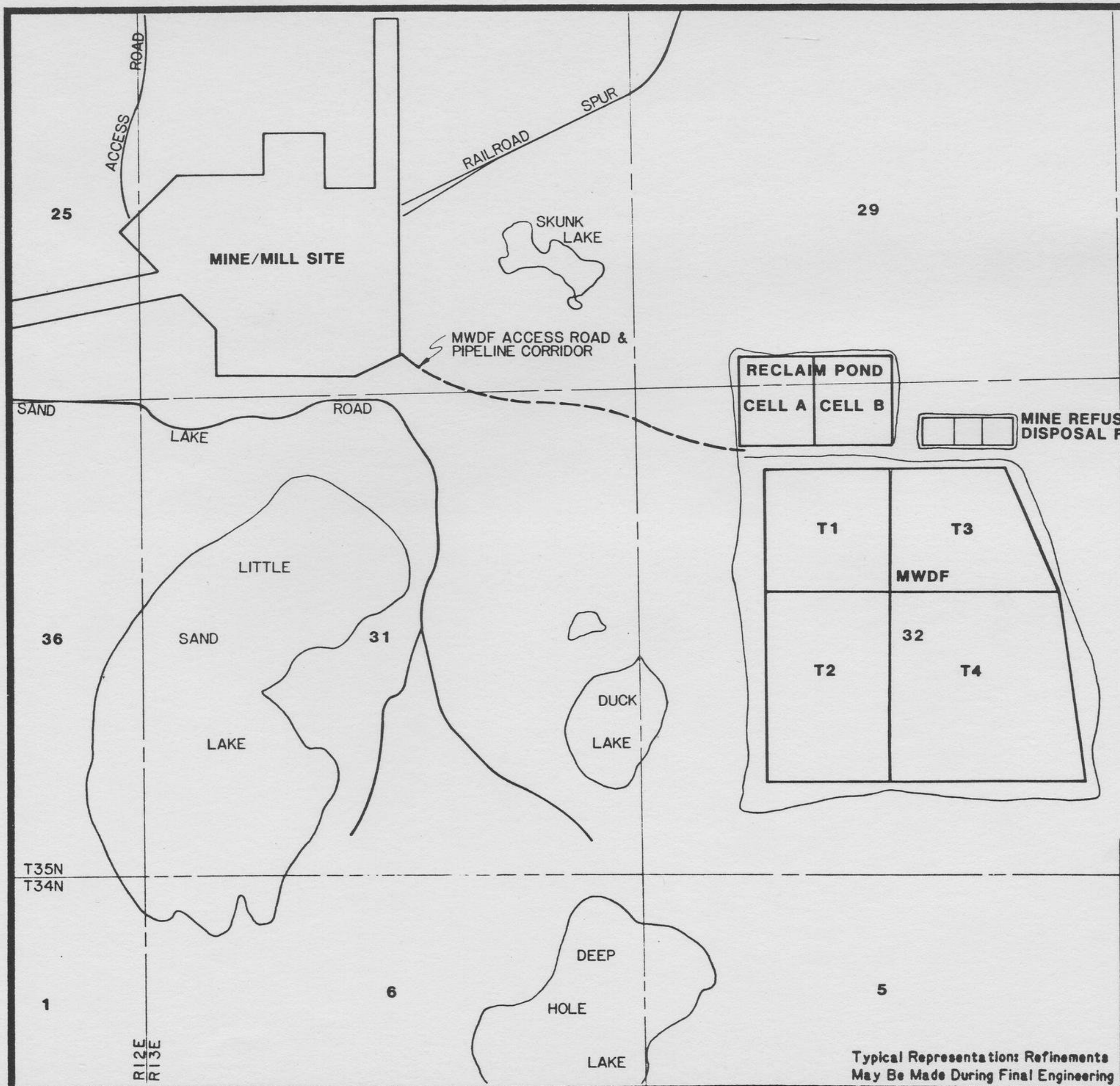
An environmental laboratory will provide monitoring capability including analyses of water discharge samples, samples from monitoring wells, and analysis of dust samples. Any biological studies required may be done by outside contractors.

1.2.3 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 1.2-22 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 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 340 acres. The four ponds will range in plan area between 60 and 135 acres and will be sequenced in construction, operation, and reclamation to accommodate the production of tailings from the mill.

The topography of the site area has been utilized in planning the layout of the tailing ponds and embankment locations. The topographic features affect the volume of earthwork required to construct the embankments and the soil volumes available for other uses in the facility. The existing topography is also an important aspect of the structural stability of the embankments and of the filled tailing



EXXON MINERALS COMPANY CRANDON PROJECT					
TITLE: MINE WASTE DISPOSAL FACILITY & RECLAIM POND LOCATION					
SCALE: SHOWN	STATE: WISCONSIN		COUNTY: FOREST		
DRAWN BY: DR SPRINGBORN	DATE: 7/84	CHECKED BY:		DATE:	
APPROVED BY:	DATE:	APPROVED BY: C.C. Schroeder		DATE: 11/85	
APPROVED BY:	DATE:	EXXON: D.T. More		DATE:	
DRAWING NO.: FIGURE 1.2-22		SHEET: OF:		REVISION NO.: 2	

ponds. Valleys or surface depressions are desirable areas for containment because of their structural stability; they also minimize the amount of earthwork required. The topographic features of the site area were used as much as possible in developing the proposed MWDF layout.

The facility has been designed to have an approximate earthwork balance during construction, operation, and closure; that is, 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 may require the development of a borrow area in the vicinity of the MWDF. Temporary storage of soil and other materials will also occur during the MWDF construction and operations.

1.2.3.1 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 1.2-7). 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, and it will be utilized as underground road material, mine backfill, and as rip-rap in the MWDF area. Separately located

TABLE 1.2-7

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.

surge piles will not be required for the waste rock at the MWDF. Waste rock will be delivered to the preproduction ore storage pad and reclaimed as needed for mine backfill or for rip-rap. About 5 percent of the mine waste will be used as rip-rap.

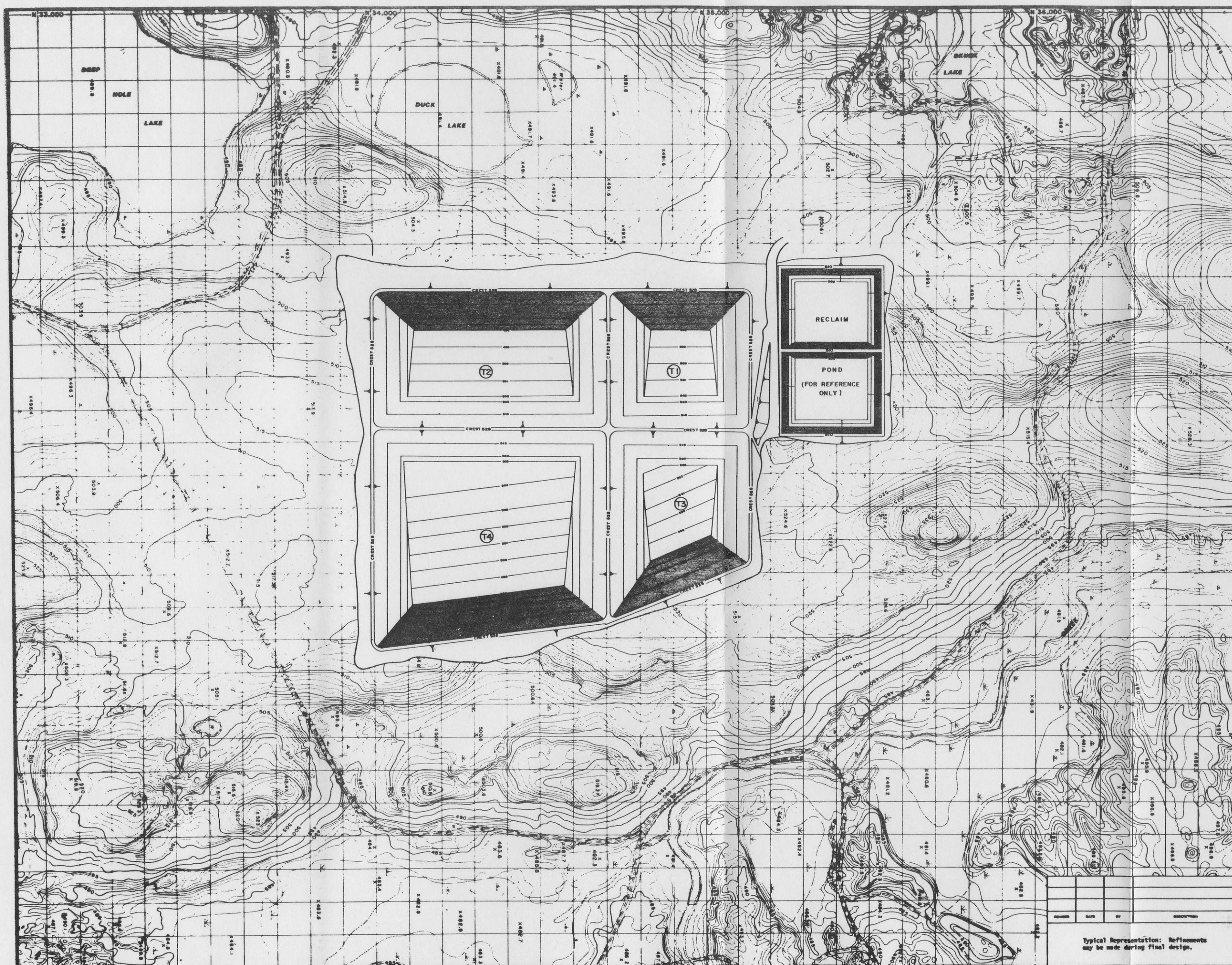
During early mine development, which occurs before the underground crusher is available, rock size will be about 24 inches or less in diameter. After the underground crusher is installed late in the construction period, waste rock hoisted to the surface will be crushed to approximately 8 inches or less 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.

1.2.3.2 Waste Rock Disposal

Waste rock volumes and approximate production schedule are presented in Table 1.2-7. 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 rip-rap in the MWDF area as depicted on Figure 1.2-23. 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.



LEGEND

- ROCK SLOPE PROTECTION
- (T2) POND NUMBER
- EMBANKMENT SLOPE

NOTE:

1) ROCK SLOPE PROTECTION DETAILS SHOWN ON PLAN SHEETS 22 & 23.

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.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
ROCK SLOPE PROTECTION PLAN

SCALE	STATE	COUNTY
AS SHOWN	WISCONSIN	FOREST

DRAWN BY: J.J.T. DATE: 10-4-85

DRAWING NO. FIGURE 1.2-23

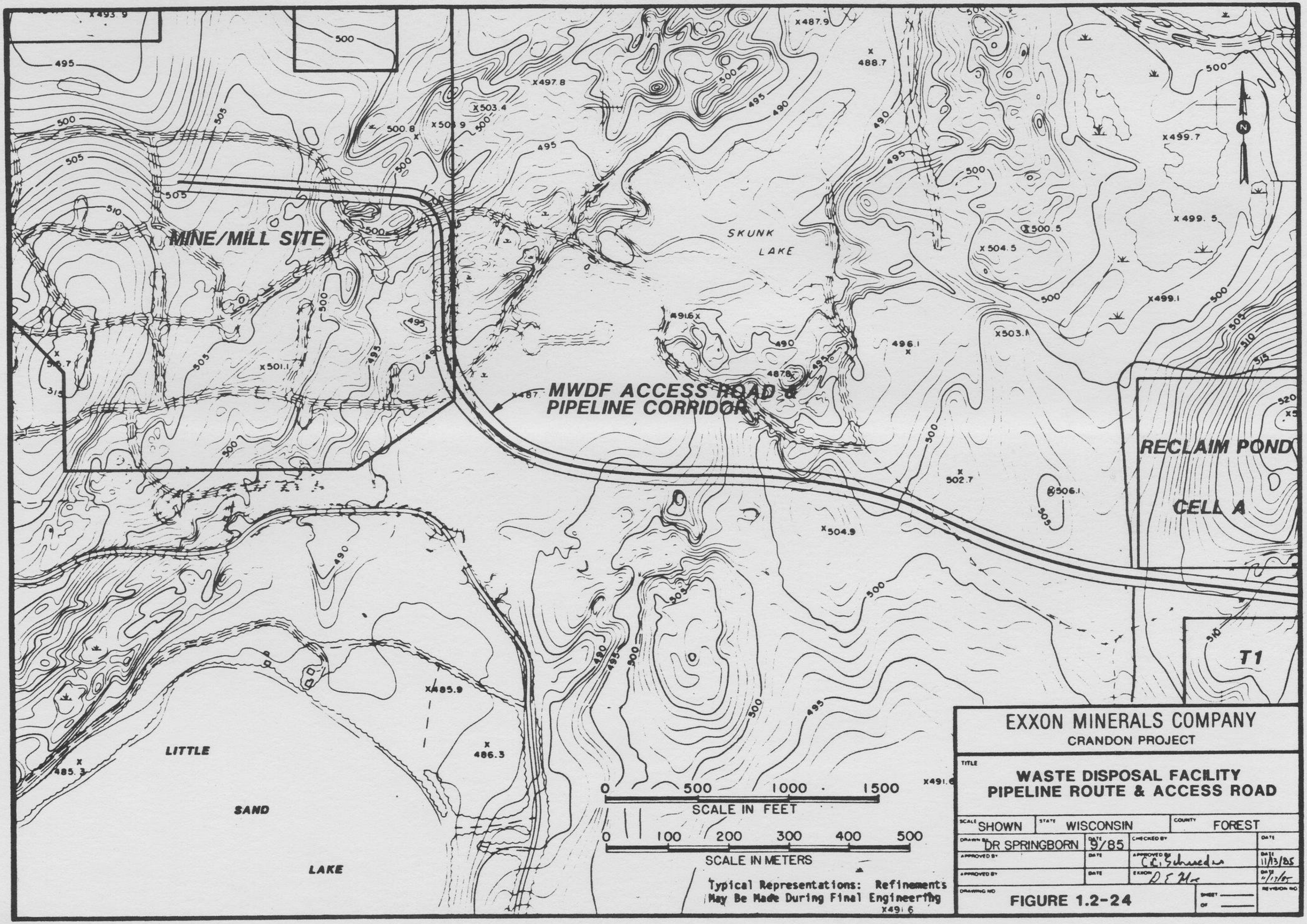
SHEET 24 OF 36

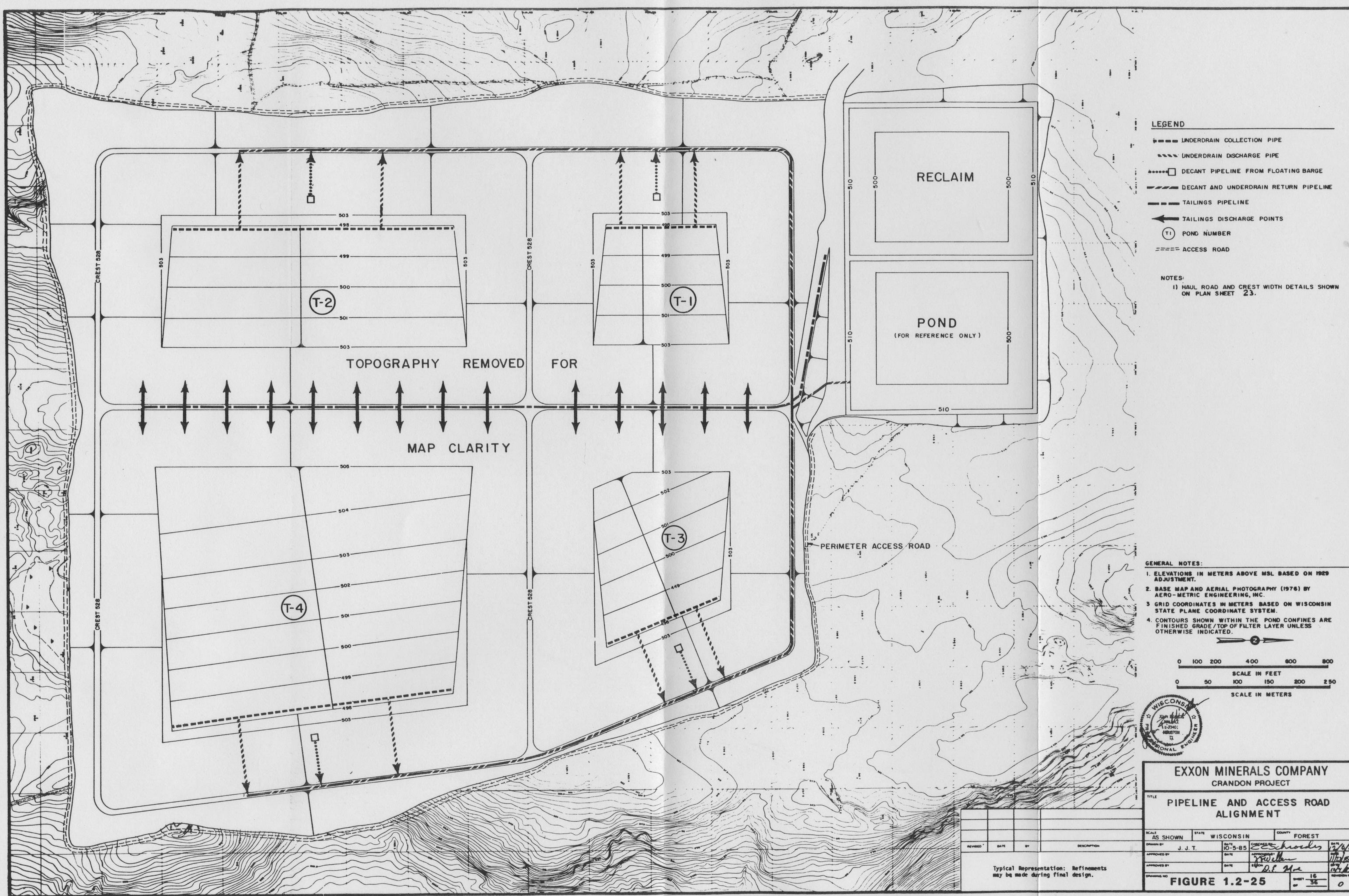
1.2.3.3 Tailings Transport and Reclaim Water Transfer

The tailings transport system will transfer the fine tailings by pipeline from the mill to the MWDF as a slurry. Figure 1.2-24 shows the proposed pipeline route. Pipes at the MWDF will be routed along the embankment crests as shown on Figure 1.2-25. The access road from the mine/mill area to the MWDF will share a common corridor with the pipeline system. From the eastern side of the mine/mill site to the southwest corner of the reclaim pond at the MWDF, the pipeline length is about 0.9 mile.

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. The access roads will be surfaced with crushed rock or granular materials to provide an all-weather surface. The access road alignments are shown on Figure 1.2-25. 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 access road to the MWDF will be 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 system will be


MINE/MILL SITE
MWDF ACCESS ROAD &
PIPELINE CORRIDOR
SKUNK
LAKE
RECLAIM POND
CELL A
T1
LITTLE
SAND
LAKE
x493.9
500
495
505
510
x497.8
x503.4
500.8
x487.9
488.7
490
x499.7
x499.5
x500.5
x504.5
x499.1
x491.6
496.1
x503.1
x501.1
x487
487.8
502.7
x506.1
x504.9
x485.9
486.3
485.3
x491.6
x491.6
520
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
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
WASTE DISPOSAL FACILITY
PIPELINE ROUTE & ACCESS ROAD
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
DATE 9/85
CHECKED BY
APPROVED BY
11/13/85
DRAWING NO
FIGURE 1.2-24
SHEET
OF
REVISION NO



RECLAIM
POND
(FOR REFERENCE ONLY)
T-1
T-2
T-3
T-4
CREST 528
TOPOGRAPHY REMOVED FOR
MAP CLARITY
PERIMETER ACCESS ROAD
LEGEND
UNDERDRAIN COLLECTION PIPE
UNDERDRAIN DISCHARGE PIPE
DECANT PIPELINE FROM FLOATING BARGE
DECANT AND UNDERDRAIN RETURN PIPELINE
TAILINGS PIPELINE
TAILINGS DISCHARGE POINTS
POND NUMBER
ACCESS ROAD
NOTES:
1) HAUL ROAD AND CREST WIDTH DETAILS SHOWN ON PLAN SHEET 23.
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.
SCALE IN FEET
SCALE IN METERS
WISCONSIN PROFESSIONAL ENGINEER
REVISED DATE BY DESCRIPTION
Typical Representation: Refinements may be made during final design.
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE PIPELINE AND ACCESS ROAD ALIGNMENT
SCALE AS SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY J. J. T.
DATE 10-5-85
DRAWING NO FIGURE 1.2-25
SHEET 16 OF 36
REVISION NO 0

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 with two operating pumps and two standby pumps. The pumps and piping system will handle approximately 555 gallons per minute of tailings slurry.

2) 15.0 inches inside diameter HDPE reclaim water return pipeline with one operating and one standby pump. The system will handle approximately 3,460 gallons per minute of water.

3) 15.0 inches inside diameter HDPE thickener overflow pipeline with one operating and one standby pump. The system will handle approximately 3,440 gallons per minute of water.

The HDPE pipe has been selected on the basis of its resistance to abrasion and corrosion. It is not affected by chemicals in the soil and does not support the growth of, and is not affected by, algae, bacteria and fungi.

With the pipe diameter chosen and planned tailings flow rates, the expected pipeline operating pressures are well below the rated allowable pipeline pressures.

To further 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. The trench will be over-excavated by 6 inches. The trench volume below the pipes will be backfilled with sand, gravel or other select material to support the pipe. Generally, the pipe bed material will be free of rock greater than 0.5 inch in size and will contain no jagged or soft rock.

After the pipe has been placed, it will be surrounded with compacted select material and backfilled with glacial till derived from trench excavation. Backfill will be compacted to about 85 percent of the maximum dry density as determined by American Society for Testing and Materials (ASTM) D-698 (Standard Compaction Test).

Instrument cable will be buried with the pipe. The cable will be used as a metal source for pipeline locating instruments.

Because the tailings ponds embankment berms are at a higher elevation than the pumping station and the discharge of tailings to the lower depths of the ponds could create a vacuum in the tailings line, a vacuum breaker will be installed at the high point of the pipeline on the tailings pond berm.

Because the pipeline will be buried, it will not be vulnerable to deliberate or accidental damage from humans, vehicles or machines. The depth of burial below the frost-line excludes the possibility of freezing. Rodent attack is unlikely at a depth of 6 feet.

Slurry characteristics determined by laboratory penetrometer testwork show that the solids are "soft-settling" (PSI, Inc., 1982). The results of the tests indicated that if the pipeline is shutdown during an emergency, the solids are soft-settling and can reslurry when the pipeline is restarted. During scheduled shutdowns of the pipeline, the solids will be flushed out with water prior to shutdown.

In the event of a sudden blockage of the pipeline, the slurry pumps will not be able to develop the pressure required to rupture the line. The increase in pipeline pressure and decreasing flowrate would activate alarms and the pipeline would be shutdown.

The technique for installation of the tailings transport, reclaim water, and thickener overflow water pipelines and the decant water pipelines from the tailing ponds is described in subsection 1.3.1.8.

Buried pipelines are inherently safer than pipelines constructed at grade. They are silent in operation and not visible. Typically, the trenched area will be seeded following final backfilling and grading and vegetative cover will be established within the first or second year after installation of the pipeline.

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 a 5,900-foot length of line would leak from the pipeline. This is equal to a volume of 10,170 gallons of slurry. Because of the low elevation heads, the rate of leakage would be low and little solid material would escape.

Clean-up would require excavation around the leak and the water and tailings would be transported to the MWDF. Repair would involve the removal of the damaged pipe and welding in new pipe. The repaired pipeline would be leak tested using water before backfilling and returning the pipeline to normal service.

Spare sections of each size of pipe would be retained in storage for repair purposes.

Pipeline leaks in conventional flanged or mechanically coupled pipelines typically occur at the flanges or in areas of the pipe where sudden changes in direction are necessary. The use of welded plastic pipe eliminates the flange or other connections and reduces the possibility of leakage. Typically, HDPE pipe can be cold bent to a minimum radius of 25 times the pipe diameter. This allows gradual direction changes to be made thus reducing the possibility of pipe wall erosion and minimizing the potential for leaks.

1.2.3.4 Tailings Disposal

Waste Volume - The size of the MWDF is based on the amount of tailings that cannot be returned to the mine. The Crandon Project 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 11,410 acre-feet has been calculated.

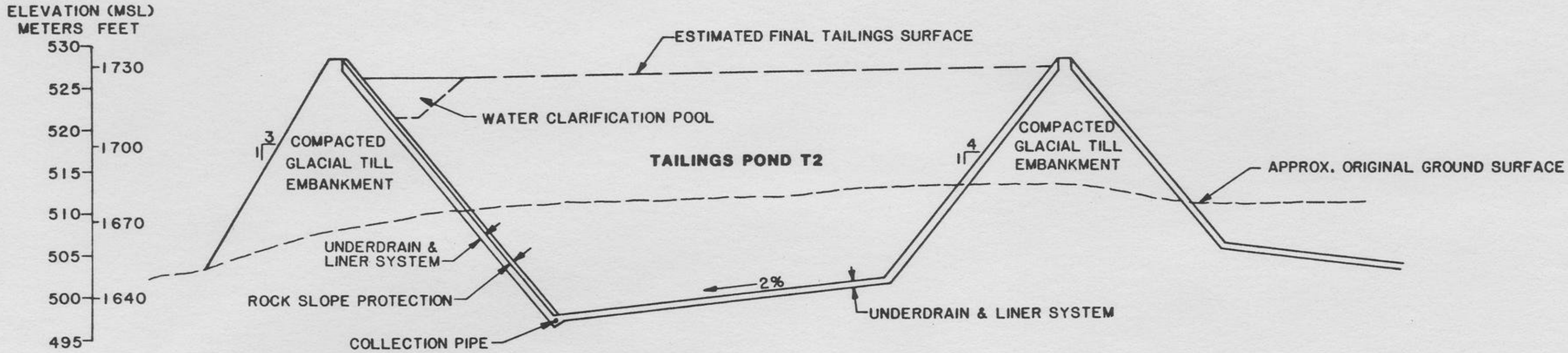
In addition to the fine tailings, the design has allowed for an additional 200 acre-feet for the sludges produced from the water treatment process. Allowing for this 200 acre-feet of sludge, a total waste storage volume of 11,610 acre-feet will be provided.

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 13,120 acre-feet.

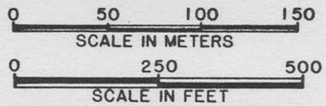
Freeboard above the normal water level when the pond is full has been designed to meet the requirements of NR 182. Calculations by Golder Associates (1982), according to the requirements of NR 182.11(1)(q), indicated that a 3-foot freeboard was sufficient to prevent overtopping of waves for the 100-year, 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 1.2-26.

Mine Waste Disposal Facility Location and Design - An area approximately 1.5 miles southeast of the mine/mill site will be used for the MWDF. This area primarily lies in Section 32, T35N, R13E in Forest County (see Figure 1.2-22).

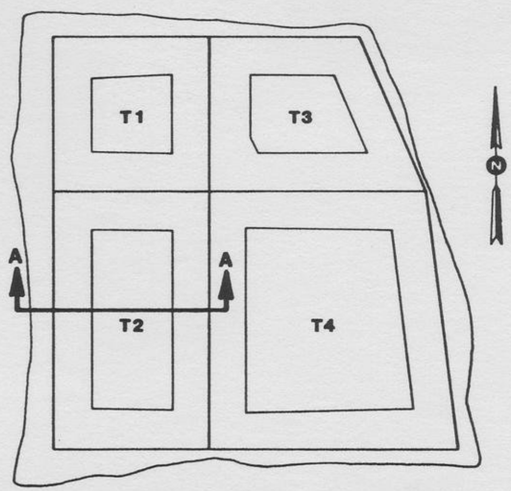
The major characteristics of this area (designated Area 41) are: (1) an extensive upper soil layer of relatively low permeability till; (2) low ground water gradients; (3) the depth from the existing ground level to the main ground water table averages approximately 100 feet; and (4) no domestic use of ground water within the compliance boundary area of the MWDF. With the distance from pond bottom to ground water of approximately 50 feet, any pond seepage from the MWDF will have to pass through a large volume of soils with considerable attenuation potential. Soil attenuation is specifically addressed in the Soil Attenuation Study - Final Report (D'Appolonia, 1982). This report includes information on the attenuation of chemical constituents in tailings leachate with Crandon site till and drift soils.



SECTION A-A



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. [illegible]	DATE 11/13/85
DRAWING NO **FIGURE 1.2-26**		SHEET ___ OF ___	REVISION NO

The design layout for the MWDF is shown on Figure 1.2-22. 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. 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.

An analysis has been performed to assess the safety of the embankment design. The technical studies included evaluations of the stability of the embankment slopes under both static and seismic conditions and the design freeboard which is influenced by precipitation, wind velocity, and process shutdown (Golder Associates, 1982).

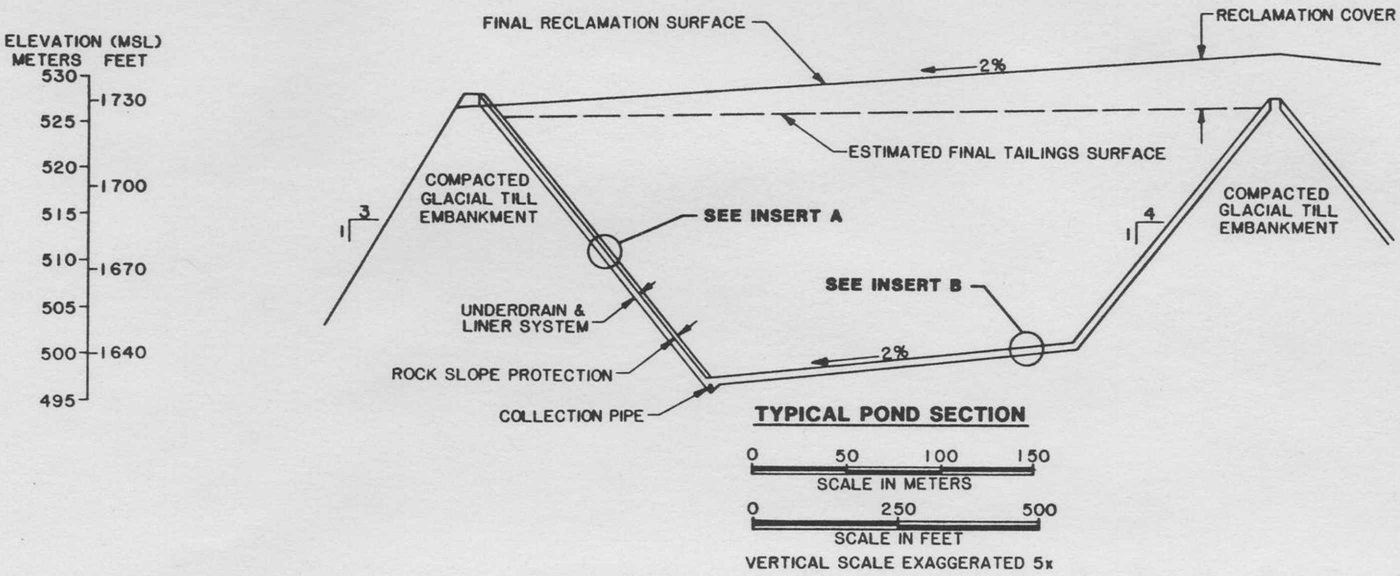
The stability analysis of the design slopes indicates that the minimum factors of safety for static and seismic conditions are 2.1 and 1.8, respectively. The stability analysis was conducted with conservative assumptions about the geometry and material properties of the embankment system. The major assumptions were: (1) the entire depth of the tailing ponds is in a liquid state with no shear strength; (2) seepage from the tailing ponds will saturate large portions of the embankment and induce major seepage forces; and (3) seismic forces of 0.06 g were applied on the basis of the possibility of 6 percent horizontal ground acceleration (Golder Associates, 1982). Using these assumptions, a simplified Bishop's method of analysis was applied to the slope geometry to assess the impact of all the physical parameters on the locally saturated system (Golder Associates, 1982). As previously described, the safety factors against both deep or shallow slope failure exceeded 1.8 in all cases (even under seismic accelerations) for the proposed embankment design, indicating that the slopes are stable.

Specific individual pond design data are included below:

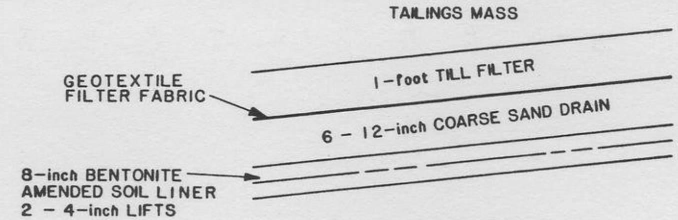
MWDF INDIVIDUAL POND DATA

Pond Data/Pond Number	Tailing Ponds			
	T1	T2	T3	T4
Area Inside Crest (acres)	43	71	50	107
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
Tailings Storage Volume (acre-feet)	1,920	3,560	2,270	5,640

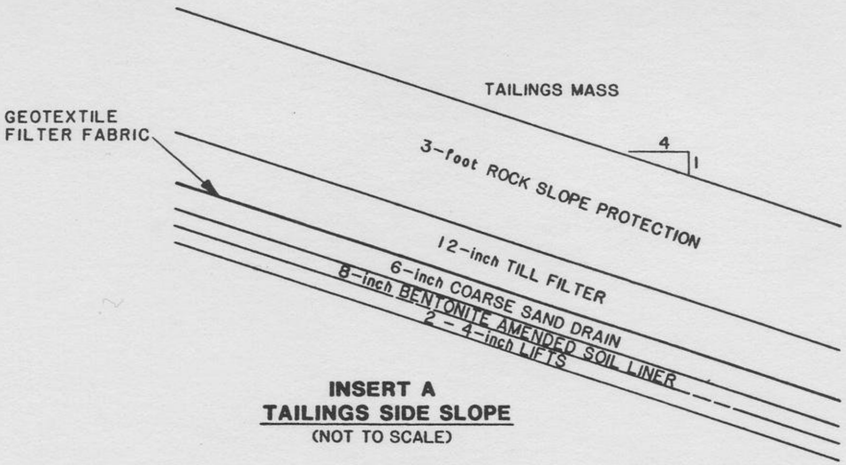
Seepage Control System - All of the ponds will utilize an underdrain system below the tailings to collect and remove seepage water. The underdrain system will be underlain by a bentonite modified soil liner. Figure 1.2-27 shows a configuration of the underdrain system with a filter layer, a drain layer, and the bentonite modified soil liner.



TYPICAL POND SECTION



INSERT B
TAILINGS POND BOTTOM
(NOT TO SCALE)



INSERT A
TAILINGS SIDE SLOPE
(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.T. [illegible]	DATE 11/13/85
DRAWING NO FIGURE 1.2-27		SHEET ___ OF ___	REVISION NO

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.

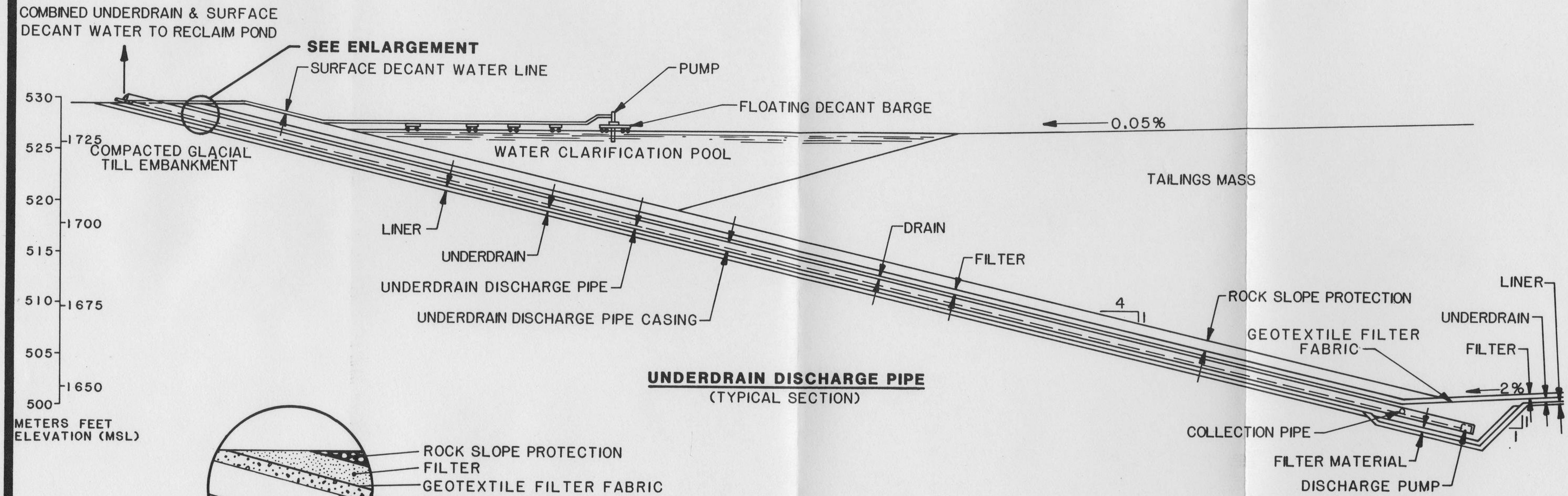
The base of the tailing disposal ponds and the bentonite modified soil liner has been designed to slope at a 2 percent grade from the common internal embankment toward the upstream toe of the external embankment. The underdrain collection pipelines located along the upstream toe of the outside tailing pond embankments facilitate collection of drainage from the embankment drain layer. The perforated collection pipes 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 locations of these pipelines are shown on Figure 1.2-25.

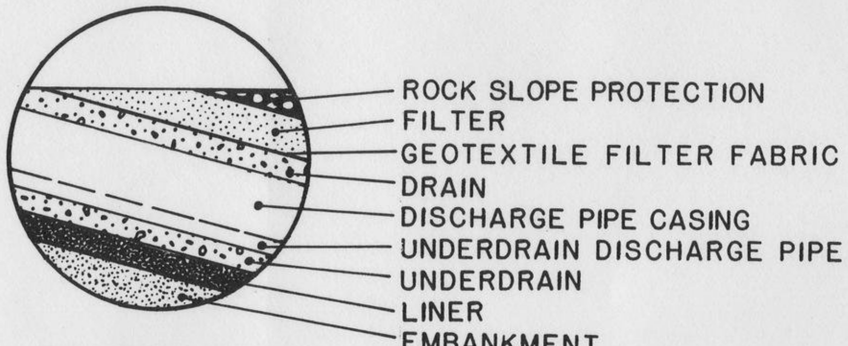
The thicknesses shown for the filter and drain layers, 12 inches and 6 to 12 inches, respectively, have been conservatively chosen to satisfy all design requirements and to also provide an adequate protective cover thickness for the liner. The bentonite modified soil liner thickness, 8 inches, and the construction procedures (see subsection 1.3.1.7) have 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 1.2-28. 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.

Tailing Pond Surge Capacity - 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 the reclaim ponds was not sufficient, the tailing ponds could be used to temporarily store water.

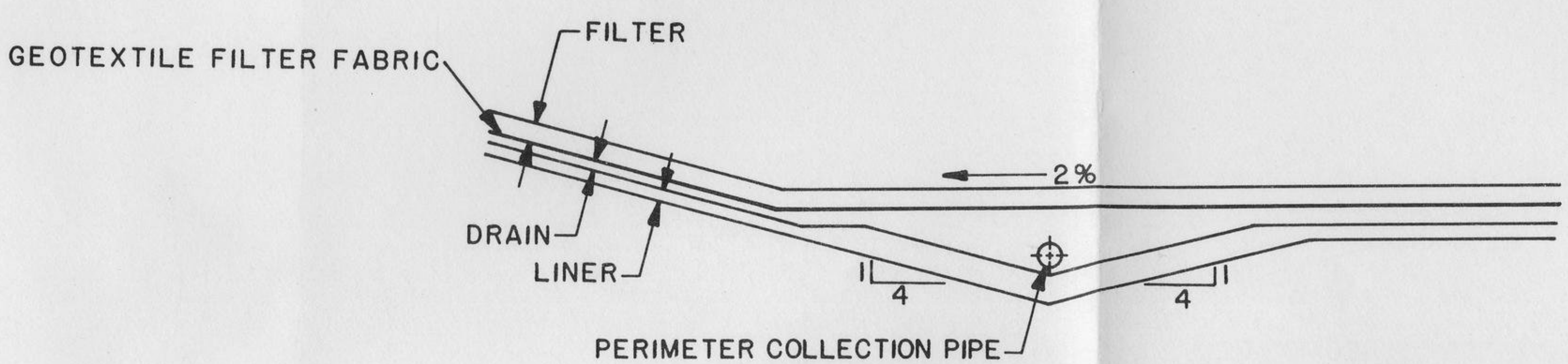
To use the tailing ponds storage capacity and maintain low seepage rates, pumping of the underdrains would continue with underdrain water circulated back to the tailing ponds. Then, depending upon the rate of decant water pumping, water level in a tailing pond could be increased to accommodate surge storage requirements. As the ponded water depth is increased, an increase in the underdrain flow rate would occur. However, the design of the underdrain system is sufficient to accommodate these potential emergency situations. If the underdrains were not pumped, they would flood. This would temporarily increase seepage, but it would not affect the integrity of the facility, nor reduce the stability of the embankments.



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: NONE	STATE: WISCONSIN	COUNTY: FOREST
DRAWN BY: DR SPRINGBORN	DATE: 10/85	CHECKED BY: / DATE:
APPROVED BY:	DATE:	APPROVED BY: C.C. Schroeder / DATE: 1/85
APPROVED BY:	DATE:	EXXON: J.E. M— / DATE: 11/13/85
DRAWING NO: FIGURE 1.2-28	SHEET ___ OF ___	REVISION NO.

Tailings deposited underwater would initially have approximately 10 percent less density than the previously deposited tailings. However, through future consolidation when surge waters are removed, most of this density loss will be regained such that the overall tailings volume change within the pond would be negligible.

Tailing pond T3 has the smallest surge capacity of the four ponds. Its lowest surge capacity (at completion of tails deposition) is approximately 16 acre-feet from the tailings surface to a level surface 3 feet below the pond crest. At a water flow rate of 2,500 gallons per minute, this volume represents about 1.5 days of surge capacity. The total minimum surge capacity (i.e., tailing pond T3 and reclaim pond surge storage) would be approximately 20 days at a 2,500 gallons per minute flow rate.

1.2.3.5 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 mature 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.

Sodium sulfate, or salt cake as it is commercially known, is consumed by Kraft pulp and paper mills. Wisconsin has three Kraft pulp mills which consume a total of 31 tons per day of salt cake.

Wisconsin Kraft Pulp Mills

Company	Location	Salt Cake Consumption (tons/day)
Mosinee	Mosinee	3
Nekoosa	Nekoosa	4
Thilmany	Kaukauna	24*

* 30 tons per day of Copeland sulfate (80% Na_2SO_4, 20% Na_2CO_3) equivalent to 24 tons per day of pure Na_2SO_4.

An additional 22 tons per day of salt cake is projected to be consumed in the states of Minnesota and Michigan and the Canadian provinces of Manitoba and Ontario.

The frequency of transportation of salt cake to Kraft pulp mills would depend up on the mode of transportation and location of the mill. Assuming approximately 25-ton shipments, then shipments would be required approximately twice a week.

Prior to sodium sulfate crystallization (removal of soluble impurities), the nearly saturated sulfate solution exiting the VCE unit will be lime neutralized and then clarified to remove insoluble impurities (heavy metals). This post treatment of the VCE brine ensures a marketable salt cake or a non-hazardous secure landfill disposal option. If the sodium sulfate can not be sold and disposal of this material becomes necessary, provisions have been made to allow the placement of the sodium sulfate in isolated cells within the MWDF. A detailed description of the sodium sulfate disposal is given in the MWDF Feasibility Report.

1.2.3.6 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 2.8 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.

Aside from the conservative sludge estimates, the operation of the tailings pond decant system offers a degree of control on the clarity of the water returned to the reclaim ponds. Some additional ponding with increased retention time in the tailings ponds could reduce suspended solids in the decant water.

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.

1.2.4 Ancillary Facilities

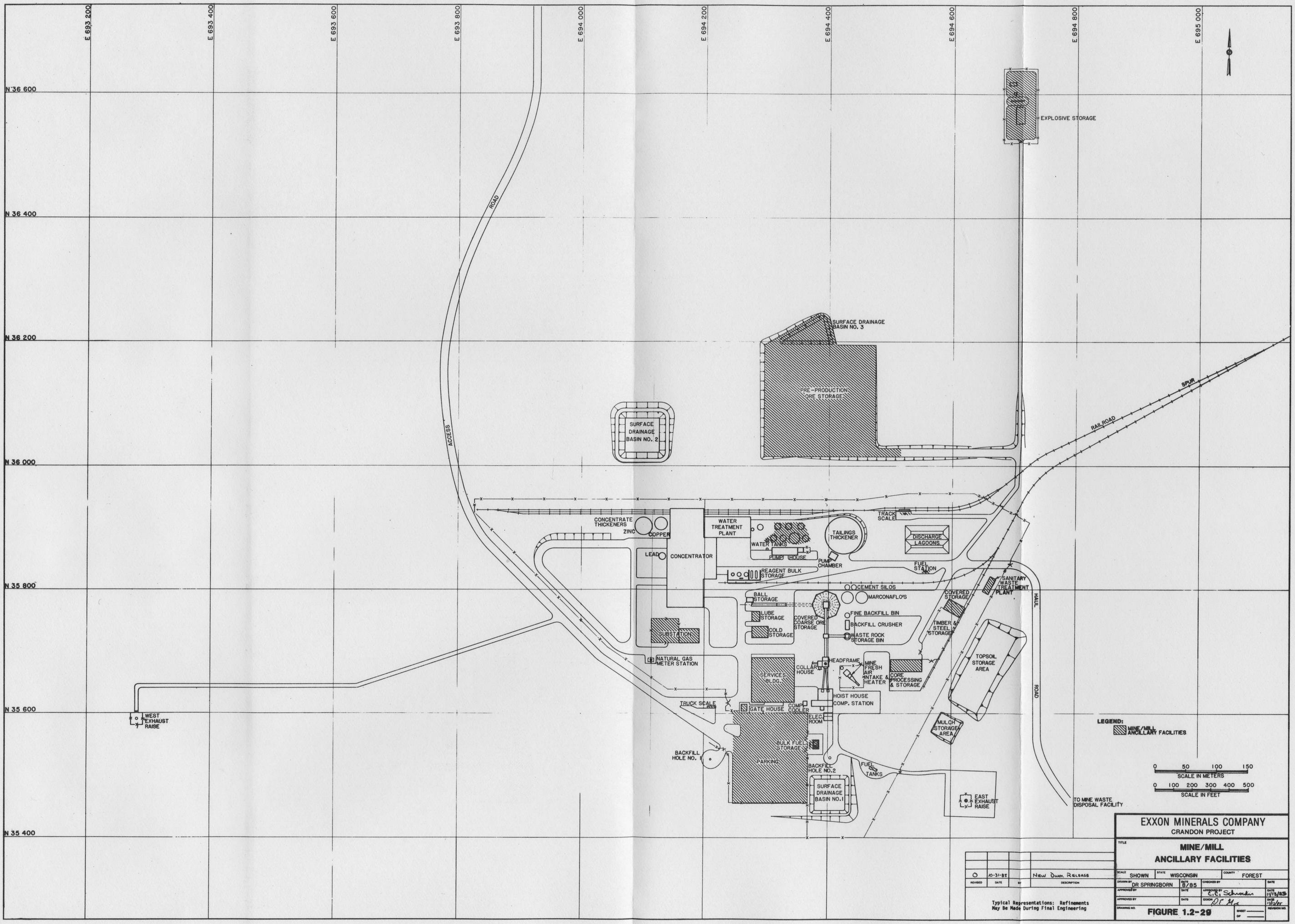
Ancillary facilities include the services building, fuel storage handling, water treatment and water distribution systems, sanitary waste treatment facility, explosives magazines, and transportation and power distribution facilities required to support the operation of the mine/mill complex. These facilities are all shown on Figure 1.2-29. 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.

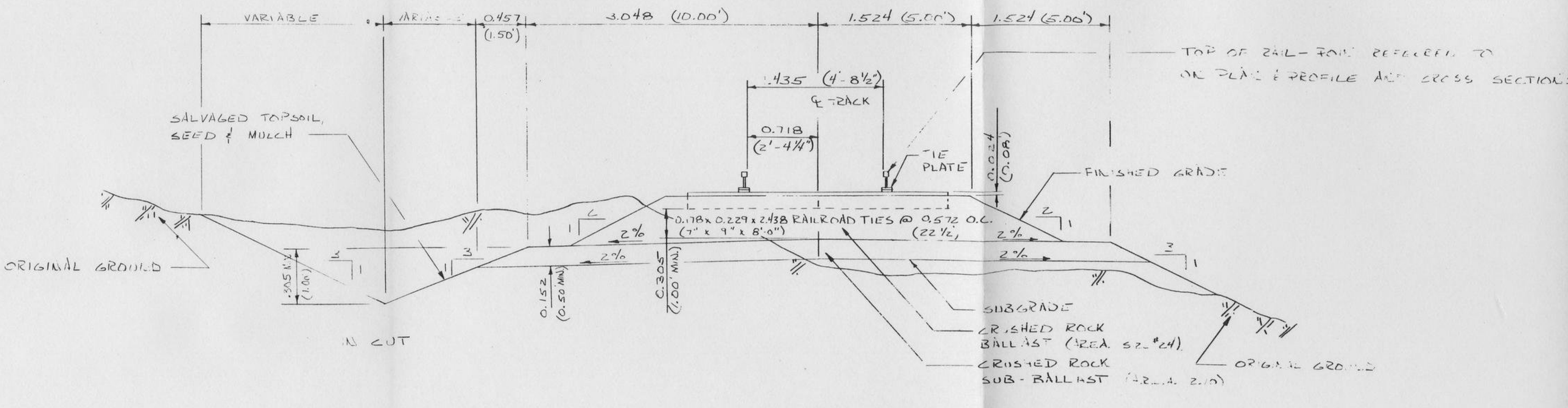
1.2.4.1 Rail Spur

A railroad system will be required to service the mine/mill site. The rail spur will be routed from a main 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 (see Chapter 3, Figures 3.4-8 and 3.4-9). A single span bridge to carry the track over Swamp Creek will be constructed of prestressed concrete girders supported on concrete abutments.

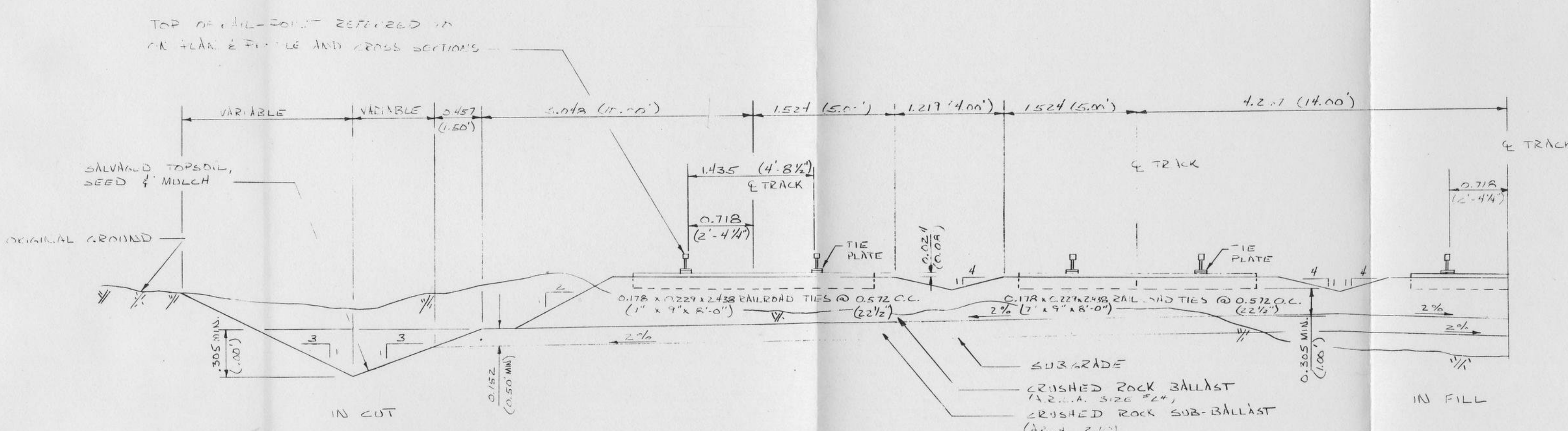
Track will be provided in the mine/mill complex as shown on Figure 1.2-29 for concentrate loading and handling of bulk materials and supplies. A locomotive will be used to move railcars within the mine/mill site and between the site and sidings.

Figures 1.2-30, 1.2-31 and 1.2-32, taken from the set of preliminary engineering drawings for the railroad spur (Foth and Van


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
EXPLOSIVE STORAGE
ACCESS ROAD
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
TAILINGS THICKENER
PUMP CHAMBER
TRACK SCALE
DISCHARGE LAGOONS
FUEL STATION
REAGENT BULK STORAGE
SANITARY WASTE TREATMENT PLANT
CEMENT SILOS
MARCONAFLO'S
COVERED STORAGE
HAUL ROAD
BALL STORAGE
LUBE STORAGE
COLD STORAGE
COVERED COARSE ORE STORAGE
FINE BACKFILL BIN
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN
TIMBER & STEEL STORAGE
SUBSTATION
NATURAL GAS METER STATION
TOPSOIL STORAGE AREA
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
WEST EXHAUST RAISE
MULCH STORAGE AREA
LEGEND:
MINE/MILL ANCILLARY FACILITIES
BACKFILL HOLE NO. 1
BULK FUEL STORAGE
PARKING
BACKFILL HOLE NO.2
FUEL TANKS
SURFACE DRAINAGE BASIN NO.1
EAST EXHAUST RAISE
TO MINE WASTE DISPOSAL FACILITY
0 50 100 150
SCALE IN METERS
0 100 200 300 400 500
SCALE IN FEET
0 10-31-85 New Dwg. Release
REVISED DATE BY DESCRIPTION
Typical Representations: Refinements May Be Made During Final Engineering
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
MINE/MILL
ANCILLARY FACILITIES
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
DATE 8/85
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 1.2-29
SHEET
OF
REVISION NO.



SINGLE TRACK SECTION



MULTI-TRACK SECTION

Typical Representation: Refinements May Be Made During Final Engineering

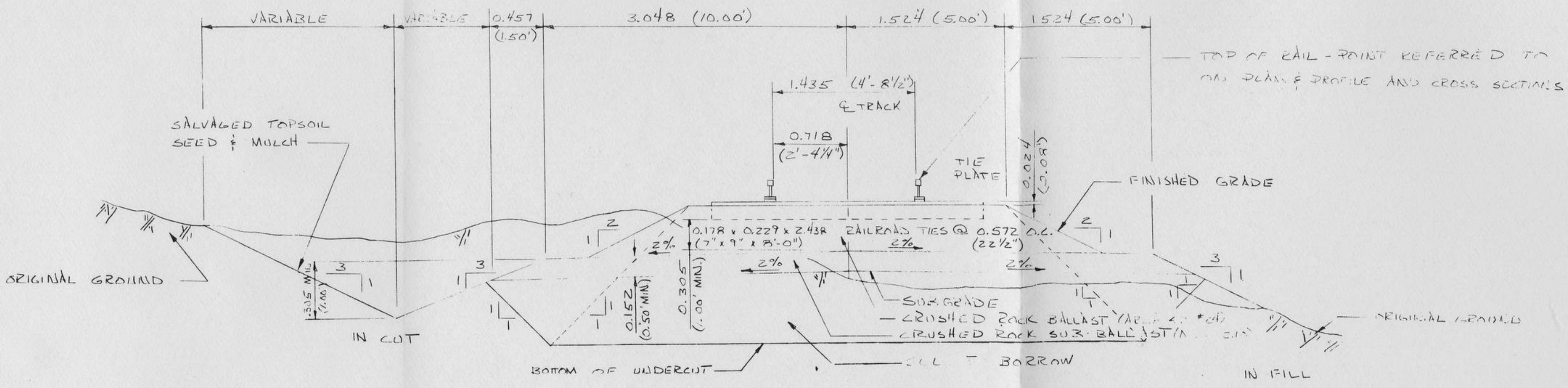
REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **RAILROAD SPUR TYPICAL SECTIONS**			
SCALE: NONE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: M.J.O.	DATE: 1-9-81	CHECKED BY: J.M.M., P.R.W.	DATE: 12-81
APPROVED BY: P.R.W.	DATE: 2-81	APPROVED BY: T.J.T.	DATE: 2-81
APPROVED BY	DATE	EXXON: D.S. Moe	DATE: 11/85
DRAWING NO.: **FIGURE 1.2-30**	SHEET / OF		REVISION NO.

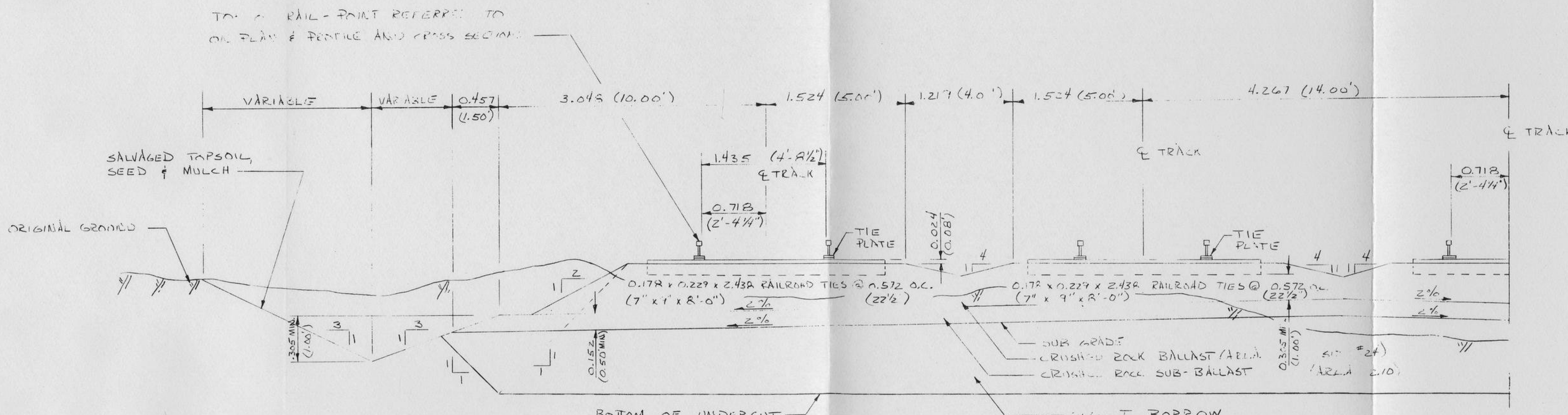
B-PE-0314

GBB 5/1981



SINGLE TRACK SECTION UNDERCUT (E.B.S.)

NOTE: DEPTH OF UNDERCUT IS [illegible] TO [illegible] [illegible] FROST [illegible] [illegible] SUSCEPTIBLE SOILS [illegible] TRACK SECTIONS.



MULTI-TRACK SECTION UNDERCUT (E.B.S.)

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **RAILROAD SPUR TYPICAL SECTIONS**

SCALE: NONE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: M.J.D.	DATE: 4-30-81	CHECKED BY: J.M.M., R.W.	DATE: 12-81
APPROVED BY: R.W.	DATE: 12-81	APPROVED BY: J.J.	DATE: 12-81
APPROVED BY:	DATE:	EXXON: B.E. Moe	11/85

DRAWING NO. FIGURE 1.2-31

B-PE-0315

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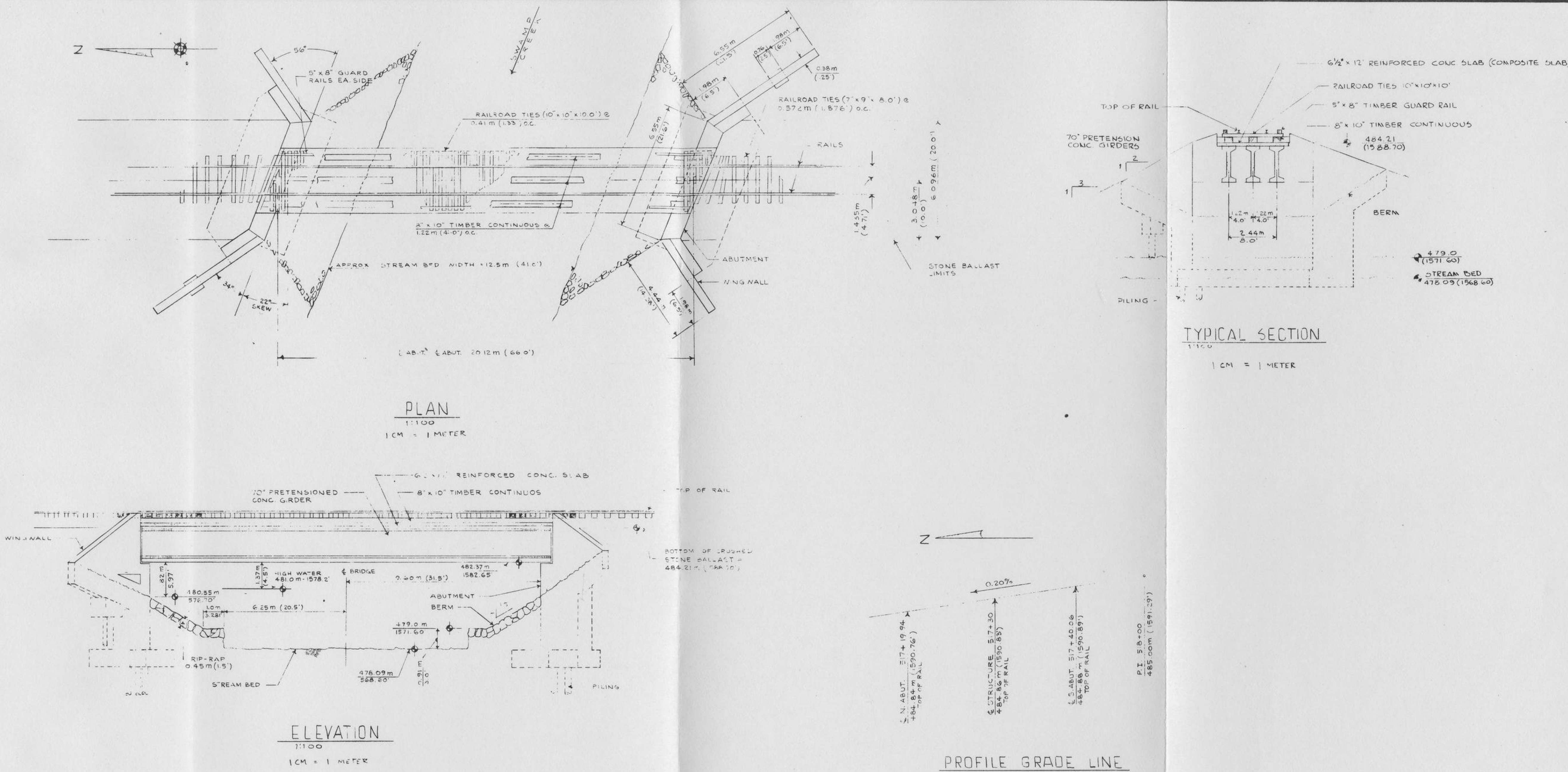


Typical Representation: Refinements May Be Made During Final Engineering

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE	**RAILROAD SPUR SWAMP CREEK BRIDGE GENERAL PLAN**		
SCALE As SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY H.W	DATE 11-81	CHECKED BY W.G.T., K.A.E.	DATE 12 81
APPROVED BY K.A.E.	DATE 12 81	APPROVED BY	DATE
APPROVED BY	DATE	EXXON D.E. Moe	DATE 11/85
DRAWING NO **FIGURE 1.2-32**	SHEET OF		REVISION NO

GBB 5/1981

BPE-0331

Dyke Associates, 1982a), provide details of the railroad cross-section and the bridge structure crossing Swamp Creek.

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 control of vegetation in the right-of-way. The ballast section will be kept free of vegetation, either through use of EPA-approved chemical herbicides or other means. Undesirable weeds or brush within other areas of the right-of way will be controlled by mowing or through use of EPA-approved chemical herbicides or other means.

The railroad right-of-way will be periodically inspected to ensure all vegetated areas are stabilized and are effectively controlling erosion. If any areas within the right-of-way show signs of erosion, measures will be taken to regrade the affected area and establish vegetative cover.

1.2.4.2 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.

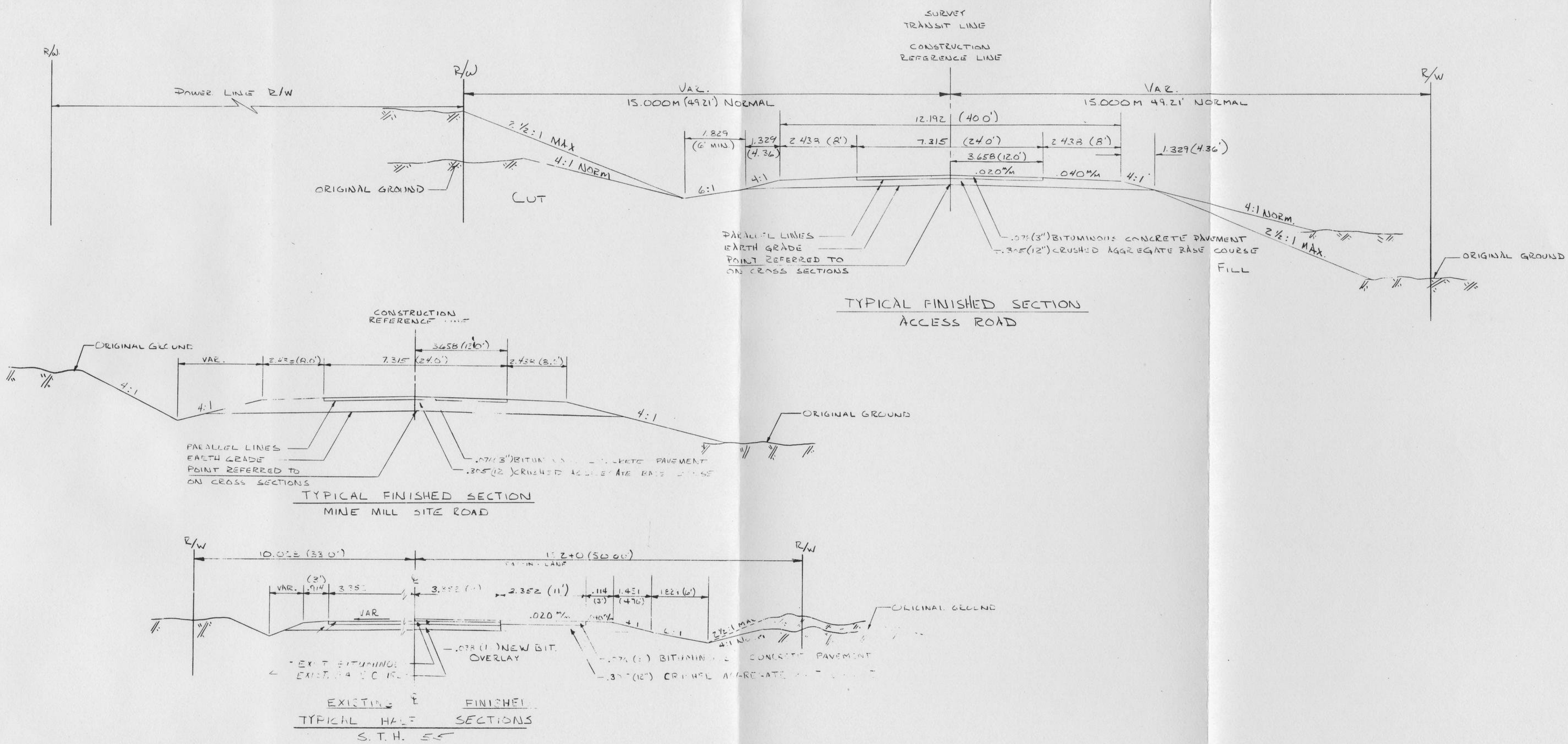
The road will connect with State Highway 55 and proceed in a southeasterly direction for 3.0 miles to the mine/mill site (see Chapter 3, Figure 3.4-10). The road will be contained in a 100-foot wide corridor. The main electrical power line to the mine/mill site will be located adjacent to the road and will require a similar corridor width. Clear cutting of the powerline corridor is not expected to be required.

Figures 1.2-33 and 1.2-34, taken from the set of preliminary engineering drawings for the access road (Foth and Van Dyke Associates, 1982b), provide details of the road cross-section and the bridge structure crossing Swamp Creek. As the cross-section indicates, 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.

The proposed width of the access road was selected to provide the greatest safety and operating standards. In winter weather the proposed roadway and shoulder width will allow for snow plowing operations and ability to maintain an open road. Also, with a stalled vehicle or an accident, traffic can be more easily maintained with this proposed width. These considerations are important since most of the traffic for the Project will occur during the three shift changes each day. An interruption to traffic flow during one of the shift changes might affect operations.

1.2.4.3 Parking and Gate House

The employee and visitor parking area will be located south of the services building. The parking area will accommodate a total of 480 vehicles. The parking area will have a Class C asphalt paving with



Typical Representation: Refinements May Be Made During Final Engineering

REVISED	DATE	BY	DESCRIPTION
1	8-18-81	P.R.W.	
2	7-15-82	P.R.W.	TYPICAL SECTION-ACCESS ROAD

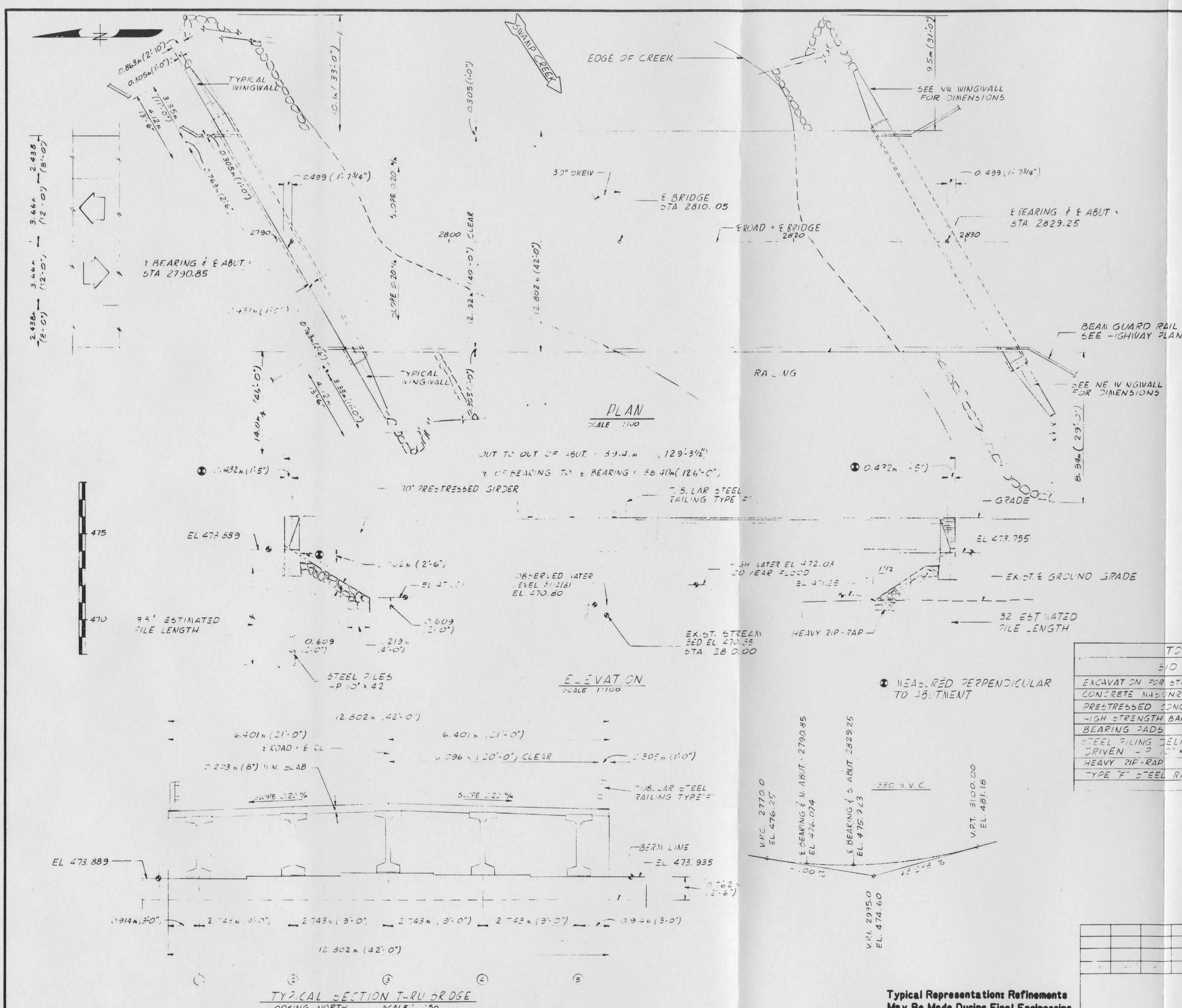
EXXON MINERALS COMPANY, U.S.A.
CRANDON PROJECT

TITLE **ACCESS ROAD TYPICAL SECTIONS**

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY M.J.O.	DATE 5-13	CHECKED BY J.G.L.	DATE 8-6-82
APPROVED BY P.R.W.	DATE 8-6-82	APPROVED BY	DATE
APPROVED BY TJJ	DATE 8-6-82	EXXON D.E. Moe	DATE 11/85
DRAWING NO. **FIGURE 1.2-33**		SHEET OF	REVISION NO.

051-115-C-002

DESIGN PRODUCTS CO.



TOTAL ESTIMATED QUANTITIES					
BID ITEMS	UNIT	N ABUT.	S ABUT.	SUPER	TOTAL
EXCAVATION FOR STRUCTURES	L.S.				
CONCRETE MASONRY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PRESTRESSED CONC. GIRDER 70"	L.M.(L.F.)	—	—	[illegible]	[illegible]
HIGH STRENGTH BAR STEEL REINF'G	L.B.S.	(BY FINAL DESIGN)			
BEARING PADS	L.S.				
STEEL PILING DELIVERED AND DRIVEN - HP 10" x 42, 32'	[illegible]	[illegible]	[illegible]	—	[illegible]
HEAVY RIP-RAP				—	[illegible]
TYPE "F" STEEL RAILING	[illegible]	—	—	[illegible]	[illegible]

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

ACCESS ROAD
SWAMP CREEK BRIDGE
GENERAL PLAN

AS SHOWN	WISCONSIN	FOREST	
W.L.Y.	7/82		
		K.A.E.	
		D.E. Moe	11/85

FIGURE 1.2-34

051-115-C-017

GBS 5/1981

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.

1.2.4.4 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.

1.2.4.5 Lubricant Storage, Cold Storage, and Covered Storage

The lubricant storage and cold storage buildings will be located east and south of the crushing and screening area of the mill (Figure 1.2-29). 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. Lubricants, paints, and cleaning materials for the mine and mill will be stored in this building. 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.

The 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.

The 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 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.

1.2.4.6 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 formaldehyde and perfume used in the chemical toilet control solutions will be in dilute concentrations compatible with 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 1.2-29.

The 16 gallons per minute estimate was developed from the current work force and visitor estimate of 650 people spread over three shifts. Following Wisconsin Administrative Code H63.15(3)(C)2, a total per day per person sanitary sewage waste generation rate of 35 gallons, (20 gallons sanitary waste and 15 gallons for showers) was assumed. Using these criteria and adding 750 gallons per day of base flow (per code), the total daily sanitary sewage flow is estimated to be 23,500 gallons or 16 gallons per minute.

Normal average BOD and TSS loadings are 0.17 and 0.20 pounds per capita per 24-hour day, respectively (NR 110.15). For the Crandon Project, based on an all adult work force and a total 9 to 10 hour daily period per person at the Project, BOD and TSS loadings are estimated at 0.10 and 0.14 pounds per employee per day, respectively.

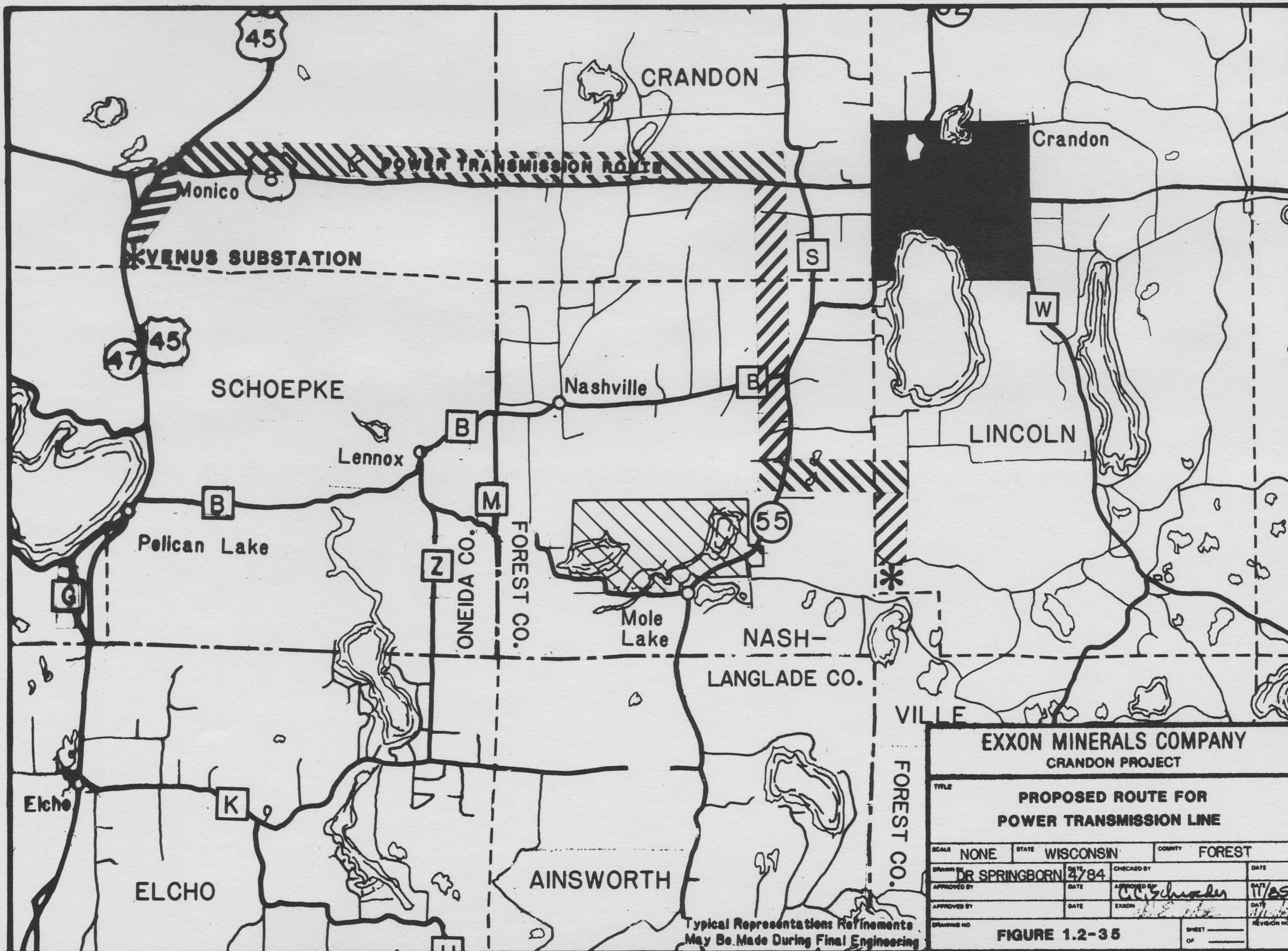
Sludge generated in the treatment plant will be transferred frequently from the sludge zone in the plant to the separate sludge holding tank. Sludge removal and disposal from the separate, larger tank will be handled by a licensed private contractor. The tank will be sized to allow 1 to 2 months accumulation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

Additional information on the proposed sanitary waste facilities is included with the facilities plans for the sewerage treatment system prepared for the Project following NR 110.09.

1.2.4.7 Power Supply Facilities

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 1.2-29). The main substation will include terminating structures, switching structures, power circuit breakers, and two 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 Crandon Project. 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 1.2-35. Wisconsin Public Service Corporation 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.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE

PROPOSED ROUTE FOR POWER TRANSMISSION LINE

SCALE NONE | STATE WISCONSIN | COUNTY FOREST

DRAWN BY DR SPRINGBORN | DATE 4/84 | CHECKED BY | DATE

APPROVED BY | DATE | APPROVED BY | DATE

APPROVED BY | DATE | EXXON | DATE

DRAWING NO | **FIGURE 1.2-35** | SHEET OF | REVISION NO

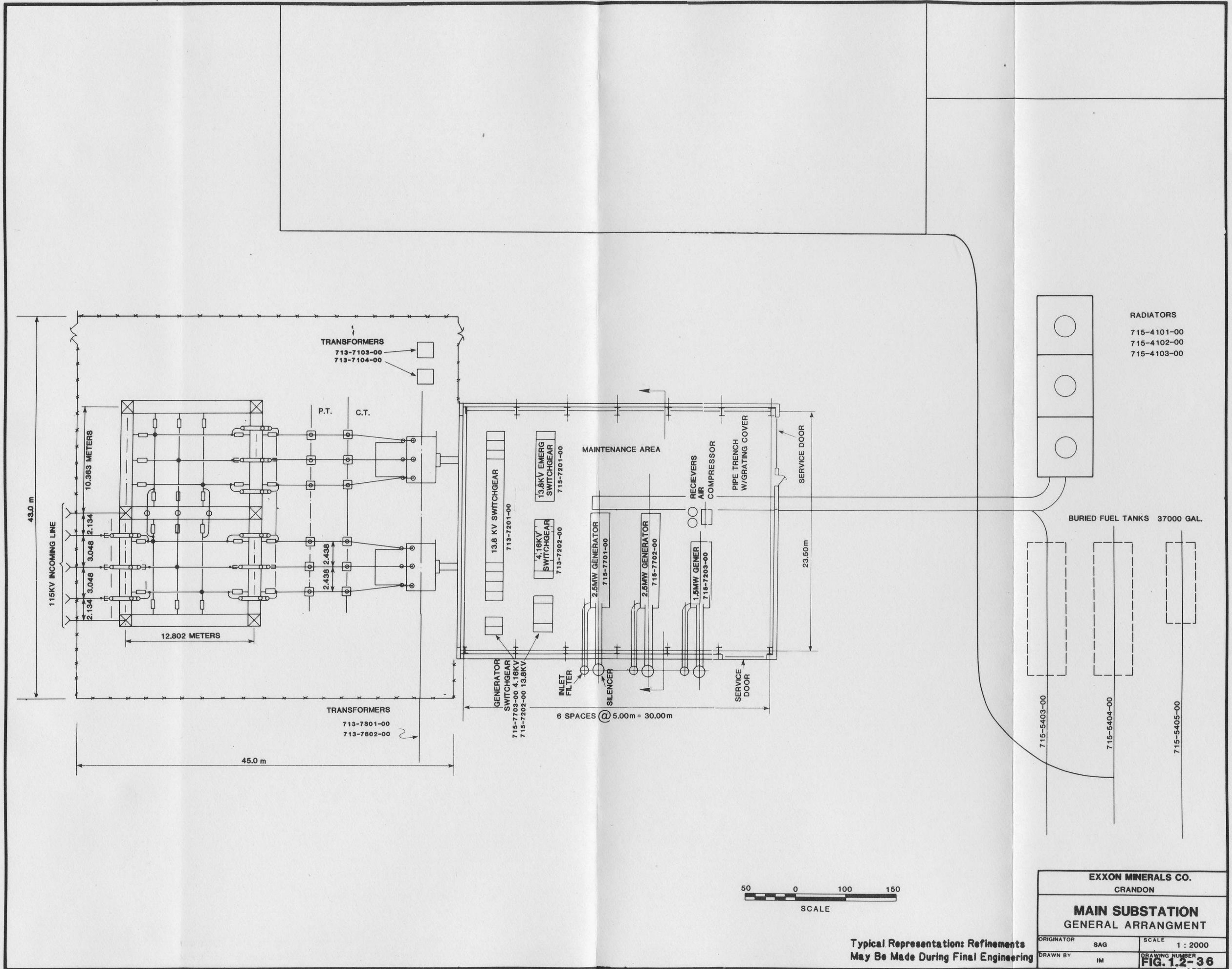
The substation area is shown on Figure 1.2-29. This general arrangement indicates relative space allocations for equipment to be installed. The layout of the main substation is shown on Figure 1.2-36. The main substation will include terminal structure, transformers, switch gear, and emergency power generators.

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.

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. Two diesel emergency generators, each with a capacity of 2,500 kW, and one 1,500-kW generator will be available to supply emergency power. These will be located in the main switch gear building at the main substation.

No special noise suppression measures have been taken to alleviate noise from transformers; however, the generator sets will be located in a block building. The noise emitted will be within the EPA guidance limits at the property boundary. All transformers are


TRANSFORMERS
713-7103-00
713-7104-00
P.T.
C.T.
10.363 METERS
43.0 m
115KV INCOMING LINE
2.134
3.048
3.048
2.134
2.438
2.438
12.802 METERS
45.0 m
TRANSFORMERS
713-7801-00
713-7802-00
13.8 KV SWITCHGEAR
713-7201-00
13.8KV EMERG SWITCHGEAR
715-7201-00
4.16KV SWITCHGEAR
713-7202-00
GENERATOR SWITCHGEAR
715-7703-00 4.16KV
715-7202-00 13.8KV
MAINTENANCE AREA
2.5MW GENERATOR
715-7701-00
2.5MW GENERATOR
715-7702-00
1.5MW GENER
715-7203-00
RECIEVERS
AIR COMPRESSOR
PIPE TRENCH W/GRATING COVER
SERVICE DOOR
23.50 m
INLET FILTER
SILENCER
SERVICE DOOR
6 SPACES @ 5.00m = 30.00m
RADIATORS
715-4101-00
715-4102-00
715-4103-00
BURIED FUEL TANKS 37000 GAL.
715-5403-00
715-5404-00
715-5405-00
50 0 100 150
SCALE
Typical Representation: Refinements May Be Made During Final Engineering
EXXON MINERALS CO.
CRANDON
MAIN SUBSTATION
GENERAL ARRANGMENT
ORIGINATOR SAG
SCALE 1 : 2000
DRAWN BY IM
DRAWING NUMBER FIG. 1.2-36

184-3-29B

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 two 2,500-kV generators and one 1,500-kW generator 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. The two large generators will produce 103 dB(A) at 3.3 feet. The smaller generator will produce 95 dB(A) at 3.3 feet. The building will absorb some of the sound transmitted from the generators. Ear protection will be required within the generator station as a safety requirement. The generators will be fitted with spark arresting silencers on the exhaust.

At the center of the substation area a point source noise will be less than the 96 dB(A) that was used in the noise model which indicated levels at the Project boundary were within EPA guidance limits. Therefore, no abatement procedures are required.

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. Power for the MWDF is also supplied underground to the edge of the facility boundary where it is converted to an overhead 13.8-kV powerline. This powerline follows the pipeline route to the MWDF and then around the facility to supply power for the pumps.

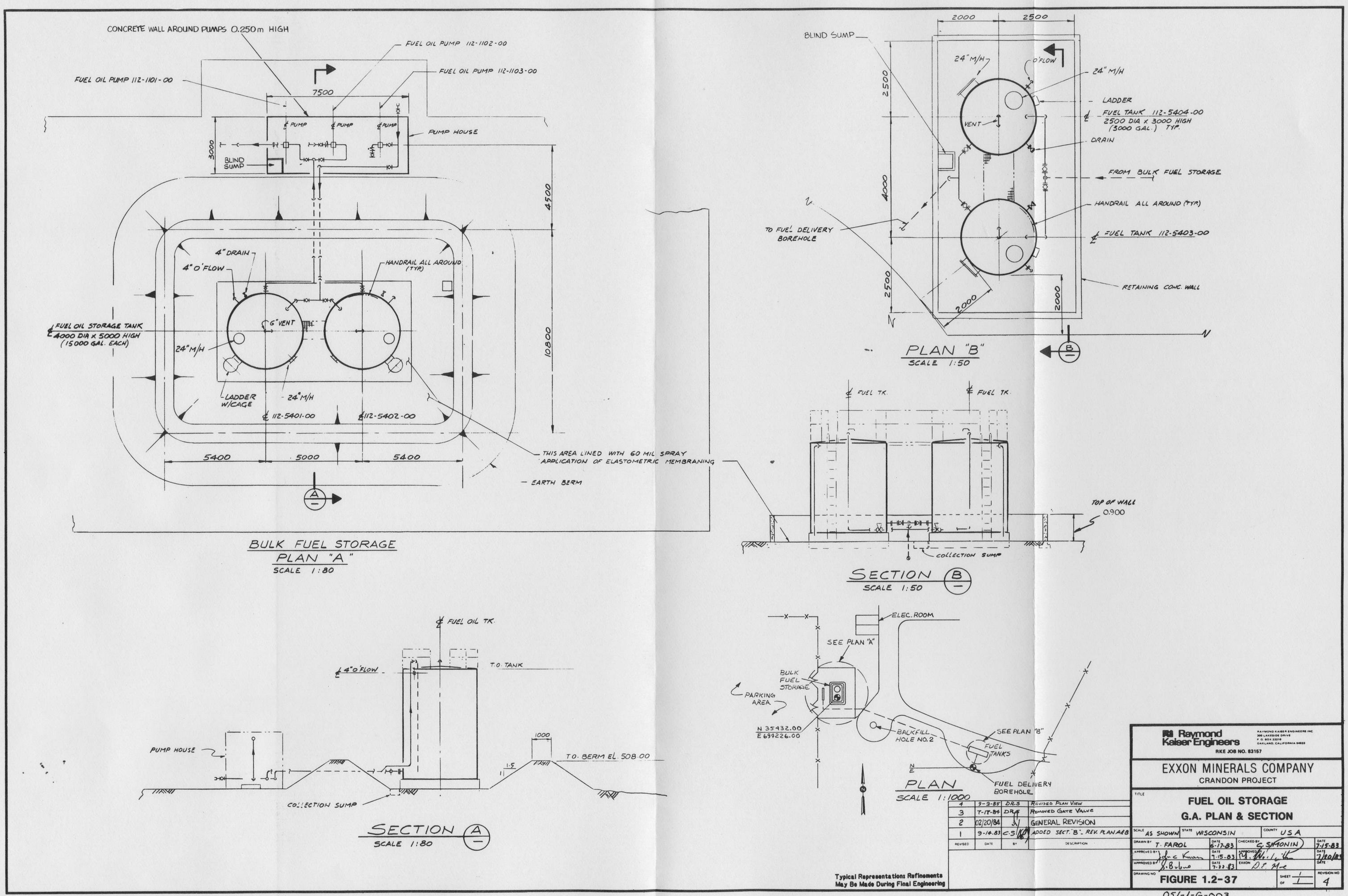
A communications duct system will provide telecommunication, data, and intercom routes throughout the Project surface facilities.

1.2.4.8 Fuel Storage and Distribution

Fuel Oil - 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. Two 15,000-gallon 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 and will be located within dikes sized to contain the fuel oil in the event of tank leakage or rupture. Design of the fuel storage facilities is presented on Figure 1.2-37.

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 3,000-gallon measuring tanks located next to the fuel delivery borehole. Pumps for this purpose are located next to the bulk storage tanks. The transfer pipeline between the bulk storage tanks and the measuring tanks will be on the surface and supported on pipe racks. No settlement is expected along this pipeline route. The pipe will be made of carbon steel, schedule 40, welded at joints.


CONCRETE WALL AROUND PUMPS 0.250m HIGH
FUEL OIL PUMP 112-1102-00
FUEL OIL PUMP 112-1103-00
FUEL OIL PUMP 112-1101-00
7500
PUMP HOUSE
BLIND SUMP
3000
4500
4" DRAIN
4" O'FLOW
HANDRAIL ALL AROUND (TYP.)
FUEL OIL STORAGE TANK 4000 DIA x 5000 HIGH (15000 GAL. EACH)
6" VENT
24" M/H
10800
LADDER W/CAGE
112-5401-00
112-5402-00
THIS AREA LINED WITH 60 MIL SPRAY APPLICATION OF ELASTOMETRIC MEMBRANING
5400
5000
5400
EARTH BERM
BULK FUEL STORAGE PLAN "A"
SCALE 1:80
BLIND SUMP
2000
2500
24" M/H
O'FLOW
LADDER
FUEL TANK 112-5404-00 2500 DIA x 3000 HIGH (3000 GAL.) TYP.
VENT
DRAIN
FROM BULK FUEL STORAGE
HANDRAIL ALL AROUND (TYP.)
TO FUEL DELIVERY BOREHOLE
FUEL TANK 112-5403-00
RETAINING CONC. WALL
4000
PLAN "B"
SCALE 1:50
FUEL TK.
FUEL TK.
TOP OF WALL 0.900
COLLECTION SUMP
SECTION B
SCALE 1:50
ELEC. ROOM
SEE PLAN "A"
BULK FUEL STORAGE
PARKING AREA
N 35432.00
E 699226.00
BACKFILL HOLE NO. 2
SEE PLAN "B"
FUEL TANKS
FUEL DELIVERY BOREHOLE
PLAN
SCALE 1:1000
FUEL OIL TK.
4" O'FLOW
T.O. TANK
1000
PUMP HOUSE
T.O. BERM EL. 508.00
COLLECTION SUMP
SECTION A
SCALE 1:80
Typical Representation: Refinements May Be Made During Final Engineering
Raymond Kaiser Engineers
RAYMOND KAISER ENGINEERS INC
300 LAKESIDE DRIVE
P. O. BOX 23210
OAKLAND, CALIFORNIA 94623
RKE JOB NO. 83157
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE FUEL OIL STORAGE G.A. PLAN & SECTION
SCALE AS SHOWN
STATE WISCONSIN
COUNTY USA
DRAWN BY T. FAROL DATE 6-17-83
CHECKED BY G. SIMONIN DATE 7-15-83
APPROVED BY DATE 7-15-83
APPROVED BY DATE 7-22-83
4 9-3-85 DRS REVISED PLAN VIEW
3 7-17-84 DRS REMOVED GATE VALVE
2 02/20/84 GENERAL REVISION
1 9-14-83 C.S. ADDED SECT. "B" - REV. PLAN A&B
REVISED DATE BY DESCRIPTION
DRAWING NO FIGURE 1.2-37
SHEET 1 OF 1
REVISION NO 4
051-1-G-003

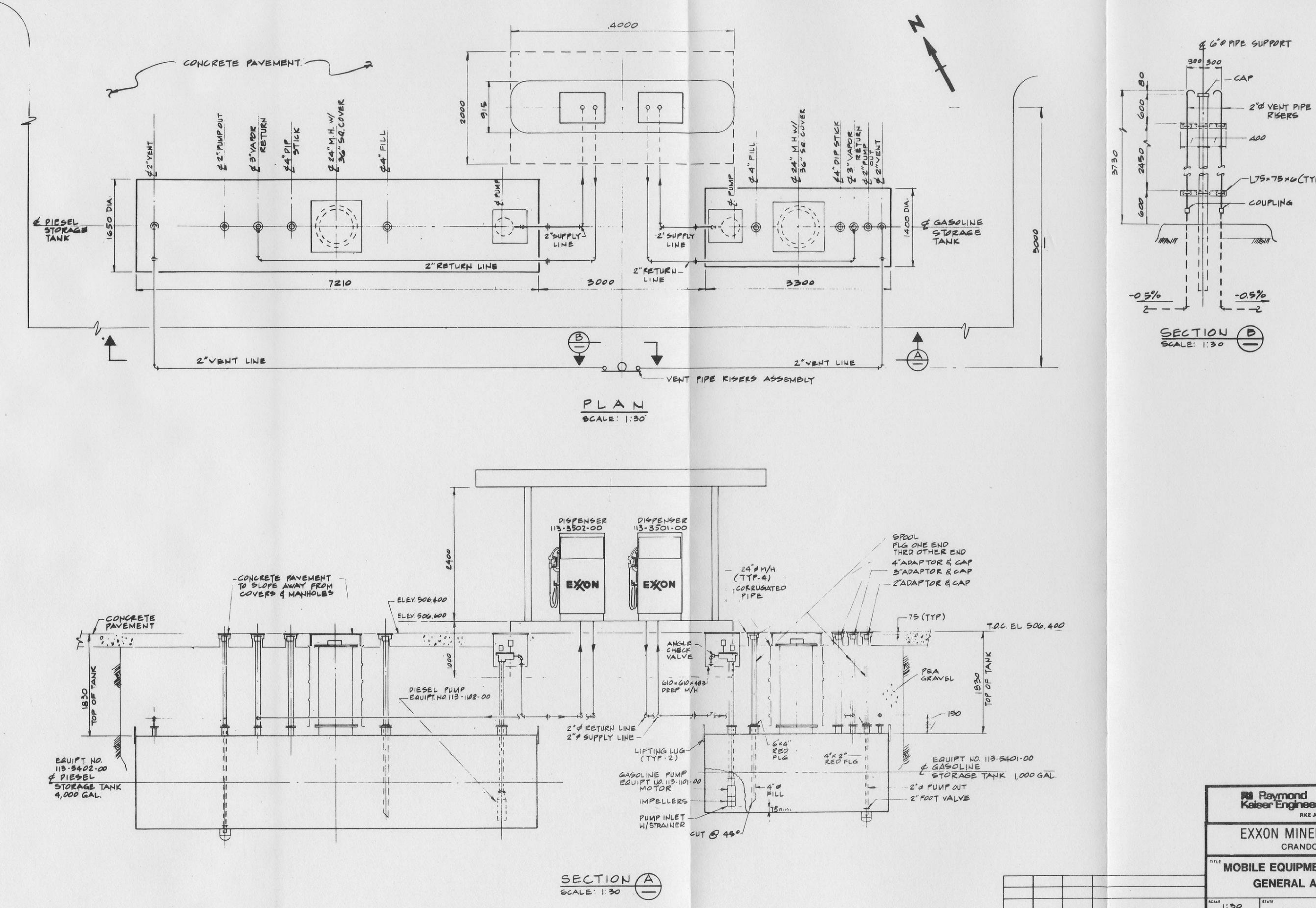
The berm around the bulk fuel storage tanks and the measuring tanks for the mine are shown on Figure 1.2-37. The berm around the bulk fuel storage tanks is designed to contain the entire contents of both. The structure around the mine measuring tanks is also designed to hold the tank contents in the event of a rupture. The area within the containment dikes surrounding the tanks will be lined with an elastomeric membrane.

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 0.8 foot high 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.

Mobile Equipment Fueling - A fueling station will be provided for dispensing fuel to surface mobile equipment (Figure 1.2-38). This station will be located east of the tailing thickener. The fueling station will have one 4,000-gallon diesel fuel tank and one 1,000-gallon gasoline tank, both of which will be buried. The fueling station will be designed in accordance with applicable state and federal codes.



Typical Representation: Refinements May Be Made During Final Engineering

REVISED	DATE	BY	DESCRIPTION

Raymond Kaiser Engineers
RKE JOB NO. 83157

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: MOBILE EQUIPMENT FUEL STATION GENERAL ARRANGEMENT

SCALE 1:30 | STATE | COUNTY

DRAWN BY T. FAROL DATE 6-10-83 | CHECKED BY K. SIMONIN DATE 7-15-83

FIGURE 1.2-38 | SHEET 1 OF 1 | REVISION NO. 0

051-1-G-004

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.

Wisconsin Public Service Corporation will identify and study potential routes for the pipeline extension. All required documentation for permitting, routing, and construction details of the gas pipeline extension to the mine/mill site will be submitted to the Wisconsin Public Service Commission for approval.

1.2.4.9 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 1.2-3). 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.

1.2.4.10 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. From the supply well and pumphouse, underground piping will carry the water to the fresh water tank at the water tank plant area (Figure 1.2-39). 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.

A 10-inch diameter well is planned with a 100-gallon per minute vertical turbine pumping system located in a small pumphouse. The capacity of the fresh water tank will be 50,000 gallons.

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 inspected for bacteriological quality.

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

1.2.4.11 Water Treatment Plant and Excess Water Discharge

The water treatment plant will be located on the east side of the concentrator (Figure 1.2-29) 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


MINE/MILL SITE
FRESH WATER TANK
T35 N, R12 E
T35 N, R13 E
SKUNK LAKE
SAND LAKE ROAD
0.15m (6")Ø POTABLE WATER TRANSMISSION LINE (TOTAL LENGTH APPROX. 2000m (6562'))
OAK LAKE
POTABLE WATER WELL (WS-1) LOCATION N 34,694m (N 113,825feet) E 693,352m (E 2,274,772feet)
LAKE ROAD
LITTLE SAND LAKE
DUCK LAKE
Water
25
26
29
30
31
32
35
36
N
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
LOCATION OF POTABLE WATER WELL FACILITIES
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
DATE 2/85
FIGURE 1.2-39

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 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.

Lime precipitation in conjunction with sulfide precipitation will be used as the basic process to treat contaminated mine water and intercepted ground water. These two treatment systems will each use the following unit operations:

Unit Operation	Primary Functions
Treatment Plant Feed Tank & Pump (Contaminated Mine Water)	Collect mine water and control flow rate to the treatment plant.
Neutralization Reactor	Two-stage reactor; first stage provides contact of recycled seed sludge with lime to promote gypsum precipitation and particle growth; second stage permits addition of influent water to react with lime-sludge slurry to precipitate metals as metal hydroxides. Air will be sparged into second stage reactor to ensure oxidation of iron from ferrous to ferric state. Sodium sulfide precipitant will be added to the slurry leaving reactor.

Unit Operation	Primary Functions
Lime Softener	Reactor/clarifier vessel that allows completion of precipitate formation and allows separation of precipitate sludge at bottom of vessel; clear water overflows top of vessel.
Dual Media Filter	Remove suspended solids from water that overflows clarifier.
Neutralization	Reduce pH of treated water to a neutral value suitable for discharge.
Excess Discharge Lagoons	Two lagoons connected in series; provide approximately 48 hours retention for treated water that will be discharged under average flow conditions.

Treated water from these two treatment processes will be pumped to the excess discharge lagoon system to be located east of the fine tailings thickener. This water will be monitored for pH, conductivity, and turbidity. A 24-hour composite sampler will be installed to collect samples of treated water for required chemical analyses. Water discharged to Swamp Creek from the lagoons will be continuously monitored for flow and pH. A 24-hour composite sampler will also be installed here to collect samples for required chemical analyses. An 8-hour control composite will be used to help control plant operations.

To operate the mill with a high level of water recycle, water sufficiently low in total dissolved solids, particularly calcium and sulfate, must be provided to control gypsum scaling in the process piping and equipment. This requires a treatment process capable of removing both cations and anions from the water treated for process recycle.

The system for treating water from the reclaim pond and a portion of the contaminated mine water for recycle to the mill will consist of the following unit operations and corresponding functions:

Unit Operation	Primary Function
Influent Feed	Water to be fed at controlled rates from reclaim water tank and from water treatment plant feed tank.
Neutralization Reactor	Two-stage reactor; first stage provides contact of recycled seed sludge with lime to promote gypsum precipitation and particle growth; second stage permits addition of influent water to react with lime-sludge slurry. Air will be sparged into second stage to ensure oxidation of iron from ferrous to ferric state.
Lime/Soda Softener and Clarifier	Reactor/clarifier vessel; sodium carbonate will be added to precipitate calcium as calcium carbonate. Remove precipitate from bottom of clarifier; clear water overflows top of vessel. Removal of calcium permits higher recovery of water in reverse osmosis by minimizing gypsum fouling in membranes
Dual Media Filter	Remove suspended solids from water that overflows reactor/clarifier.
Neutralization	Neutralize effluent from lime-soda softening to a pH suitable for reverse osmosis.
Reverse Osmosis	Concentrate dissolved constituents into smaller brine stream; provides most of the treated water for recycle.
Vapor Compression Evaporation	Further concentrates dissolved constituents into more highly concentrated brine stream; condensate becomes part of recycle water.

Unit Operation	Primary Function
Brine Softener	Removes precipitated gypsum from evaporator brine stream; addition of lime precipitates any heavy metals as hydroxides.
Brine Crystallizer	Recovers sodium sulfate cake product from brine; condensate becomes part of recycle water.

Treated water from this process will normally be pumped to the mill treated fresh water tank for use in the mill. Provision will be made to allow treated recycle water to be discharged through the excess water discharge lagoons. This will allow for the volume of water in the reclaim pond that has accumulated due to the net gain in precipitation over evaporation to be discharged after treatment through the recycle water treatment system.

The discharge lagoons will be located just east of the tailings thickener. The lagoons will allow for just over 48 hours retention of treated water prior to discharge to Swamp Creek under average flow conditions. Design details for the lagoons are presented in the Preliminary Engineering Report for the water treatment facility.

The treatment plant will be designed with sufficient operating flexibility to permit operators to respond to certain situations that may arise. Accordingly, all unit process equipment for treating the contaminated mine water and recycle process water will be sized to handle 20 percent more than the anticipated maximum volume. The process equipment for treating the intercepted ground water will also be designed to handle about 20 percent more than the anticipated maximum volume. The system for treating water for recycle to the mill will be designed with sufficient flexibility to allow operation at much lower rates than the design capacity. This will be achieved by building the reverse osmosis treatment equipment in a number of modules.

The following chemicals will be used in the water treatment plant:

Treatment of Contaminated Mine Water and Intercepted Ground Water for Discharge

Lime (CaO)
Sodium Sulfide ($Na_2S \cdot 9H_2O$)
Ferric Sulfate [$Fe_2(SO_4)_3$] (Coagulant, if needed)
Flocculant (Polyacrylamide)
Sulfuric Acid (H_2SO_4)

Treatment of Water for Recycle to Mill Process

Lime (CaO)
Soda Ash (Na_2CO_3)
Ferric Sulfate [$Fe_2(SO_4)_3$] (Coagulant, if needed)
Flocculant (Polyacrylamide)
Sulfuric Acid (H_2SO_4)
Sodium Hexametaphosphate $(NaPO_3)_6$ (Anti-scalant)

Lime and soda ash will be prepared in the lime and soda ash preparation areas adjacent to the water treatment plant and delivered via closed loop pipelines to the water treatment plant.

Sodium sulfide precipitant for the water treatment plant will be supplied in solution form from the mill reagent preparation area.

Ferric sulfate, flocculant, and sodium hexametaphosphate will be stored in the water treatment plant and solutions will be prepared in the water treatment plant. The same protective measures as described for the reagent preparation area in the mill will be provided. These include adequate building ventilation, concrete berms around mix tanks, and blind sumps to collect any spills for reuse.

Sulfuric acid will be delivered to the water treatment plant by truck and stored in a steel tank inside the building. This tank will have a protective berm designed to hold the entire contents of the tank in the event of a leak or tank rupture. The tank itself has been sized to hold about 9,700 gallons of acid. Sulfuric acid will be metered into the various process addition points as required.

Power consumption for the water treatment systems will be approximately 45,600 kilowatt-hours per day. Natural gas consumption will be approximately 120,000 standard cubic feet per day.

Excess water (treated mine water and intercepted ground water) will be discharged into Swamp Creek downstream from the bridge on County Trunk Highway M about 5 miles west of the Project site. The discharge system will consist of pumps at the excess water discharge lagoon, approximately 6.1 miles of buried 14-inch diameter pipe, and a discharge structure at Swamp Creek.

There will be three pumps available to pump discharge water: two 110-hp pumps and one 170-hp pump. During normal operation (discharge less than 2,000 gallons per minute), one 110-hp will be used with the others available as spares. When the discharge rate approaches 3,000 gallons per minute, all three pumps will be used.

The water discharge pipeline will be constructed of 14-inch diameter, high-density polyethylene (HDPE) pipe that will be buried 6 feet below ground and beneath the frost level. Engineering calculations show that HDPE pipe rated at 250 pounds per square inch internal design pressure will be well above expected pipeline pressure.

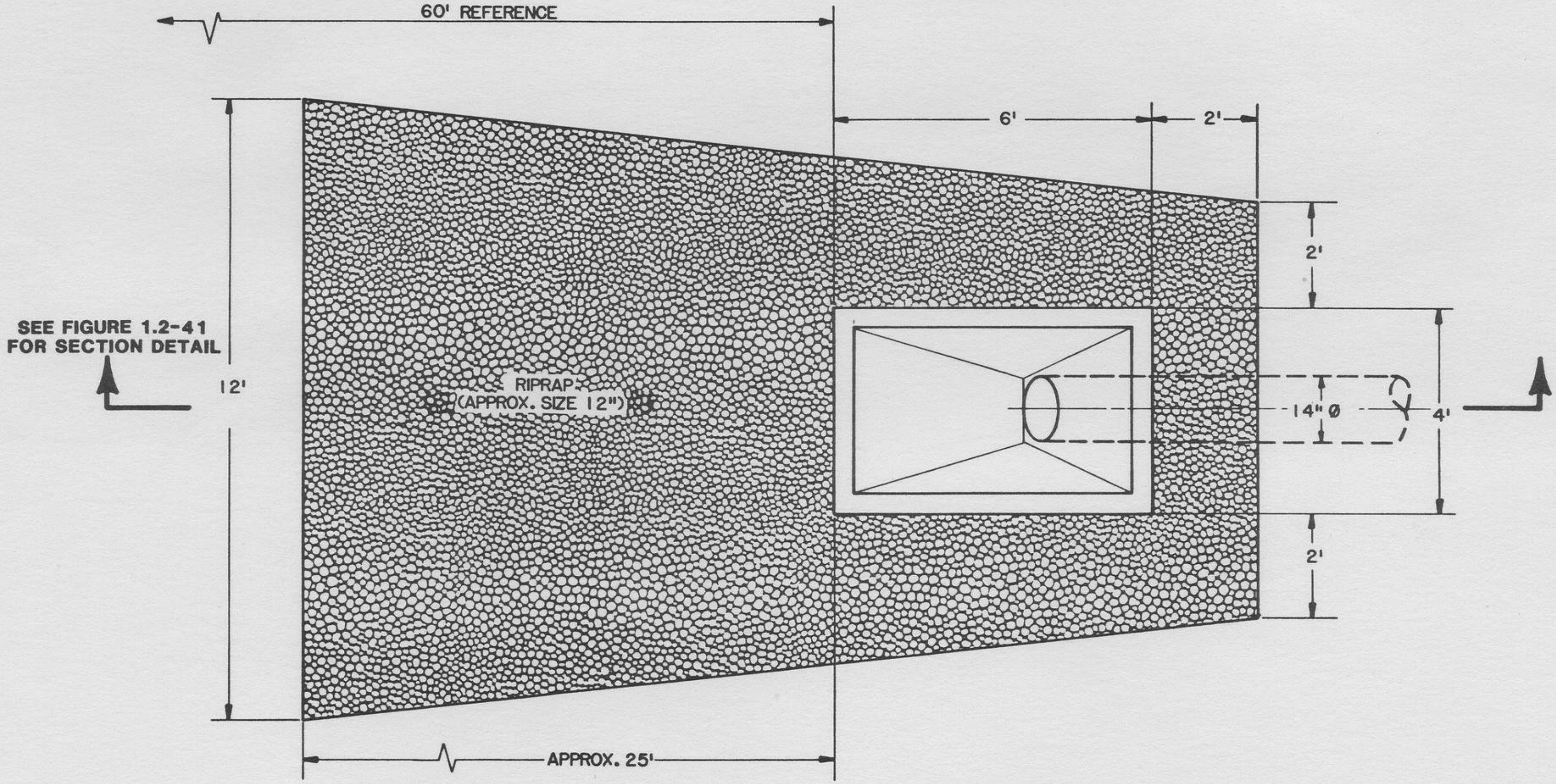
The pipe will be received, inspected, and installed in the same manner as the tailings transport pipeline described in subsection 1.3.1.8.

Blockage of the pipeline due to settled solids will not be a problem because solids in the discharge water will be less than 20 mg/l. Any solids that accumulate during a pipeline shutdown would be resuspended and flushed out at start-up.

Vacuum breakers will be installed in the pipeline to prevent any vacuum forming in the pipeline system.

Clean-up and removal of spilled water will not be necessary because of the good quality of the water being discharged. Repair of any breaks in the pipeline will involve removal of the damaged pipe section and welding in a new section using the portable butt welding equipment. The repaired section would be leak tested before putting the pipeline back in service.

Figures 1.2-40 and 1.2-41 present plan and section views of the discharge structure adjacent to Swamp Creek. This structure will be designed to prevent bank and streambed erosion.



NOTE:

1) PROVIDE SLIGHT CHANNEL IN RIPRAP TO DIRECT FLOW OF STREAM

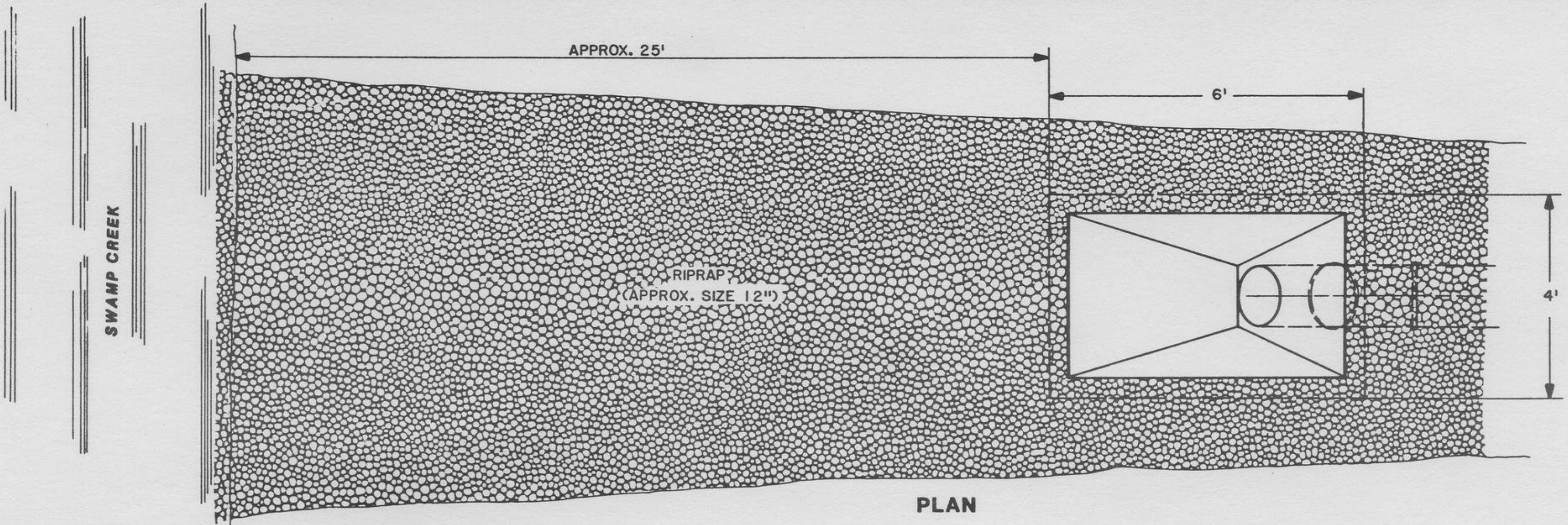
2) ADJUST 25' RIPRAP LENGTH TO CARRY RIPRAP TO EDGE OF STREAM WATER AT NORMAL WATER LEVEL

Typical Representation : Refinements May Be Made During Final Engineering

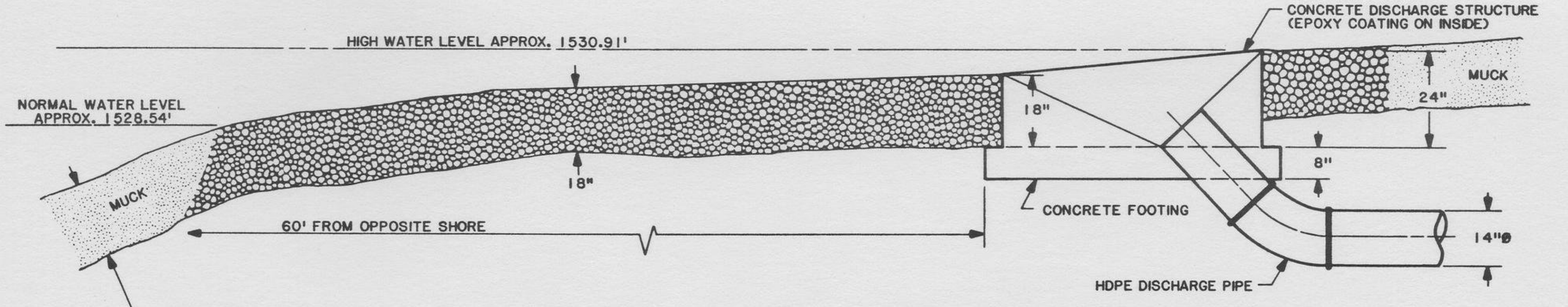
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WATER DISCHARGE STRUCTURE
- PLAN -

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 6/83	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 1.2-40			SHEET ___ OF ___	REVISION NO



PLAN



SECTION

NOTES:

1) PROVIDE SLIGHT CHANNEL IN RIPRAP TO DIRECT FLOW OF STREAM
2) ADJUST 25' RIPRAP LENGTH TO CARRY RIPRAP TO EDGE OF STREAM AT NORMAL WATER LEVEL
3) VARY THICKNESS OF FOOTING TO CARRY BOTTOM OF FOOTING TO BOTTOM OF MUCK

0 1 2 4 6
SCALE IN FEET

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY CRANDON PROJECT				
TITLE **WATER DISCHARGE STRUCTURE PLAN & SECTION**				
SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 5/84	CHECKED BY		DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder		DATE 11/13/85
APPROVED BY	DATE	EXXON D E Moe		DATE
DRAWING NO **FIGURE 1.2-41**		SHEET ____ OF ____		REVISION NO.

1.2.4.12 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 1.2-22. 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).

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 pond 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 19 days of water flow at a rate of 2,500 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.

Surge capacity in the tailings ponds is discussed in subsection 1.2.3.4, Tailings Disposal.

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 operating storage volume of the two reclaim pond cells is similar.

The reclaim pond dimensions will be:

	Estimated Dimensions	
	Cell A	Cell B
Area Inside Crest (acres)	18	18
Bottom Area (acres)	10	10
Lined Slope Area (acres)	6.5	6.5
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

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.

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. For an estimated freezing index at the Project site of 1,500 degree-days, a maximum depth of frost penetration of 4.6 feet was determined (Corps of Engineers EM-1110-345-306). Consequently, frost penetration to the liner is not anticipated. Frost effects on the outer shell and crest of the embankments will not affect embankment performance. Final design of the water reclaim system will have protection against ice damage. Rip-rap 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.

The double liner and underdrain/vent system concept was developed as a precautionary safety feature. In the unlikely event the primary synthetic liner system develops a leak, seepage would be collected in the underdrain and removed. The back-up underliner (bentonite modified till liner) will impede leakage from the underdrain towards the underlying aquifer. Potential leakage through a properly installed synthetic liner is anticipated to be relatively small, thereby allowing only minimal leakage to the underdrain, negligible seepage head on the underliner and consequently negligible seepage loss through the total system.

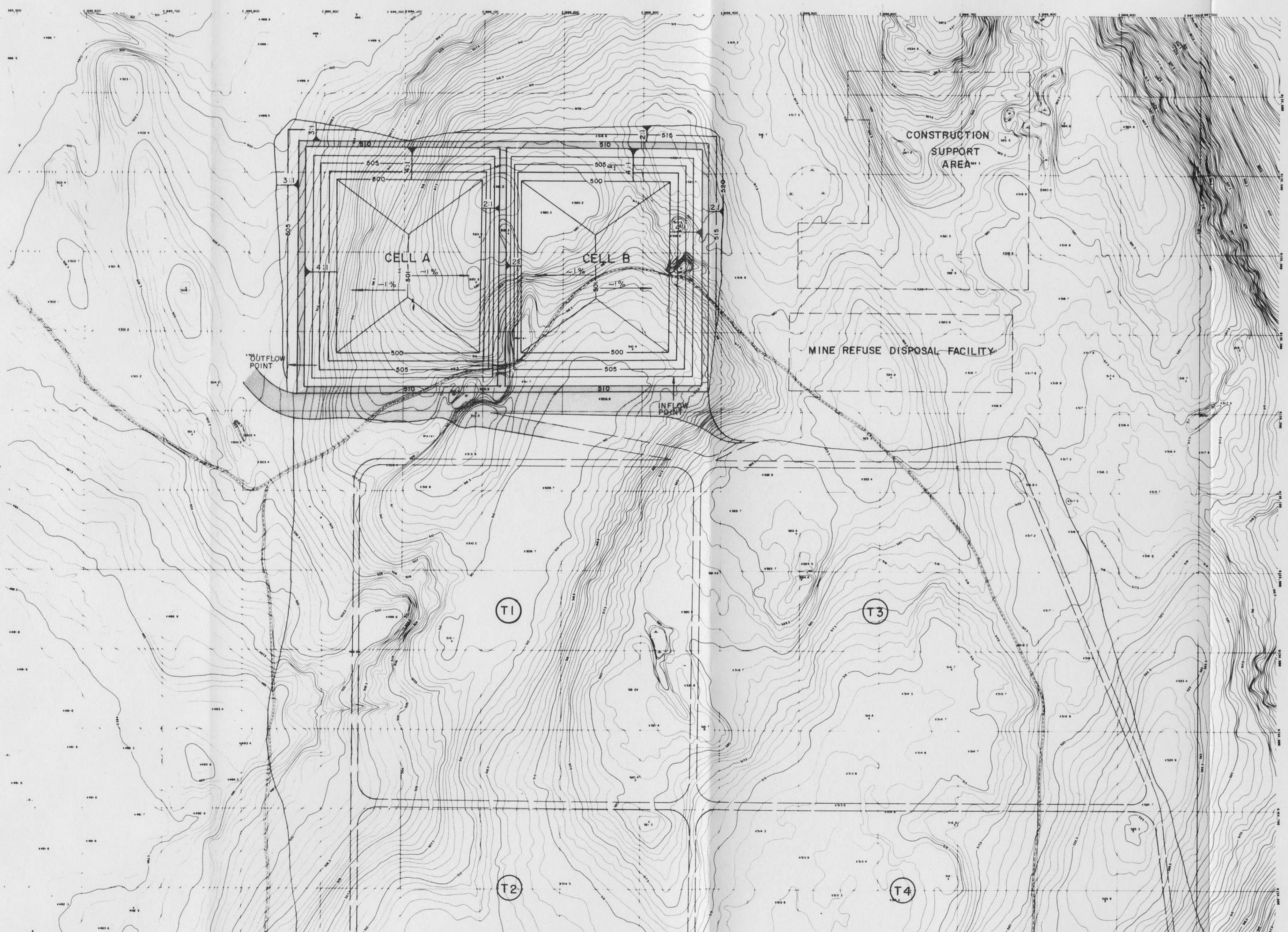
Details of the preliminary design of the reclaim pond water ponds are shown on Figures 1.2-42 through 1.2-46. Preliminary material and construction specifications are included on the drawings.

In addition to the seepage control system design, the basic contingency measure available for repair to the water reclaim pond would be to drain the leaking cell and perform the necessary liner repairs. Sufficient flexibility will be available in the water management system to allow operations to continue with only one cell in operation.

Two potential membrane liners for the ponds have been identified to date. Chlorosulfonated polyethylene (CSPE - more commonly known by DuPont's tradename "Hypalon") and high density polyethylene (HDPE) have been suggested as potential liners. The liner choice will be made during final engineering based on additional study and the latest available information. Suggested repair procedures would be considered in the choice of liner, but if repairs are completed in an empty pond, no difficulty would be expected for either type of liner.

1.2.4.13 Reclaim Water Pumping System

Location of the main features of the water handling systems at the reclaim pond is shown on Figure 1.2-47. 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



RECLAIM POND DATA NOTES	
POND DATA	
Period of Use (yrs.)	2-32
Area Inside Crest (ac)	36
Bottom Area (ac.)	21
Lined Slope Area (ac.)	13
Maximum Operating Interior Depth (ft)	20
Maximum Exterior Fill Height (ft)	35
Crest Elevation (ft)	1673
Lowest Bottom Elevation (ft)	1640
Total Storage Volume (ac. ft.)	1027
Till Excavation ($x10^6 yd^3$)	3.82
Till Embankment ($x10^6 yd^3$)	0.036
Synthetic Liner Area (ac)	37
Till/Bentonite Liner Volume ($x10^6 yd^3$)	0.040
Rock Slope Protection Volume ($x10^6 yd^3$)	0.053
Protective Cushion Above Synthetic Liner ($x10^6 yd^3$)	0.090

NOTES:

1. BASE GRADE ELEVATIONS SHOWN ARE TO TOP OF FINAL CONSTRUCTED SURFACE. SUBTRACT ROCK, FILTER, DRAIN, AND LINER THICKNESS TO DETERMINE SUBGRADE ELEVATIONS.
2. SECURITY FENCE OUTSIDE PERIMETER OF FACILITY.

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.

0 100 200 400 600 800
SCALE IN FEET

0 50 100 150 200 250
SCALE IN METERS

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE DURING FINAL ENGINEERING

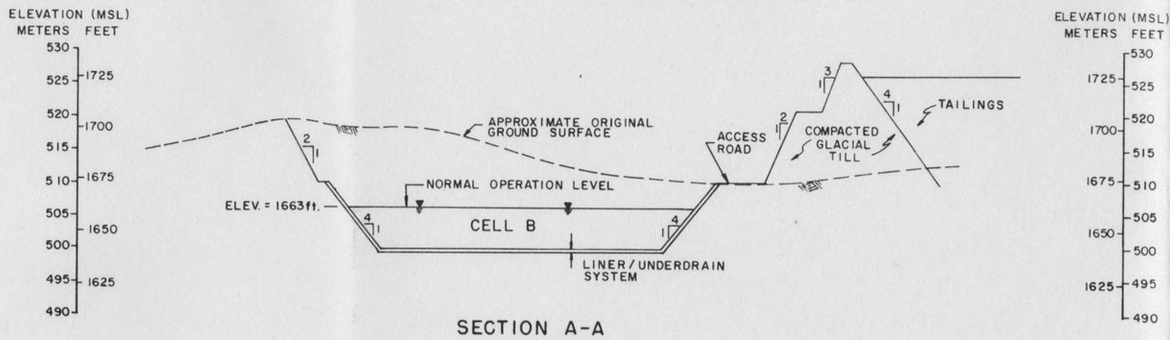
REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
RECLAIM POND BASE GRADE PLAN
SITE 41-114C

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST
DRAWN BY P. D. P.	DATE 10/21/85	CHECKED BY — DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder — DATE 11-25-85
APPROVED BY	DATE	EXXON D.E. Moe — DATE 11/22/85
DRAWING NO FIGURE 1.2-42	SHEET 1 OF 6	REVISION NO

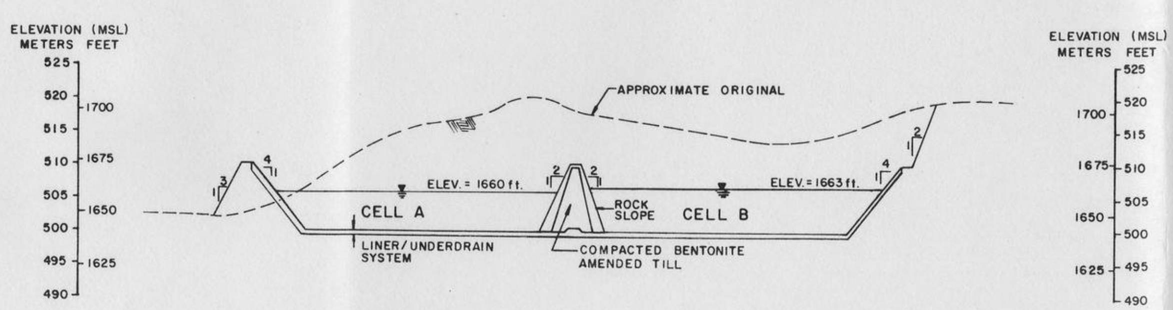
DESIGN PRODUCTS CO.—



SECTION A-A

0 50 100 150 200 250
SCALE IN METERS

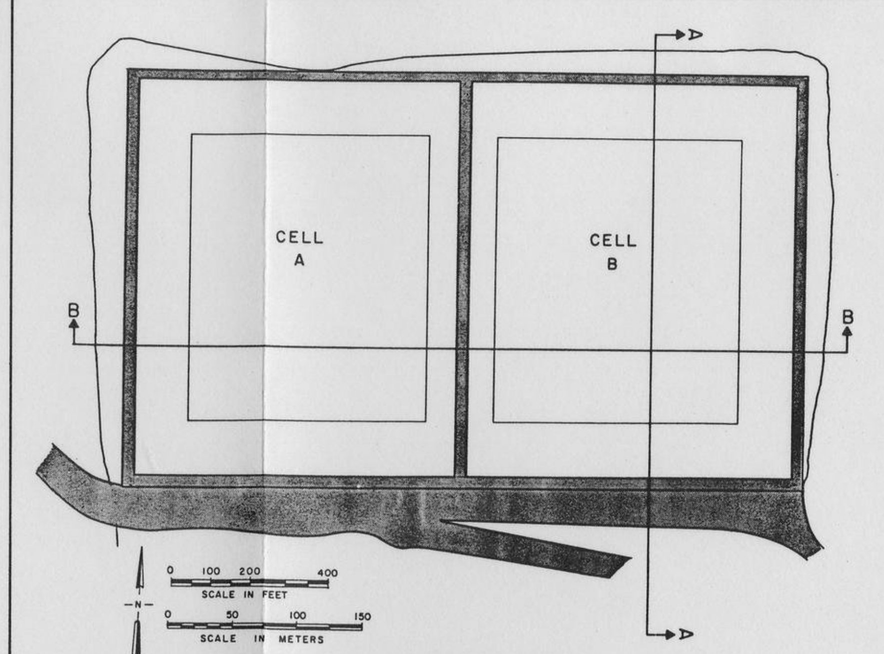
0 100 200 400 600 800
SCALE IN FEET



SECTION B-B

0 50 100 150 200 250
SCALE IN METERS

0 100 200 400 600 800
SCALE IN FEET



CROSS SECTION INDEX

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE DURING FINAL ENGINEERING

REVISED	DATE	BY	DESCRIPTION

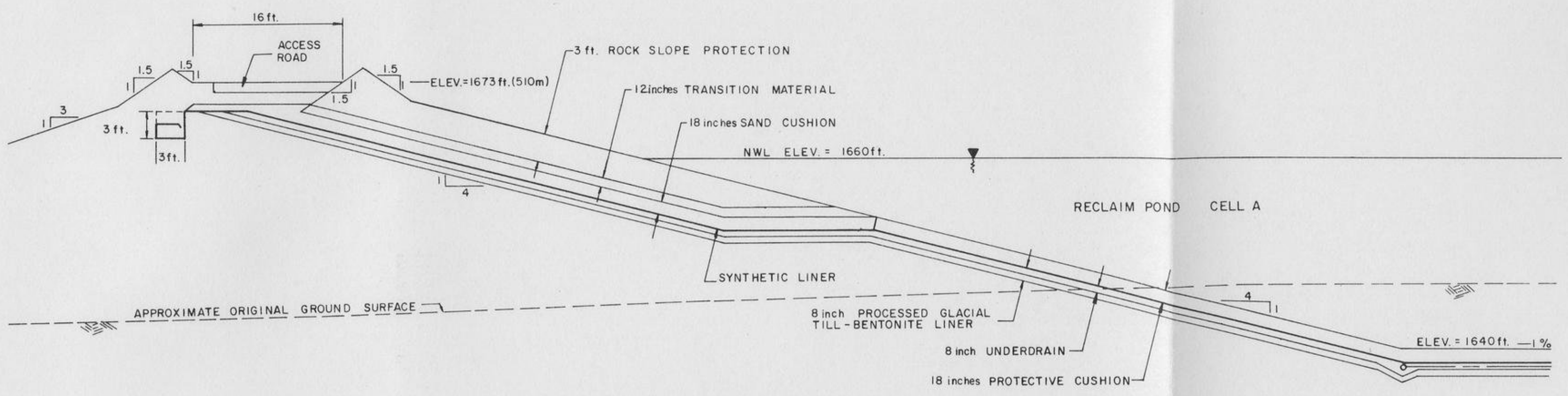
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
RECLAIM POND
CROSS SECTIONS A-A & B-B
SITE 41-114C

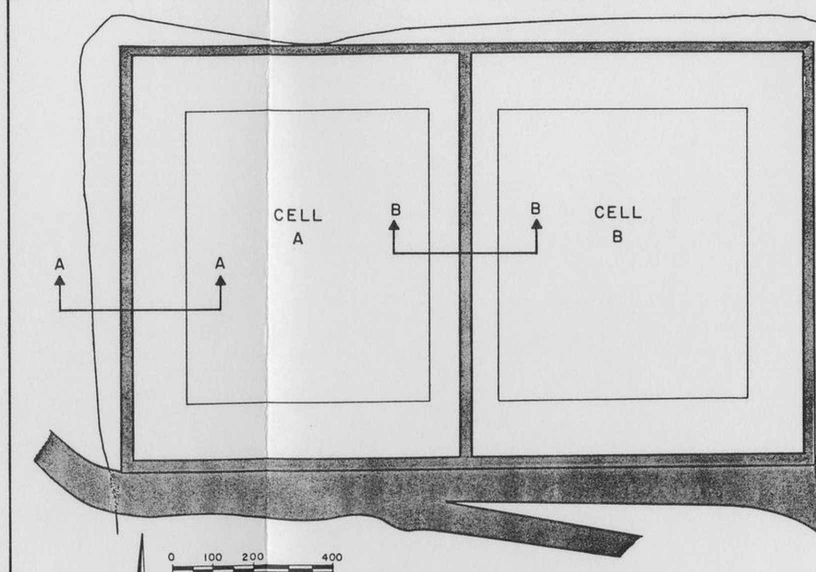
SCALE: AS SHOWN | STATE: WISCONSIN | COUNTY: FOREST

DRAWN BY: P.D.P. | DATE: 10-21-85

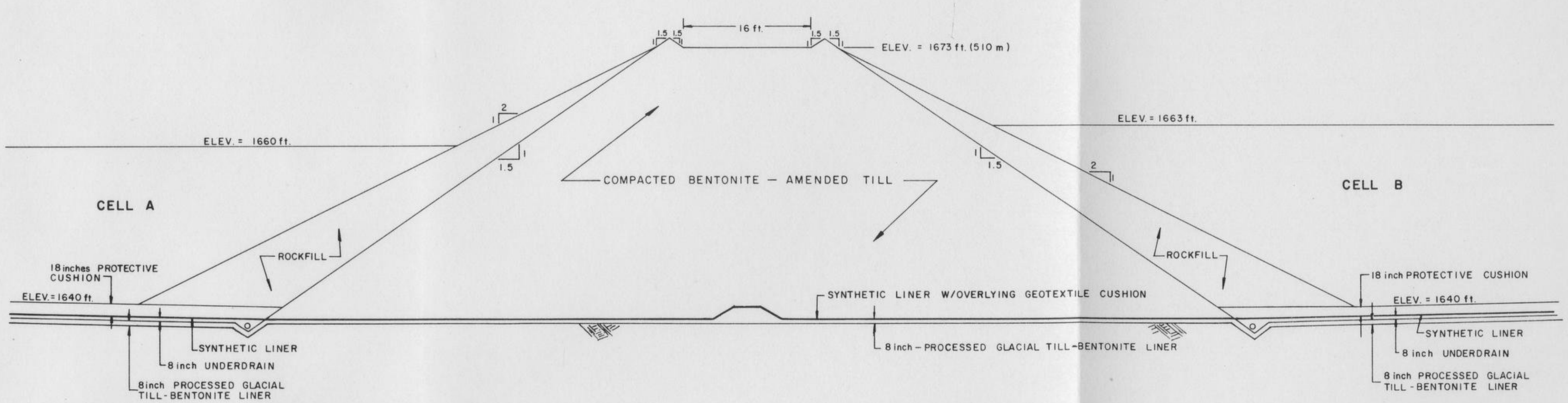
DRAWING NO: FIGURE 1.2-43 | SHEET 2 OF 6



SECTION A–A



CROSS SECTION INDEX



SECTION B–B

Notes:

1. NWL - normal operation water level.
2. Section for Reclaim Pond Cell B will be similar to Section A-A.
3. Liner to be made with processed glacial till finer than 3/4 in. U.S. Standard sieve, modified with bentonite. Liner to be compacted to 95% maximum dry density determined by ASTM D-698.
4. Rock slope protection to consist of pre-production waste rock.
5. Transition material beneath rock slope protection shall be glacial soil coarser than #4 U.S. Standard sieve with D_{85} - 1.25 in.
6. Synthetic liner shall have a thickness of approximately 36 mils and be composed of either:
   a.) Chlorosulfonated polyethylene (CSPE)
   b.) Polyethylene either high density (HDPE) or low density (LDPE)
7. The sand cushion above the synthetic liner shall not be compacted and shall conform to the Manufacturers specifications.
8. The protective cushion above the synthetic liner (at locations other than under the rock slope protection) shall be glacial soil finer than #4 U.S. Standard sieve and shall not be compacted.
9. The sand cushion (Underdrain) below the synthetic liner shall conform to the Manufacturers specifications.

TYPICAL REPRESENTATION; REFINEMENTS MAY BE MADE DURING FINAL ENGINEERING

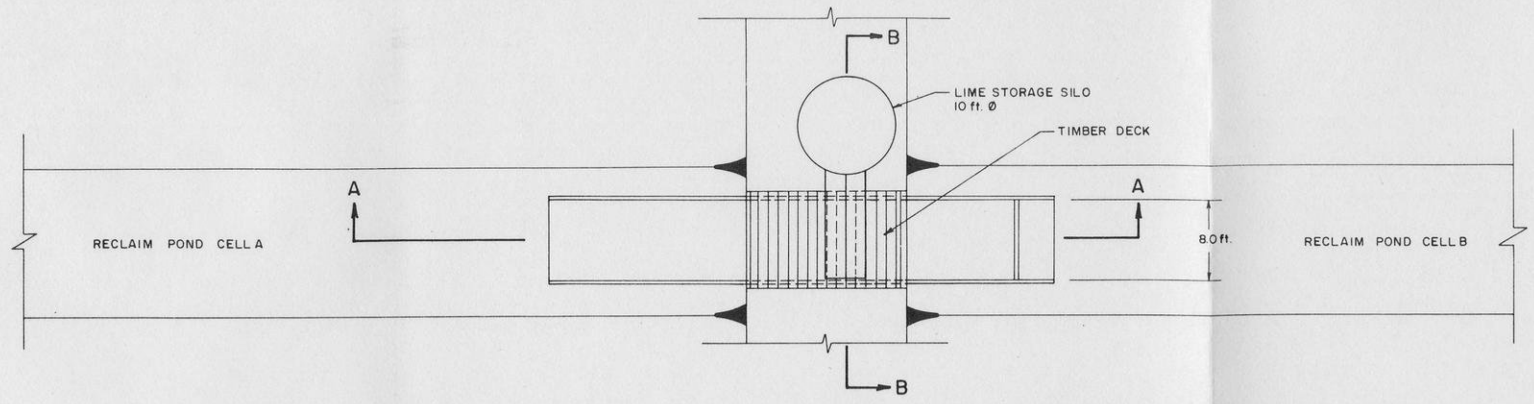
REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

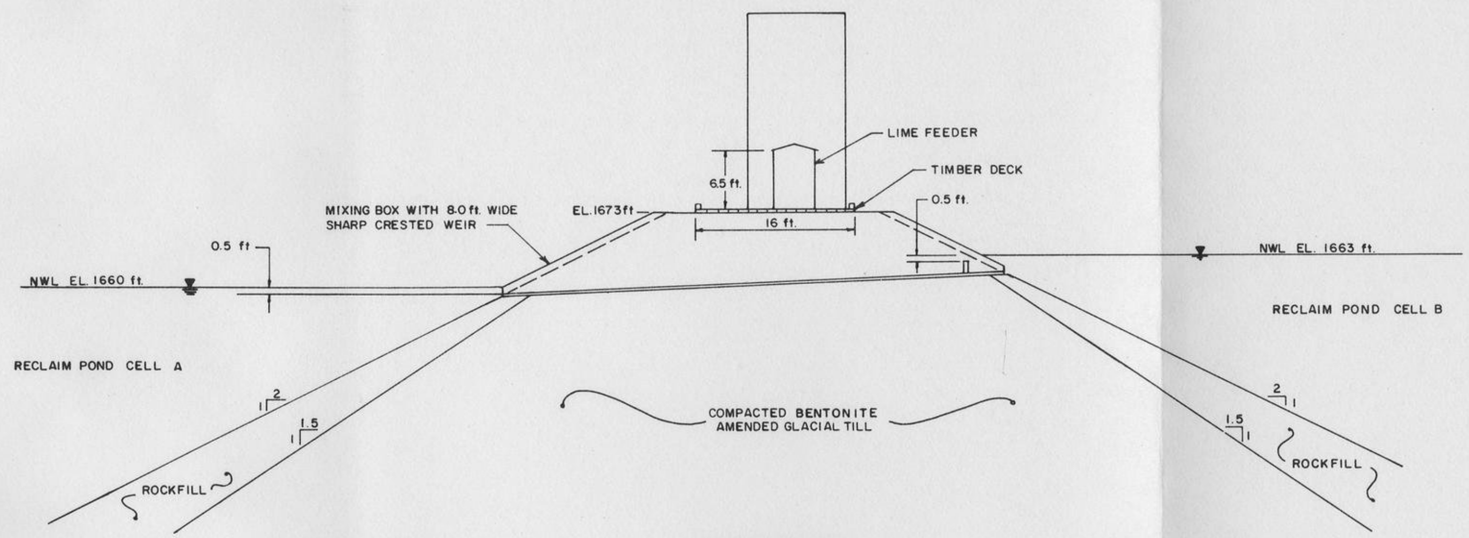
TITLE: RECLAIM POND EMBANKMENT DETAILS

SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: P. D. P.	DATE: 10/24/85	CHECKED BY: [signature]	DATE: 11/22/85
APPROVED BY	DATE	APPROVED BY: C. C. Schroeder	DATE: 11-25-85
APPROVED BY	DATE	EXXON: D. E. Moe	DATE: 11/25/85
DRAWING NO: FIGURE 1.2-44		SHEET 3 OF 6	REVISION NO

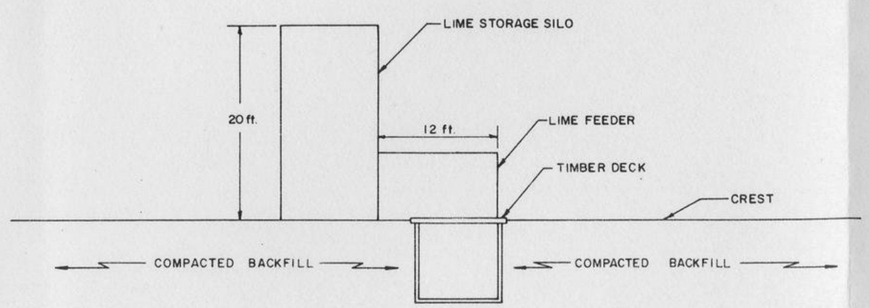
DESIGN PRODUCTS CO —



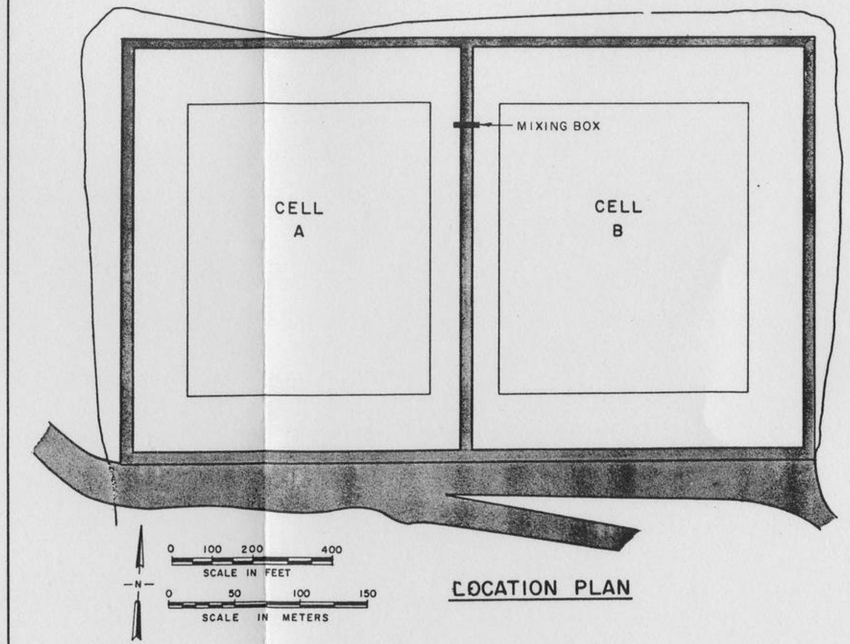
PLAN VIEW
MIXING BOX BETWEEN THE TWO RECLAIM POND CELLS



SECTION A-A



SECTION B-B



LOCATION PLAN

Notes:

1. NWL - Normal operating water level
2. Details of Mixing Box

   Type: Sharp Crested, Rectangular Weir
   Width: 8.0 ft.
   Depth of Flow: 6 in.
   Depth of Tail Water: 6 in.

   The weir box should be designed for structural and mixing requirements.

0 5 10 15 20 25 30 35
SCALE IN FEET

0 1 2 3 4 5 6 7 8 9 10
SCALE IN METERS

REVISED	DATE	BY	DESCRIPTION

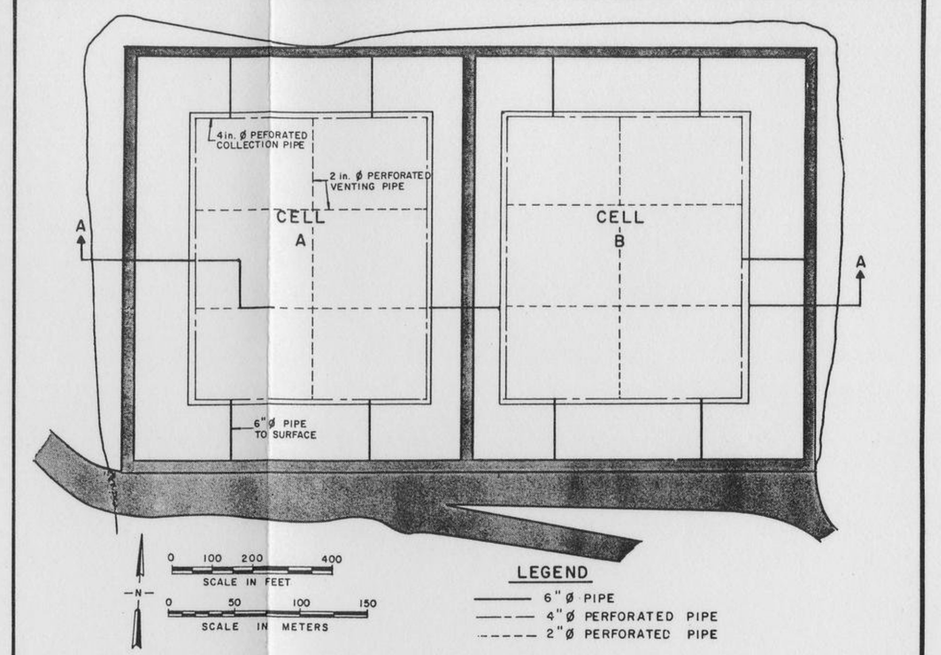
TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE DURING FINAL ENGINEERING

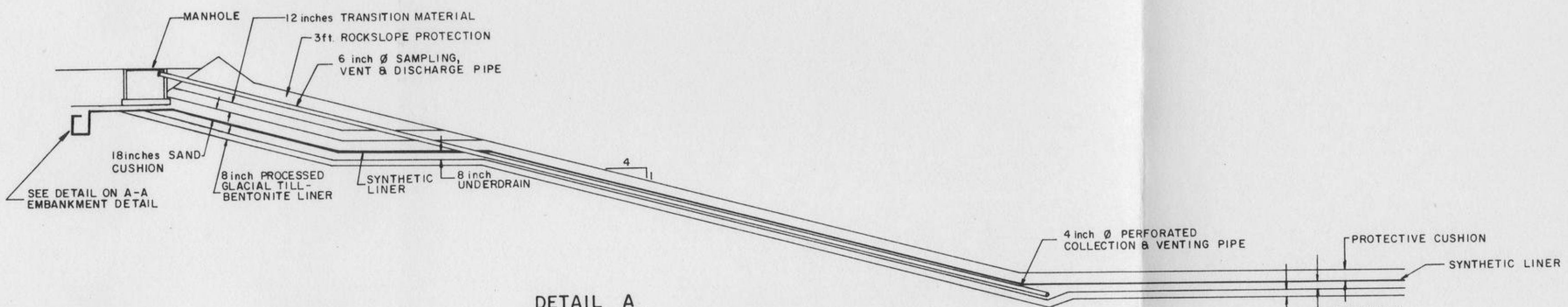
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
RECLAIM POND MIXING BOX DETAILS

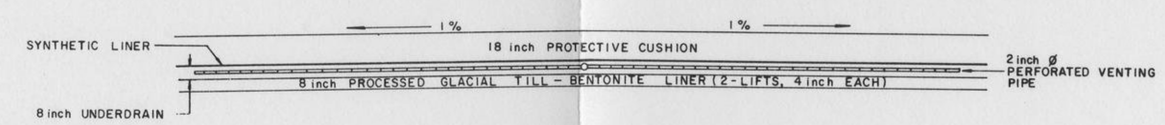
SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: J.J.T.	DATE: 10-24-85	CHECKED BY: J.F. Wallace	DATE: 11-26-85
APPROVED BY:	DATE:	APPROVED BY: C.C. Schrader	DATE: 11-25-85
APPROVED BY:	DATE:	EXXON: D.E. Moe	DATE: 11/22/85
DRAWING NO: **FIGURE 1.2-45**		SHEET 4 OF 6	REVISION NO

DESIGN PRODUCTS CO.

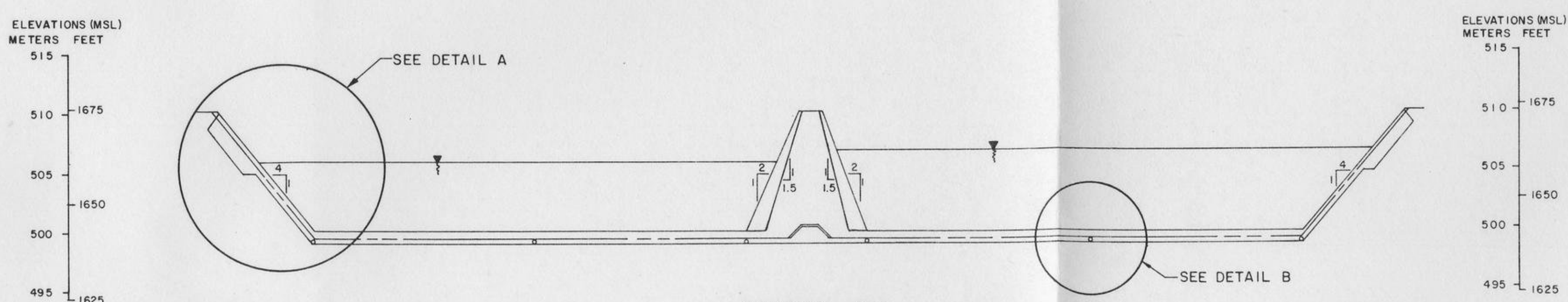




DETAIL A
NOT TO SCALE



DETAIL B
NOT TO SCALE



SECTION A-A

0 50 100 200
SCALE IN FEET

0 25 50 100
SCALE IN METERS
VERTICAL EXAGGERATION 5x

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE DURING FINAL ENGINEERING

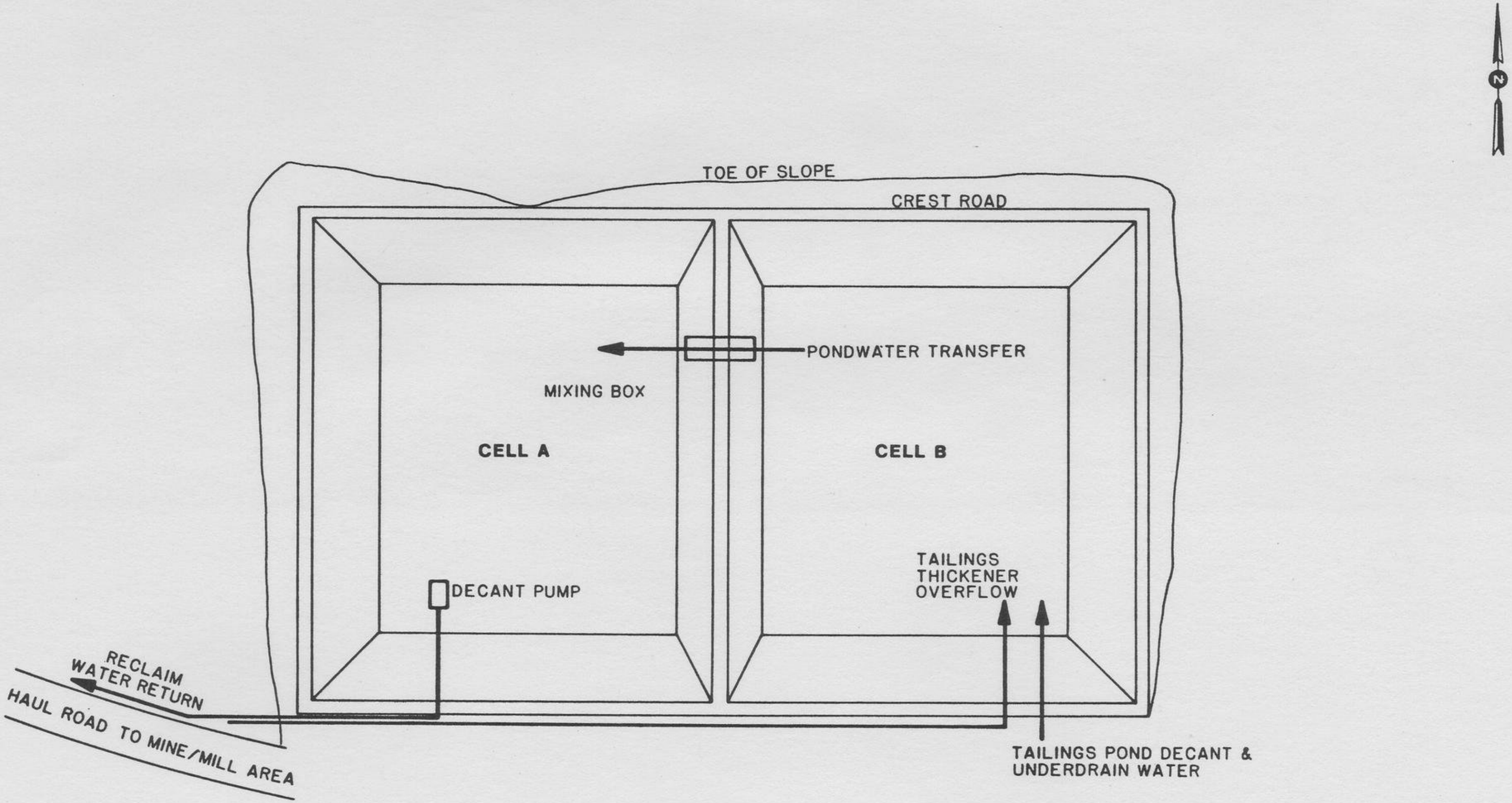
REVISED	DATE	BY	DESCRIPTION

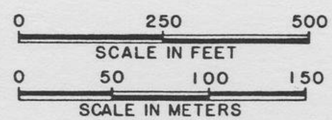
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
RECLAIM POND
GAS VENTING & LEAK DETECTION
PIPING SYSTEM

SCALE: AS SHOWN | STATE: WISCONSIN | COUNTY: FOREST
DRAWN BY: P. D. P. | DATE: 10/25/85 | CHECKED BY: [signature] | DATE: 11-21-85
APPROVED BY | DATE | APPROVED BY: D. E. Moe | DATE: 11/22/85
APPROVED BY | DATE | EXXON: E. C. Schroeder | DATE: 11-25-85
DRAWING NO: FIGURE 1.2-46 | SHEET 5 OF 6 | REVISION NO

DESIGN PRODUCTS CO.—





Typical Representations: Refinements
May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
**RECLAIM WATER POND
WATER HANDLING SYSTEM**

SCALE SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 9/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.R. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON DT Moe	DATE 11/13/85
DRAWING NO FIGURE 1.2-47		SHEET ____ OF ____	REVISION NO

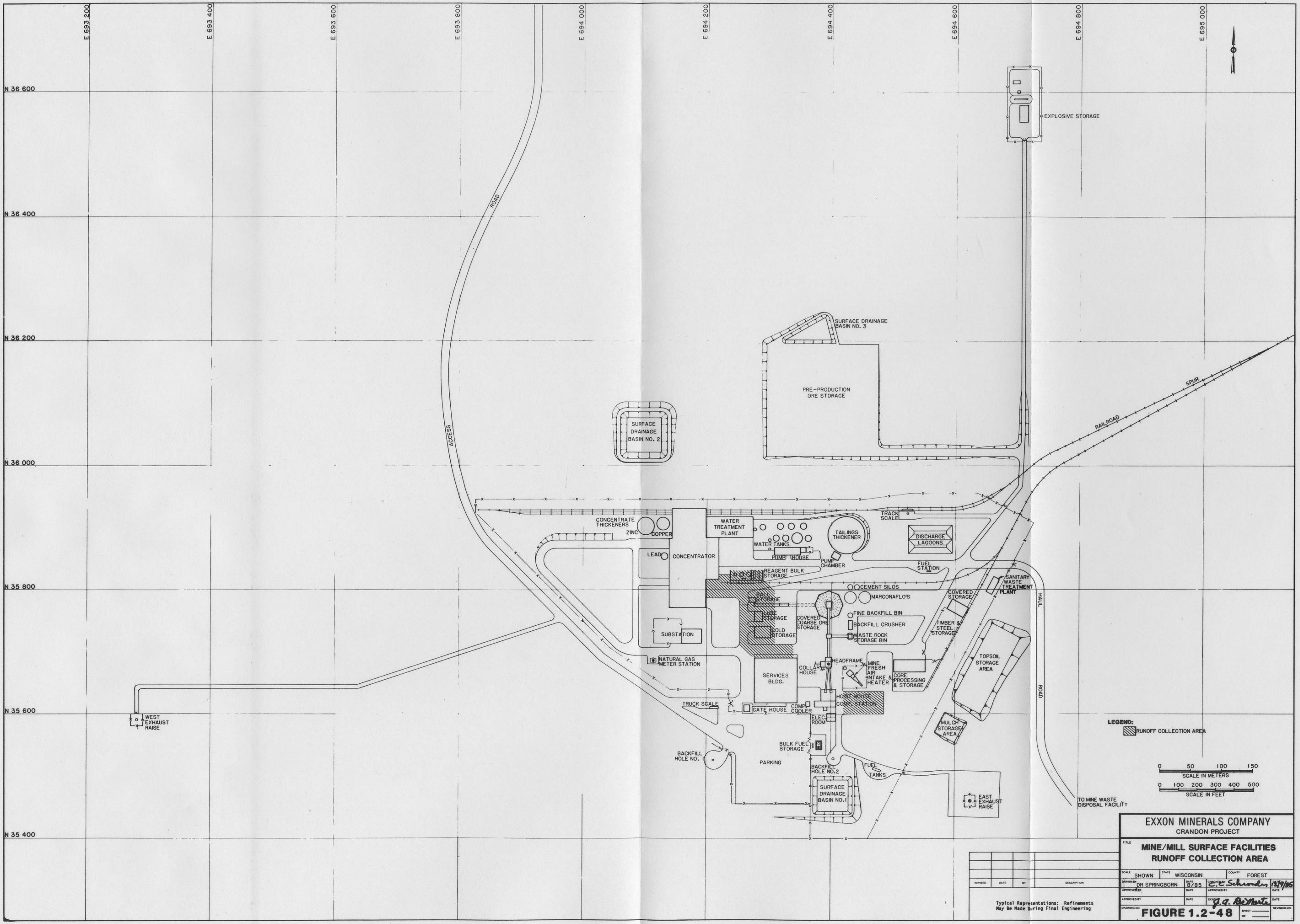
the pond are shown on Figure 1.2-47. The locations were chosen to provide maximum retention time in the system. The water pumping system from the reclaim pond will return the reclaim water to the mine/mill site for reuse in the ore processing operations.

A floating barge approximately 15 x 15 feet in size connected with an access bridge will be used to mount vertical shaft centrifugal pumps to return the reclaim water to the mine/mill site. Two 100-hp, 3,460 gallons per minute pumps, one operating and one standby, will provide the necessary pumping capacity.

1.2.4.14 Other Water Facilities

Other water facilities include those for handling runoff water from the mine/mill site that have potential for contamination. This subsection will only include a description of those facilities that are not discussed elsewhere in Chapter 1.

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; this area is shown on Figure 1.2-48. Runoff from this area will flow to a swale immediately north of the conveyor gallery leading to the fine crusher. 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.

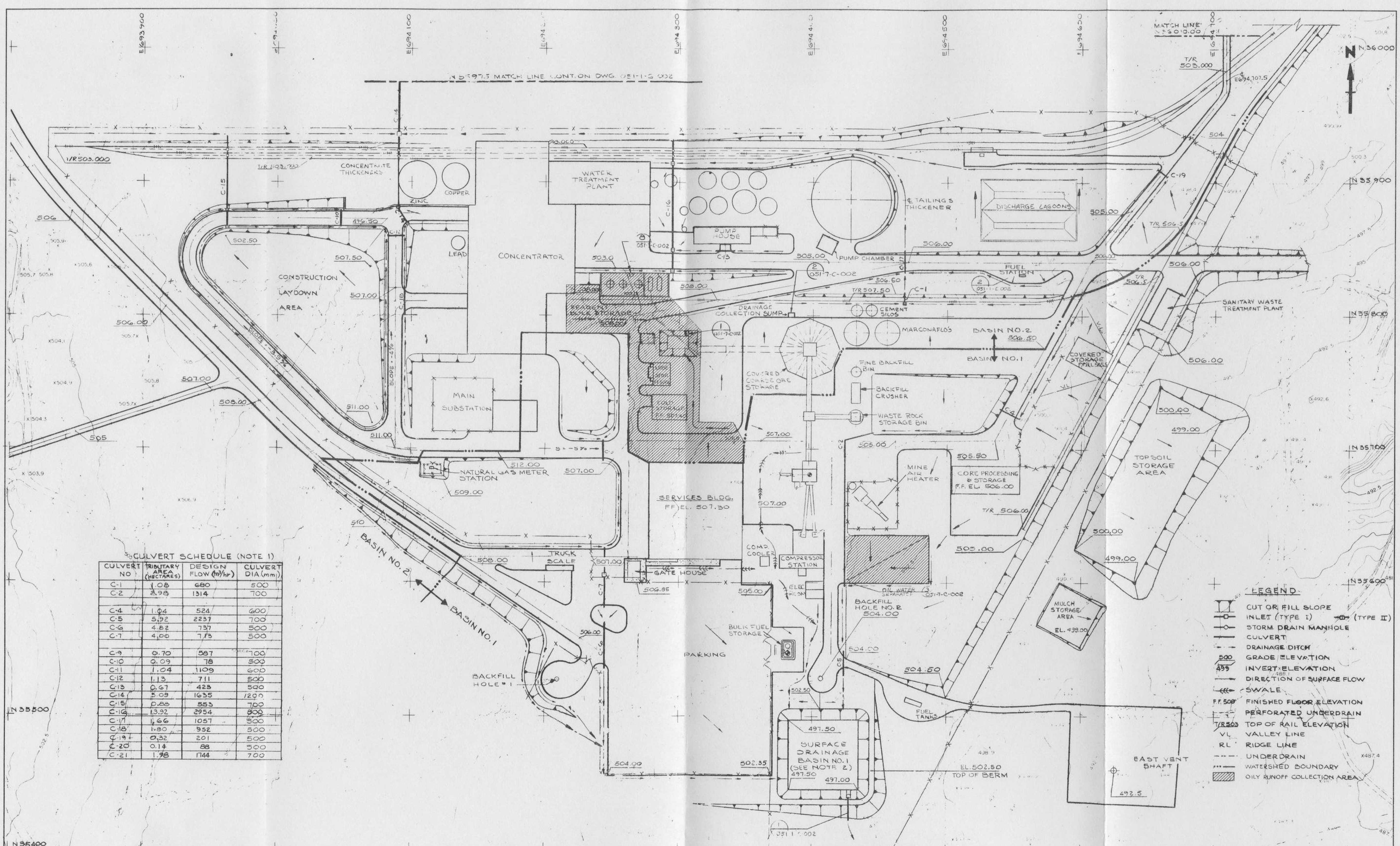

E 693 200
E 693 400
E 693 600
E 693 800
E 694 000
E 694 200
E 694 400
E 694 600
E 694 800
E 695 000
N 36 600
N 36 400
N 36 200
N 36 000
N 35 800
N 35 600
N 35 400
EXPLOSIVE STORAGE
ACCESS ROAD
SURFACE DRAINAGE BASIN NO. 3
PRE-PRODUCTION ORE STORAGE
SURFACE DRAINAGE BASIN NO. 2
RAILROAD SPUR
CONCENTRATE 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
SANITARY WASTE TREATMENT PLANT
HAUL ROAD
CEMENT SILOS
MARCONAFLO'S
COVERED STORAGE
BALL STORAGE
LUBE STORAGE
COLD STORAGE
COVERED COARSE ORE STORAGE
FINE BACKFILL BIN
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN
TIMBER & STEEL STORAGE
TOPSOIL STORAGE AREA
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
MULCH STORAGE AREA
WEST EXHAUST RAISE
BULK FUEL STORAGE
BACKFILL HOLE NO. 1
PARKING
BACKFILL HOLE NO.2
FUEL TANKS
SURFACE DRAINAGE BASIN NO.1
EAST EXHAUST RAISE
TO MINE WASTE DISPOSAL FACILITY
LEGEND:
RUNOFF COLLECTION AREA
0 50 100 150
SCALE IN METERS
0 100 200 300 400 500
SCALE IN FEET
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
MINE/MILL SURFACE FACILITIES
RUNOFF COLLECTION AREA
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
DATE 9/85
C. C. Schroeder 12/9/85
APPROVED BY
DATE
J. A. DeMarte
REVISED
DATE
BY
DESCRIPTION
DRAWING NO.
FIGURE 1.2-48
SHEET OF
REVISION NO.
Typical Representations: Refinements May Be Made During Final Engineering

Equipment Laydown Area - An area located south 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 2.9 acres. Assuming average annual precipitation and no allowance for evaporation, runoff from these areas will add 16 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 contractor to a reprocessing facility. Waste oil with a flashpoint under 140°F will not be used. An estimate of the volume of waste oil is not available and, therefore, frequency of shipment to reprocessing facilities is unknown.

Surface Water Drainage - Figures 1.2-49 and 1.2-50 show 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. Sizing criteria for these basins are included on Figures 1.2-49 and 1.2-50. Details of the drainage basins and the other surface water drainage facilities are included on Figure 1.2-51.



CULVERT SCHEDULE (NOTE 1)

CULVERT NO	TRIBUTARY AREA (HECTARES)	DESIGN FLOW (m^3/hr)	CULVERT DIA (mm)
C-1	1.08	680	500
C-2	2.98	1314	700
C-4	1.04	524	600
C-5	5.92	2237	700
C-6	4.82	737	500
C-7	4.00	713	500
C-9	0.70	587	700
C-10	0.09	78	500
C-11	1.04	1109	600
C-12	1.13	711	500
C-13	0.67	428	500
C-14	5.09	1635	1200
C-15	0.88	553	700
C-16	13.92	2954	800
C-17	1.66	1057	500
C-18	1.80	952	500
C-19	0.32	201	500
C-20	0.14	88	500
C-21	1.98	1744	700

NOTES:

1. CULVERT DIAMETERS ARE BASED ON ABILITY TO PASS THE PEAK FLOW FROM 10-YR STORMS CALCULATED BY THE RATIONAL FORMULA AND USING THE FOLLOWING RUNOFF COEFFICIENTS:
   - PAVED AREAS AND ROOFS C=0.90
   - GRAVEL AND NATURAL GROUND C=0.50
   - COMPOSITE AREAS C=0.70

   MINIMUM CULVERT DIAMETER = 500MM
2. VOLUME OF SURFACE DRAINAGE BASIN NO. 1 IS BASED ON THE FOLLOWING CRITERIA:
   - WATER CAPACITY IS BASED ON THE 25-YR, 24-HR STORM VOLUME (8325 M^3 NOT INCLUDING FREEBOARD & SEDIMENT VOLUME)
   - RUNOFF/RAINFALL RATIO = 0.75
   - FREEBOARD = 1.0 M
   - SEDIMENT DEPTH = 1.0 M

REVISED	DATE	BY	DESCRIPTION
4	10-8-85	DRS	[illegible]
3	1-11-84	DRS	GEN REVISION
2	11-16-83	JD	GENERAL REVISION
1	9-16-83		GENERAL REVISION

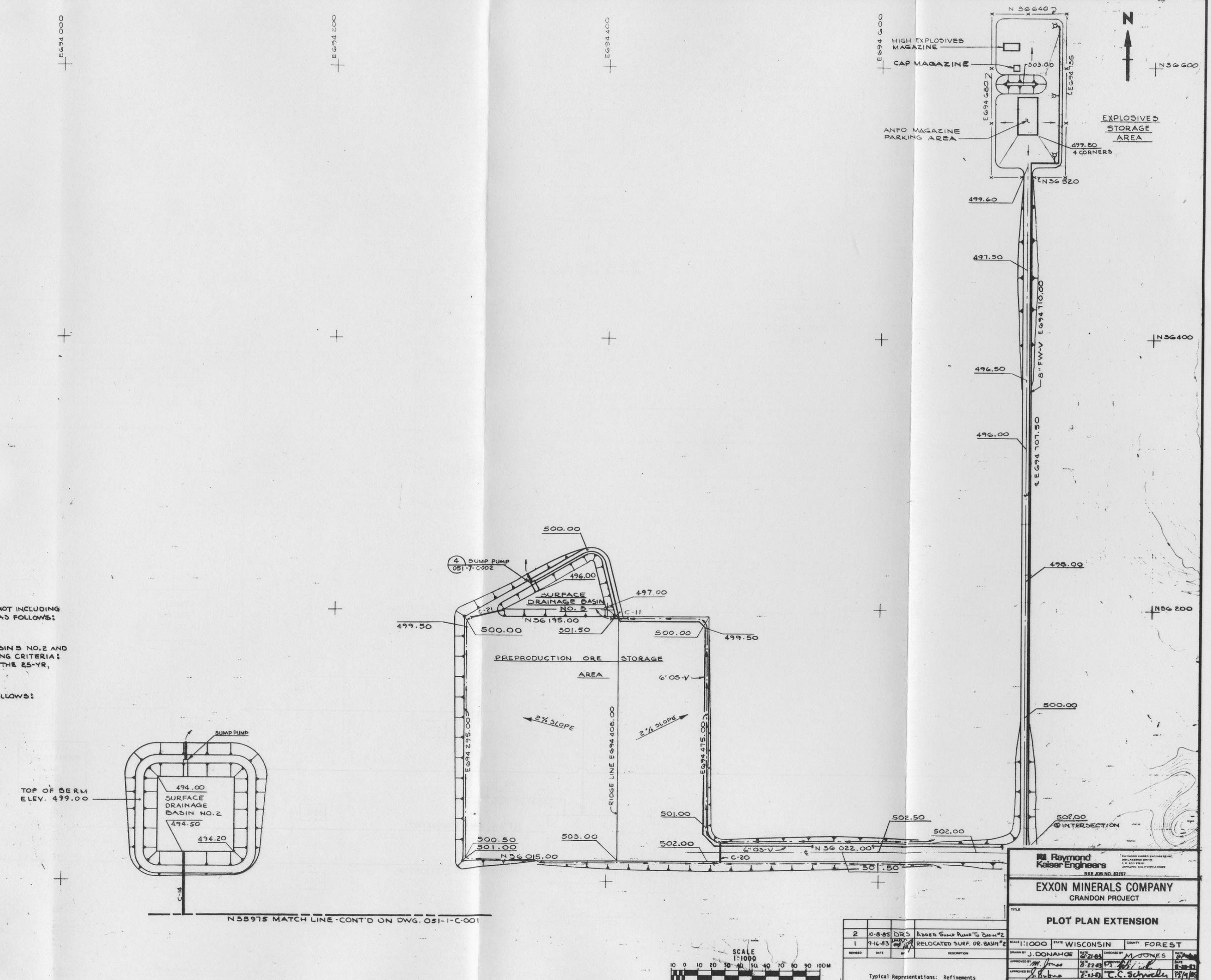
Raymond Kaiser Engineers
RAYMOND KAISER ENGINEERS INC.
300 LAKESIDE DRIVE
P. O. BOX 23210
OAKLAND, CALIFORNIA 94623
RKE JOB NO. 83157

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
GRADING & DRAINAGE PLAN

SCALE 1:1000 | STATE WISCONSIN | COUNTY FOREST
DRAWN BY J. DONAHOE DATE 6/23/83 | CHECKED BY M. JONES DATE 8/22/83
APPROVED BY [signature] DATE 8/22/83 | APPROVED BY [signature] DATE 8/25/83
APPROVED BY [signature] DATE 8/25/83 | EXXON C. C. Schroeder DATE 12/9/83
DRAWING NO. **FIGURE 1.2-49** | SHEET 1 OF 1 | REVISION NO. 4

051-1-C-001



NOTES:

1. SURFACE DRAINAGE BASIN VOLUMES NOT INCLUDING FREEBOARD AND SEDIMENT VOLUME ARE AS FOLLOWS:
   - BASIN NO. 2 - 10,900 M^3
   - BASIN NO. 3 - 3,460 M^3
2. VOLUME OF SURFACE DRAINAGE BASINS NO. 2 AND NO. 3 ARE BASED ON THE FOLLOWING CRITERIA:
   - WATER CAPACITY IS BASED ON THE 25-YR, 24-HR STORM.
   - FREEBOARD = 1.0 m
   - SEDIMENT DEPTH = 1.0m
   - RUNOFF/RAINFALL RATIO IS AS FOLLOWS:
     - BASIN NO. 2 - 0.75
     - BASIN NO. 3 - 1.00

REVISED	DATE	BY	DESCRIPTION
2	10-8-85	DRS	ADDED SUMP PUMP TO BASIN #2
1	9-16-83	[illegible]	RELOCATED SURF. DR. BASIN #2

Typical Representations: Refinements May Be Made During Final Engineering

Raymond Kaiser Engineers
RKE JOB NO. 83157

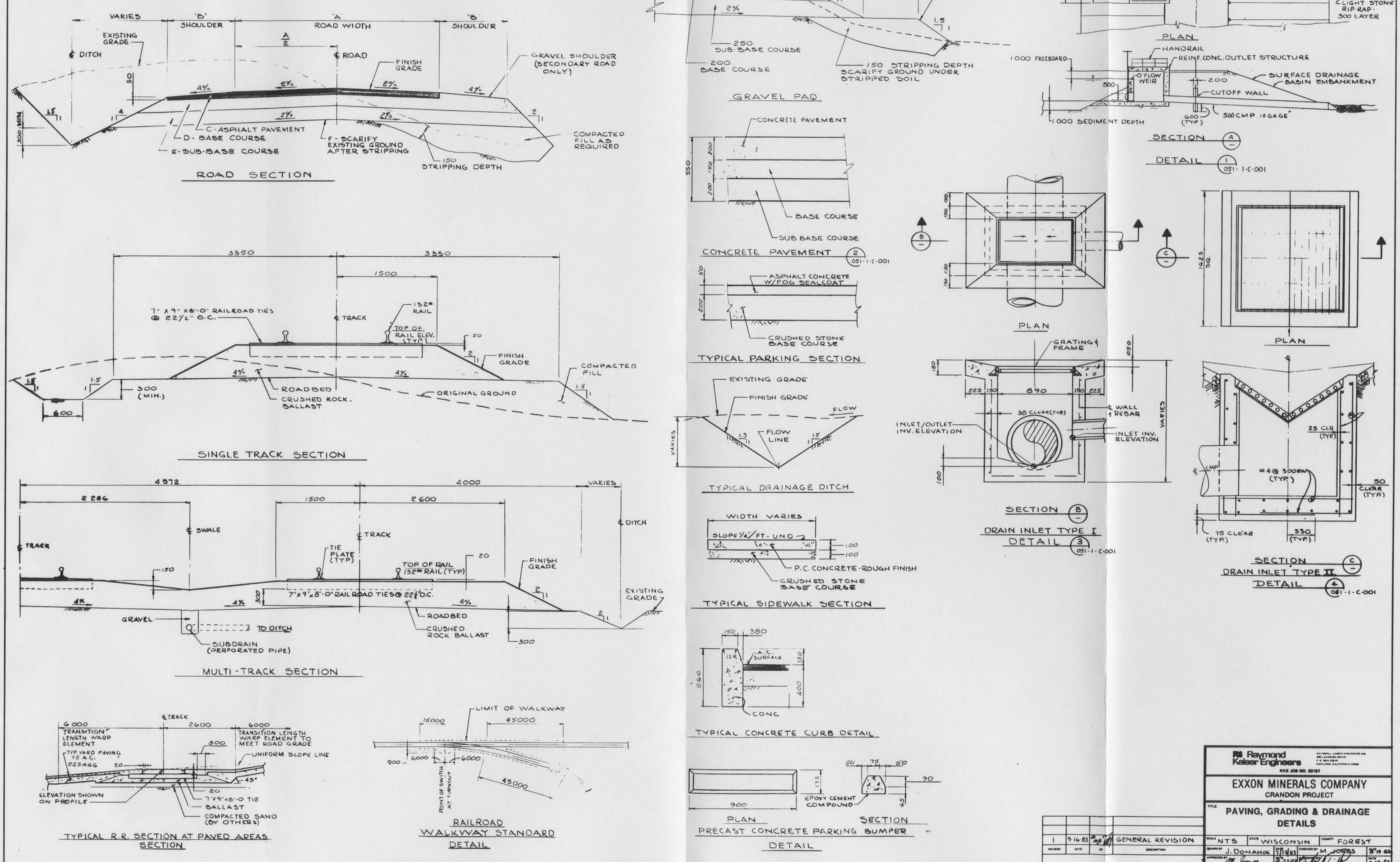
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: PLOT PLAN EXTENSION

SCALE 1:1000	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY J. DONAHOE	DATE 6-21-83	CHECKED BY M. JONES	DATE [illegible]
APPROVED BY M. Jones	DATE 8-22-83	APPROVED BY [illegible]	DATE 8-23-83
APPROVED BY S. Bubna	DATE 8-23-83	EXXON C.C. Schroeder	DATE 12/9/85
DRAWING NO. FIGURE 1.2-50		SHEET 1 OF 1	REVISION NO. 2

ROAD PAVEMENT SCHEDULE

NAME	A	B	C	D	E	F
CLASS A	7.500	2.500	0.100	0.200	0.250	0.150
CLASS B	7.500	1.800	0.100	0.200	0.250	0.150
CLASS C	6.00	–	0.050	0.200	–	0.150
CLASS D	VARIES	VARIES	–	0.200	–	0.150



REVISION	DATE	BY	DESCRIPTION
1	9-16-83		GENERAL REVISION

Raymond Kaiser Engineers

EXXON MINERALS COMPANY
CRANDON PROJECT

PAVING, GRADING & DRAINAGE DETAILS

SCALE NTS | STATE WISCONSIN | COUNTY FOREST
DRAWN BY J. DONAHOE | CHECKED BY M. JONES

FIGURE 1.2-51 | SHEET 1 | REVISION NO 1

051-1-C-002

If the basins collect sediment in excess of their design, the sediments will be removed (excavated) and hauled to the topsoil stockpile or one of the soil material stockpiles at the MWDF. Separate basins (e.g., surface drainage basins No. 2 and 3) are provided in the mine/mill site to collect and transfer for treatment any surface waters that could potentially be contaminated from mining operations.

Except for possible contaminants from parking lots and roadways and slightly higher suspended solids content, the surface runoff water quality should be comparable to current surface drainage water quality in the site area.

Water from drainage basin No. 1 will be discharged to the south of the mine/mill site into wetland F11 between Skunk and Little Sand lakes. Ultimately, this water would enter Little Sand Lake. Basin No. 2 will provide a temporary containment area for emergency spills from the mill. Spill materials and surface water runoff entering this basin will be pumped to the reclaim pond via the tailings thickener overflow. This basin will contribute an estimated 10 gallons per minute to the reclaim pond.

1.2.4.15 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. Details of the storage area are shown on Figure 1.2-50. 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 has a volume of about 1,480,000 gallons and is sized to hold the volume of water from a 25-year, 24-hour storm event collected on a 8-acre area. The calculated volume of water from such a storm event is 912,000 gallons; therefore, the volume is more than adequate to handle runoff from such a storm event.

1.2.4.16 Core Processing and Storage

A pre-engineered building with an area of 10,760 square feet will be constructed east of the coarse ore storage building (Figure 1.2-29). This building will be used for processing and storage of drill cores.

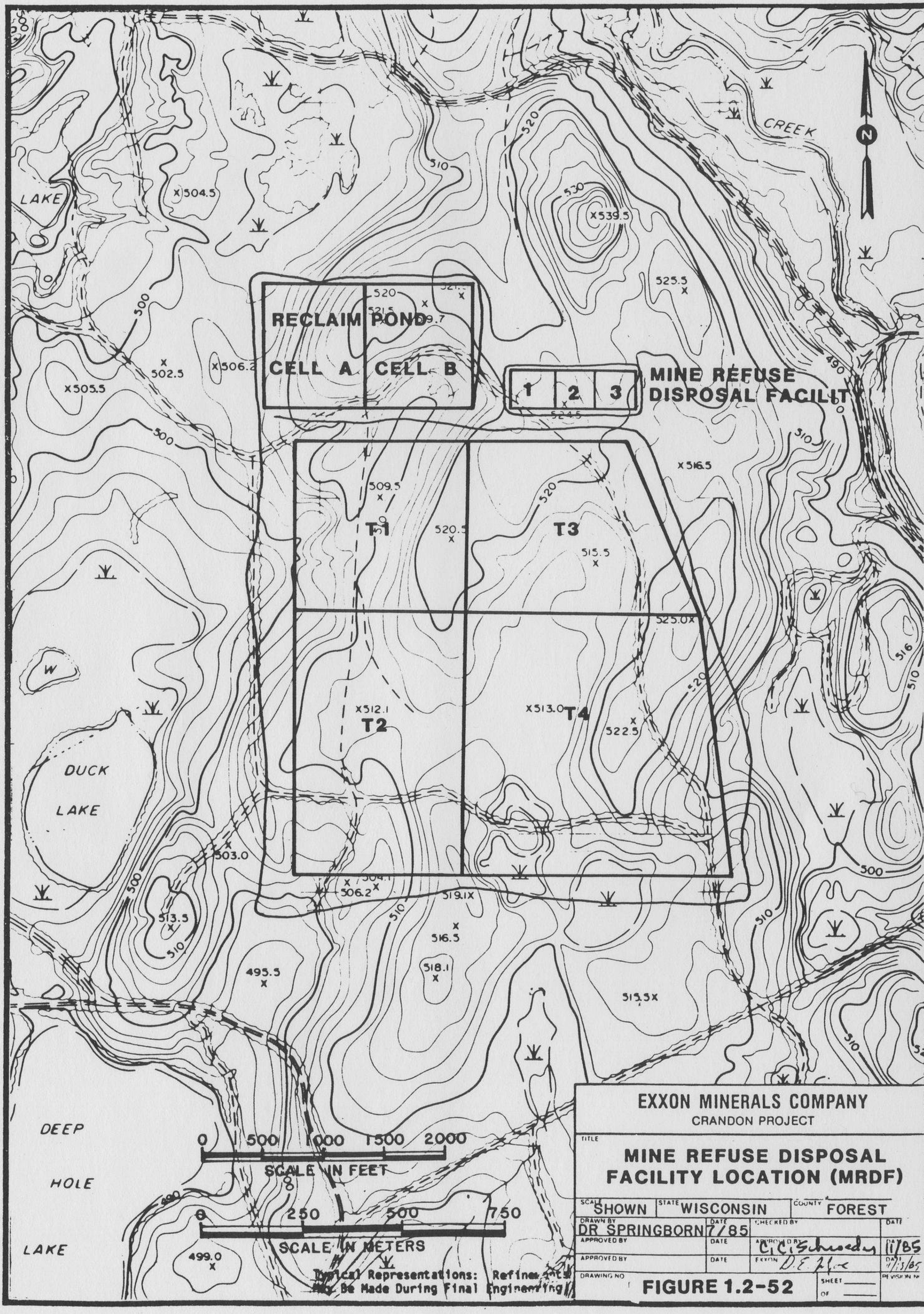
1.2.4.17 Truck and Railroad Scales

A truck scale will be located on the main access road at the approach to the gate house (Figure 1.2-29). 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 approximately 985 feet east of the concentrate loadout area (Figure 1.2-29). The purpose of this scale will be to weigh carloads of concentrate prior to shipment and bulk materials such as lime, soda ash, and cement that will be received.

1.2.4.18 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 1.2-52. Based on quantity projections of refuse for disposal over the life of the Project, the facility would require approximately 15 acres. The MRDF would be developed one cell at a time with each cell covering approximately 5 acres. Phased development will



EXXON MINERALS COMPANY

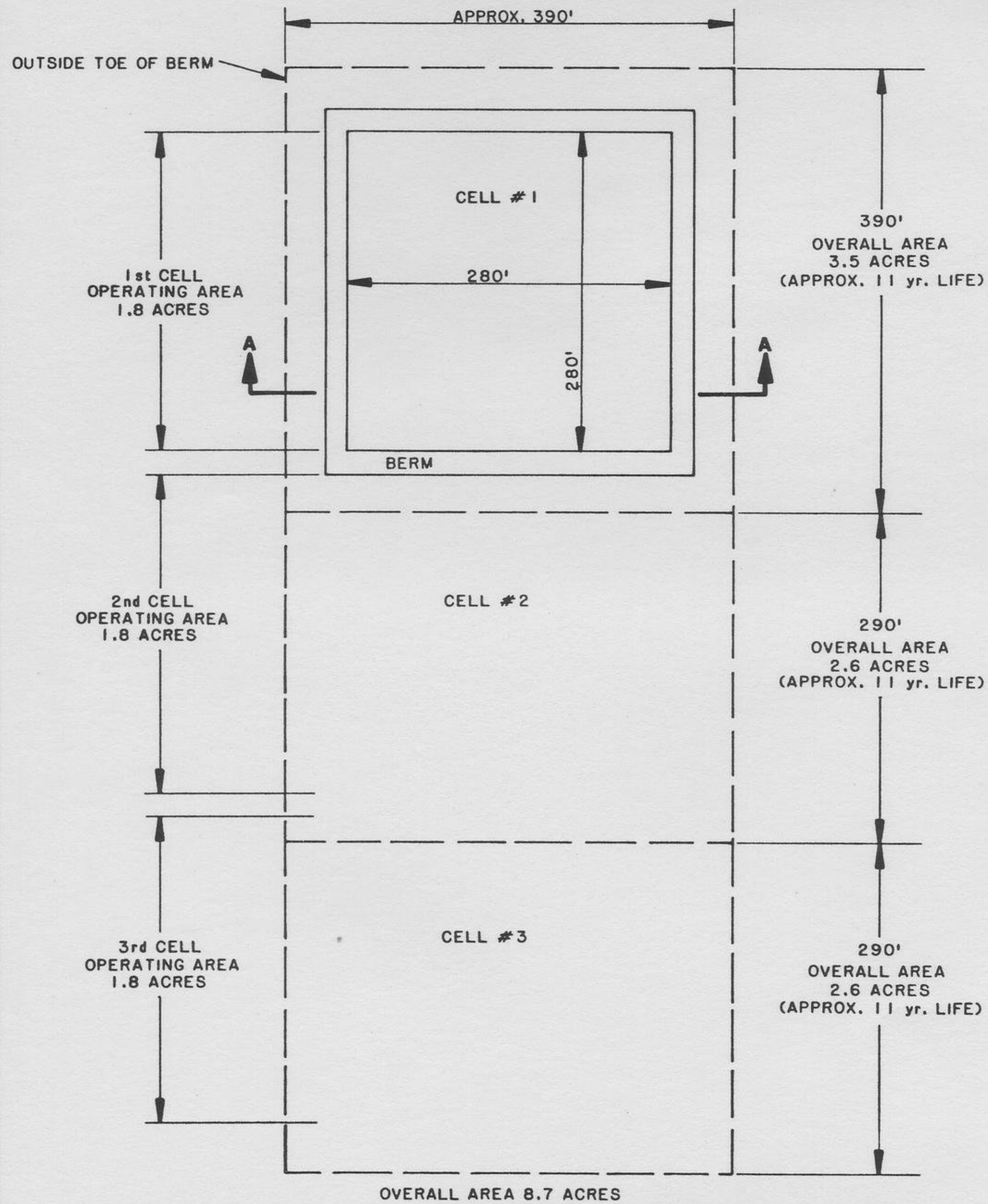
CRANDON PROJECT

TITLE

MINE REFUSE DISPOSAL FACILITY LOCATION (MRDF)

SCALE SHOWN	STATE WISCONSIN	COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 7/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroedy	11/85
APPROVED BY	DATE	EXXON D.E. [illegible]	11/13/85
DRAWING NO	FIGURE 1.2-52	SHEET OF	REVISION No

allow resizing of the later cells if necessary. The MRDF will employ seepage control and leachate collection features in the pond bottom and a final reclamation seal to prevent long-term infiltration. A generalized configuration and cross-section for the MRDF is presented on Figure 1.2-53. Specific detail for this facility is included in the Feasibility Report for the MRDF.



GENERALIZED CONFIGURATION

(CONFIGURATION NOT ADJUSTED FOR SPECIFIC TOPOGRAPHY)

0 100 200 300

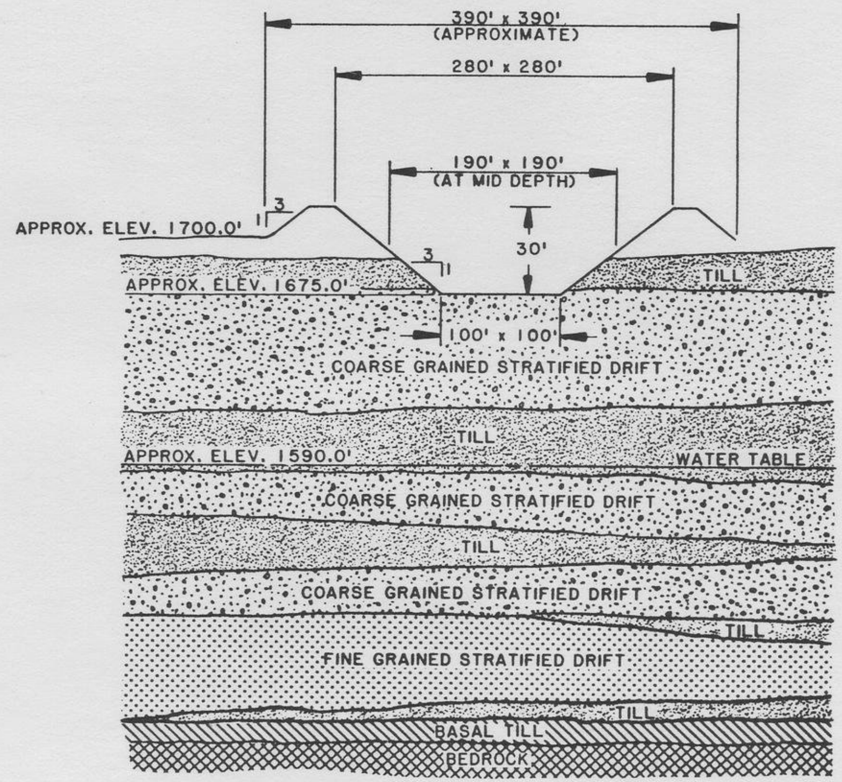
SCALE IN FEET

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. Schroeder	DATE: 11/13/85
APPROVED BY:	DATE:	EXXON: DF Moe	DATE: 11/13/85
DRAWING NO: FIGURE 1.2-53		SHEET ___ OF ___	REVISION NO

1.2.5 References Cited

D'Appolonia Consulting Engineers, Inc., 1982, Soil attenuation study, v. 1 of 2, Exxon Minerals Company Crandon Project: D'Appolonia Consulting Engineers, Inc., Pittsburgh, Pennsylvania.

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______, 1982b, Preliminary engineering, mine/mill access road (alternate alignment): Foth and Van Dyke and Associates, Inc., Green Bay, Wisconsin.

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Pipeline Systems, Inc., 1982, Tailings slurry and solution transport pipeline systems: Pipeline Systems, Inc., Orinda, California.

Prickett & Associates, 1984, Predictive ground water inflow modeling and sensitivity analysis for the proposed Crandon mine: Report prepared for Exxon Minerals Company, Crandon Project, by Thomas A. Prickett & Associates, Champaign, Illinois.

1.3 CONSTRUCTION

The construction plan for the Crandon Project, including equipment, manpower, schedule and techniques, is described in the following subsections. The construction sequence is subject to optimization, along with equipment and techniques, during final engineering.

Construction of the facilities will not require new or unproven technology. The necessary craft skills, equipment types, and construction procedures for the surface facilities are well established and readily quantifiable. The work below ground will follow standard mining practices.

All personnel at the job-site will receive basic instruction in good safety practices and such practices will be strictly enforced throughout the life of the Project. All contractors will be required to follow safety procedures established by Exxon as well as applicable governmental codes. Exxon's safety programs and procedures have been developed as a result of experience gained on many major construction projects.

The schedule for construction will be paced by the main mine shaft and crusher facilities installation and sequenced to assure the availability of all environmental protection systems well in advance of the need date. In the subsections that follow, the principal elements of the construction program are addressed.

1.3.1 Facilities Construction

Activities scheduled to be performed during the Project construction phase are described in this subsection. Table 1.3-1 presents the current schedule of land area disturbance and reclamation phases from construction through operation and facilities closure phases.

1.3.1.1 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 Forest Inventory and Timber Appraisal Report prepared for the Crandon Project (Steigerwaldt, 1982) included an estimate of timber resources recoverable during mine/mill site development. By adjusting estimates presented in the above report to actual cleared area for the mine/mill site and applying percentage waste factors, the amount of wood waste from timber harvesting was estimated. Using a factor of 65 percent waste (culls, branches, and tops) on an air dry weight basis, a

TABLE 1.3-1

AREA DISTURBANCE / RECLAMATION SCHEDULE

ACTIVITY	CONSTR.			OPERATIONS																													RECLAM.				
CONSTRUCTION PHASE	PHASE 1				PHASE 2							PHASE 3							PHASE 4														PHASE 5				
Elapsed Time (Years)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Start Construction	▼																																				
Mine/Mill Site	115	(25)	(35)	(10)																														(15)	(15)	(15)	
Access Road	35	(10)																																		(25)	
Railroad Spur & Siding	45	(10)																																	(35)		
Discharge Water Line	15	(15)																																			
Haul Road / Tailings Pipeline	10																																			(10)	
Landfill	5									5	(5)										5	(5)														(5)	
Reclaim Pond	25	(5)		25	(10)																												(35)				
Tailings Pond T1	30	30	(10)					(25)	(25)																												
Tailings Pond T2					95		(20)								(45)																					(30)	
Tailings Pond T3		25										45		(15)								(25)	(30)														
Tailings Pond T4													20						120		(30)														(60)	(50)	
Construction Support Area	25																																		(25)		
Borrow Area																																		40		(40)	
Net Disturbed Area	305	295	250	265	350	350	330	305	280	285	280	325	345	330	285	285	285	285	405	405	380	350	320	320	320	320	320	320	320	320	320	320	285	310	175	0	

NOTES: AREAS IN ACRES (ROUNDED TO NEAREST 5 ACRES)
AREAS IN PARENTHESES INDICATE RECLAMATION

Typical Representations: Refinements May Be Made During Final Engineering

12/16/85

wood quantity of approximately 1,900 tons was estimated. The calculations leading to these totals are presented in Table 1.3-2 and are further detailed in Appendix 1.3A (Hansen, 1984). Stumps removed during grubbing would increase these totals.

The approximate 1,900 tons of waste wood that are chipped for mulch and stockpiled will be stored adjacent to the topsoil storage area. Assuming a density of 20 pounds per cubic foot for the waste wood, approximately 7,070 cubic yards of storage volume will be required.

To minimize the amount of burning that will be required during clearing of the Project site, consideration will be given to using contractors having whole tree chipping capability for the removal of wood.

The site will be cleared, grubbed, and rough graded during the initial construction activities. Since there is no phasing to this work, there will be no interim conditions for any length of time.

A plot plan for the mine and mill site is presented on Figure 1.2-2. The storage area for the salvaged topsoil, estimated at 70,000 cubic yards, is shown on the east side of the mine/mill site (Figure 1.2-2). Earthwork calculations for the mine/mill site indicate a net material excess of 92,400 cubic yards in addition to the topsoil stockpile. This excess material will be utilized in the construction of the MWDF.

Erosion control will be developed as necessary with the rough grading. To the extent possible, the three permanent surface drainage basins will be used for runoff control. The basin areas will be

TABLE 1.3-2

WASTE WOOD FROM MINE/MILL SITE, ACCESS ROAD AND RAILROAD SPUR CLEARING (STEIGERWALDT, 1982)

Acres	Pulpwood (Cords)	Saw Timber (Board Feet)
Mine/Mill Site		
201	2,761	186,795
(Revise cleared area to 115 acres)		
115/201 (approximate)	1,565	105,943
Air dry tons	2,739	198
Waste at 65%*	1,780	129
Total: 1,909 Tons		
Access Road		
75	550	12,157
(Revise cleared area to 35 acres)		
35/75 (approximate)	272	5,997
Air dry tons	476	11.2
Waste at 65%*	309	7
Total: 316 Tons		
Railroad Spur		
74	676	40,709
(Revise cleared area to 45 acres)		
45/74 (approximate)	411	24,755
Air dry tons	719	46.4
Waste at 65%*	467	30
Total: 497 Tons		

Notes: Cord - 128 ft^3
Wood Volume - 80 ft^3
Air dry weight (hardwoods) - 3,500 lb/cord (1.75 tons per cord)
Air dry weight (hardwoods) - 45 lb/ft^3 (0.0225 $tons/ft^3$)

*Source: Dames and Moore 1978-1979 report prepared for WPSC on wood availability in northern Wisconsin. This 65% represents culls, branches, and tops normally left in the field after harvest - stumps would increase the percentage.

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 provision 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 portion of the final storm drainage system not installed with the initial site work will 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 might 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.

Figures 1.2-49 and 1.2-50 include a culvert schedule which presents the water flow rates in the ditches and culverts for a 10-year, 24-hour storm. Runoff coefficients and tributary areas are included on this figure.

Except for the road to the explosive storage area on the northeast side of the mine/mill site, all surface water will be directed to surface drainage basins No. 1 and 2. The drainage basins are sized for a 25-year, 24-hour storm, with pond depth allowance for sediment accumulation and maintenance of freeboard. As shown on Figure 1.2-49, drainage is also collected separately from two other small areas in the central portion of the mine/mill site. This water will be directed through an oil/water separator and then to the water reclaim pond system via the tailing thickener overflow sump.

Dust control for areas under development will be accomplished using sprinkler trucks when necessary.

The type, size, quantity, and schedule of standard earth-working equipment typical of that to be used during site preparation activities are presented in subsection 1.3.3.2.

The primary nonmetallic materials needed for construction of the Project along with approximate quantities and 1985 costs (material only) are summarized below:

Item	Quantity	1985 $/Unit
Concrete (includes surface and undergound)	51,000 yd^3	37.60
Base Course (includes access road and in-plant roads)	32,000 yd^3	7.30
Subbase (includes access road and in-plant roads	37,700 yd^3	4.30
Asphalt Pavement	9,700 yd^3	32.50
Railroad Ballast (includes spur and siding)	41,700 tons	4.20
Railroad Subbase	13,700 tons	4.30
Bentonite	6,000 tons	128.20

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. Descriptions of the batch plants and their estimated air emissions have been included in the air permit application. 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.

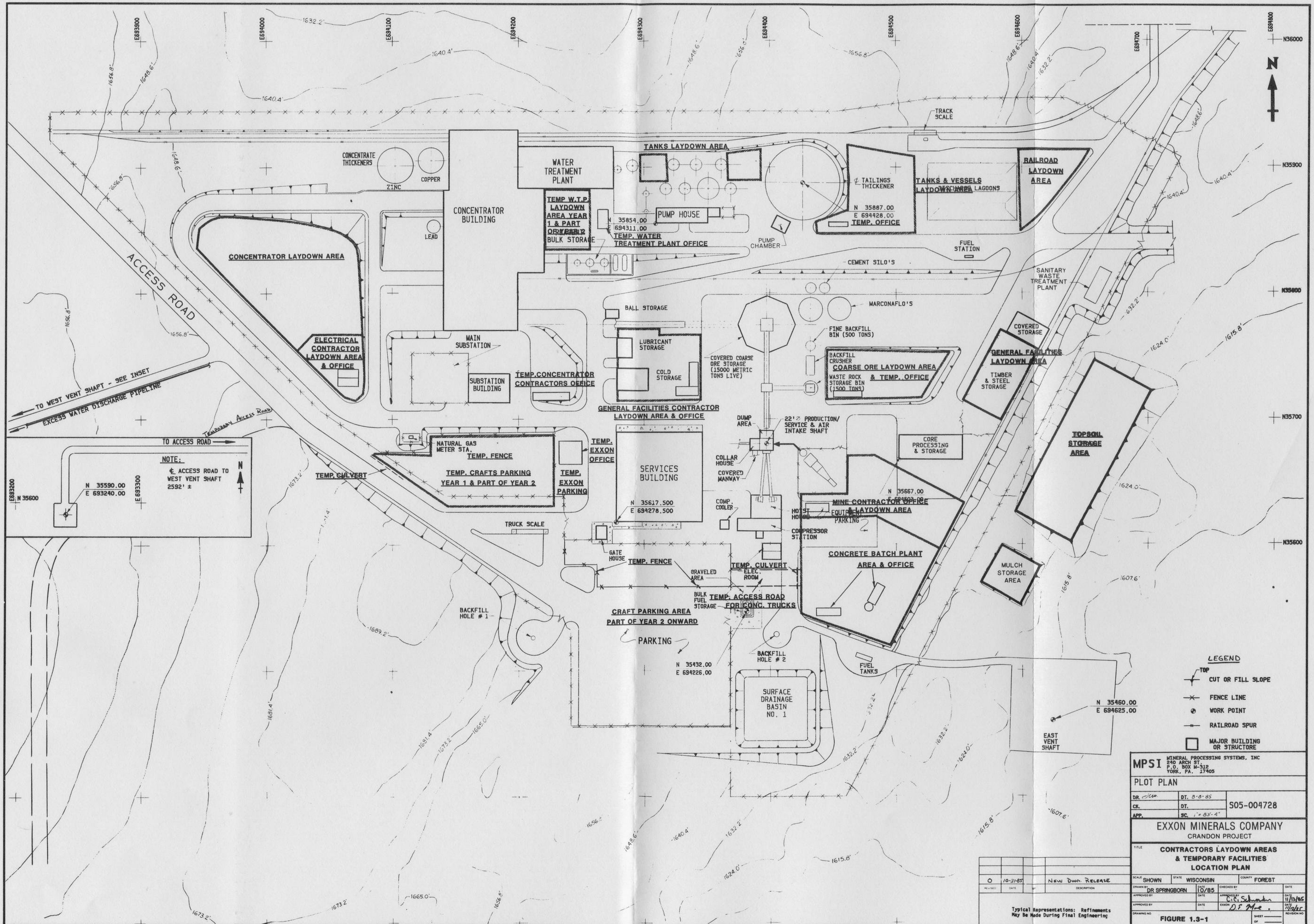
A second processing plant will be located in the tailing ponds construction area. This plant will be used to mix bentonite with native soils to provide liner material for the tailing ponds, reclaim water pond, refuse facility, surface water drainage basins, and the preproduction ore storage pad.

1.3.1.2 Temporary Facilities

The need for temporary structures 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 1.3-1).

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 (approximately 30 months).


ACCESS ROAD
CONCENTRATE THICKENERS
ZINC
COPPER
CONCENTRATOR BUILDING
LEAD
WATER TREATMENT PLANT
TANKS LAYDOWN AREA
TEMP W.T.P. LAYDOWN AREA YEAR 1 & PART OF YEAR 2
BULK STORAGE
N 35854.00 E 694311.00
PUMP HOUSE
TEMP. WATER TREATMENT PLANT OFFICE
PUMP CHAMBER
TAILINGS THICKENER
N 35887.00 E 694428.00
TEMP. OFFICE
TANKS & VESSELS LAYDOWN AREA
RECLAIM LAGOONS
RAILROAD LAYDOWN AREA
TRACK SCALE
FUEL STATION
CEMENT SILO'S
SANITARY WASTE TREATMENT PLANT
CONCENTRATOR LAYDOWN AREA
MARCONAFLO'S
BALL STORAGE
FINE BACKFILL BIN (500 TONS)
MAIN SUBSTATION
LUBRICANT STORAGE
COLD STORAGE
COVERED COARSE ORE STORAGE (15000 METRIC TONS LIVE)
BACKFILL CRUSHER
COARSE ORE LAYDOWN AREA & TEMP. OFFICE
WASTE ROCK STORAGE BIN (1500 TONS)
COVERED STORAGE
GENERAL FACILITIES LAYDOWN AREA
TIMBER & STEEL STORAGE
ELECTRICAL CONTRACTOR LAYDOWN AREA & OFFICE
SUBSTATION BUILDING
TEMP. CONCENTRATOR CONTRACTORS OFFICE
GENERAL FACILITIES CONTRACTOR LAYDOWN AREA & OFFICE
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 35590.00 E 693240.00
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
DUMP AREA
22' ∅ PRODUCTION/ SERVICE & AIR INTAKE SHAFT
COLLAR HOUSE
COVERED MANWAY
CORE PROCESSING & STORAGE
TOPSOIL STORAGE AREA
COMP. COOLER
HOIST HOUSE
EQUIPMENT PARKING
COMPRESSOR STATION
N 35667.00 E 694503.00
MINE CONTRACTOR OFFICE & LAYDOWN AREA
TRUCK SCALE
GATE HOUSE
TEMP. FENCE
GRAVELED AREA
TEMP. CULVERT
ELEC. ROOM
CONCRETE BATCH PLANT AREA & OFFICE
MULCH STORAGE AREA
BULK FUEL STORAGE
TEMP. ACCESS ROAD FOR CONC. TRUCKS
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
E693300
E694000
E694100
E694200
E694300
E694400
E694500
E694600
E694700
E694800
E693200
N36000
N35900
N35800
N35700
N35600
N35600
N
LEGEND
TOP
CUT OR FILL SLOPE
FENCE LINE
WORK POINT
RAILROAD SPUR
MAJOR BUILDING OR STRUCTORE
MPSI
MINERAL PROCESSING SYSTEMS, INC
240 ARCH ST.
P.O. BOX M-312
YORK, PA. 17405
PLOT PLAN
DT. 8-8-85
SC. 1" = 83'-4"
505-004728
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
0
10-31-85
NEW DWG. RELEASE
Typical Representations: Refinements May Be Made During Final Engineering
FIGURE 1.3-1

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 (N 34,694, E 693,352) 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, other arrangements would be made for supply of potable and construction water. During this time the 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 either be 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.

1.3.1.3 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.

The amount of wood waste from timber harvesting in the rights-of-way for the access road and railroad spur was estimated using forest inventory and timber appraisal data compiled by Steigerwaldt (1982). By adjusting the Steigerwaldt estimates to include cleared areas for the access road and railroad spur and applying a percentage waste factor of 65 percent, the amounts of wood wastes from timber harvesting were estimated to be approximately 320 tons for the access road right-of-way and 500 tons for the railroad spur (Table 1.3-2).

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 6 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.

After the various temporary sediment traps along the access road are no longer required, the sediments will be removed and transferred to either the topsoil stockpile area at the mine/mill area or to the soil stockpile areas at the MWDF.

Preliminary engineering drawings prepared by Foth and Van Dyke (1982) for the access road depict the entire alignment from State Highway 55 to the mine/mill site interface point. Drainage structure locations, typical sections showing revegetation, and settling basin details are included. The plan sheets also show the approximate slope intercept lines along the entire route, including limits of revegetation after construction.

Implementation of runoff and erosion control methods will be conducted concurrently with the cut-and-fill activities. These methods include topsoil application and hydroseeding promptly following finish grading to reduce the exposure of bare ground.

Locations of the temporary erosion control facilities to be utilized during construction, such as the straw bale or filter fabric silt traps and the sheet piling at the Swamp Creek crossing, will be determined during final engineering. These temporary facilities will be subject to further minor adjustments in the field depending upon actual conditions and performance.

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.

Wetland crossings will include temporary berms at the edge of the fill slopes to catch runoff from disturbed areas for sediment removal before the water enters the wetland. Where organic peat is removed from wetlands, it will be replaced with selected cut materials from locations within the road alignment.

The bridge at Swamp Creek will be provided with concrete abutments and wingwalls and the stream banks will be protected by rip-rap 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.

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.

The proposed access road will consist of a 3-inch bituminous concrete pavement underlain by a 12-inch crushed aggregate base. An estimated quantity of 62,500 tons of crushed aggregate base material will be required for the access road.

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.

1.3.1.4 Mine Construction

1.3.1.4.1 Mine Surface Facilities

Those surface facilities which relate specifically to the mine are the main shaft, headframe and collar house, hoist and compressor house, mine air heaters, backfill handling facilities, main mine exhaust fans, service building, mine dry (shower/locker facility), diesel fuel tanks, explosives magazines, and temporary development headframe and hoist at the east exhaust vent shaft collar.

1.3.1.4.2 Shafts and Collar

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

1) Main production and service shaft 22 to 24 feet finished diameter;

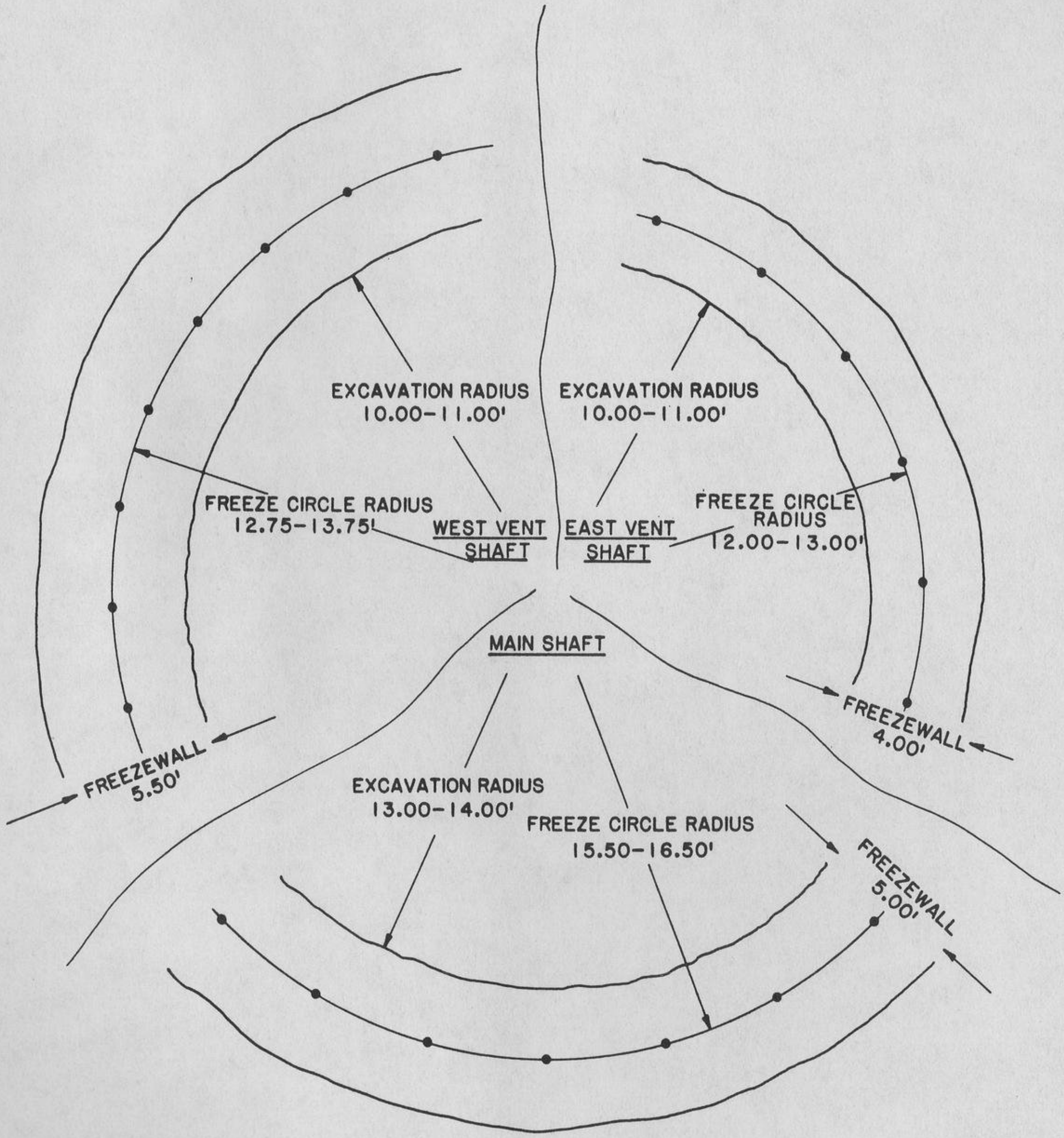
2) East exhaust vent shaft 16 to 18 feet finished diameter; and

3) West exhaust vent shaft 16 to 18 feet finished diameter (constructed during Year 5 of operations).

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 (calcium chloride brine) through a circular pattern of vertical pressure-tested steel cased boreholes (4 1/2 - 6 inches diameter) containing inner (1 1/2-inch diameter) 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.

Freezing system design, including the number of freeze holes, hole spacing, and required ice wall thickness, is contingent upon the geohydrologic conditions of each site. Designs for the Crandon shaft collars were prepared by Ground/Water Technology, Inc. (1983). Site design details are shown on Figures 1.3-2 through 1.3-4.



FREEZE PIPES AT 3.00-4.00' CENTERS
(TYPICAL)

MAIN SHAFT
FINISHED Ø - 22-24ft.

VENT SHAFTS
FINISHED Ø - 16-18ft.

LOCATION OF FREEZE PIPES

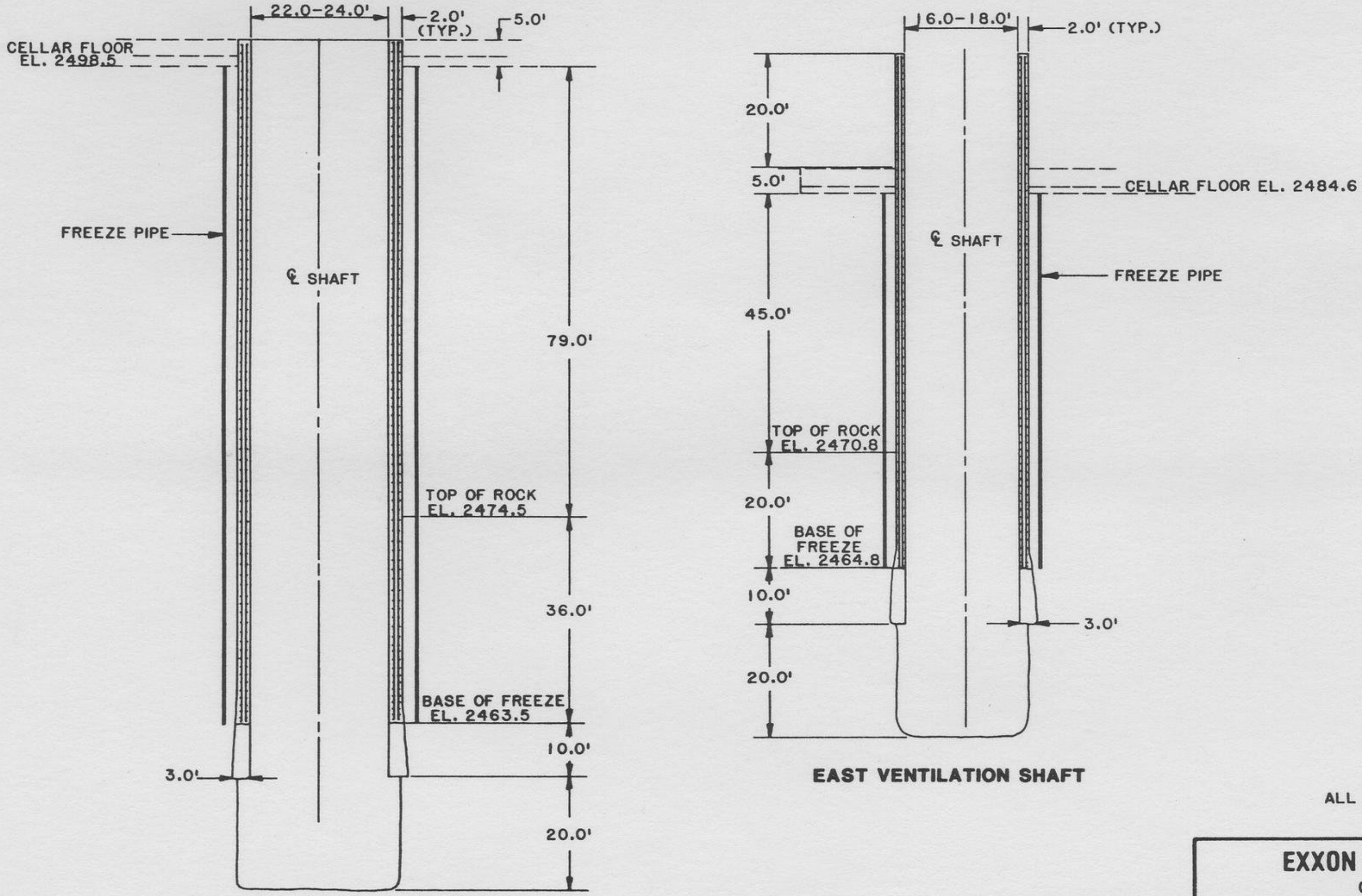
ALL DIMENSIONS ARE IN FEET

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
FREEZING OF THREE SHAFT COLLARS
DESIGN DETAILS

SCALE NONE	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 9/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON D.S. Moe	DATE 11/13/85
DRAWING NO FIGURE 1.3-2		SHEET ___ OF ___	REVISION NO



PRODUCTION (MAIN) SHAFT

EAST VENTILATION SHAFT

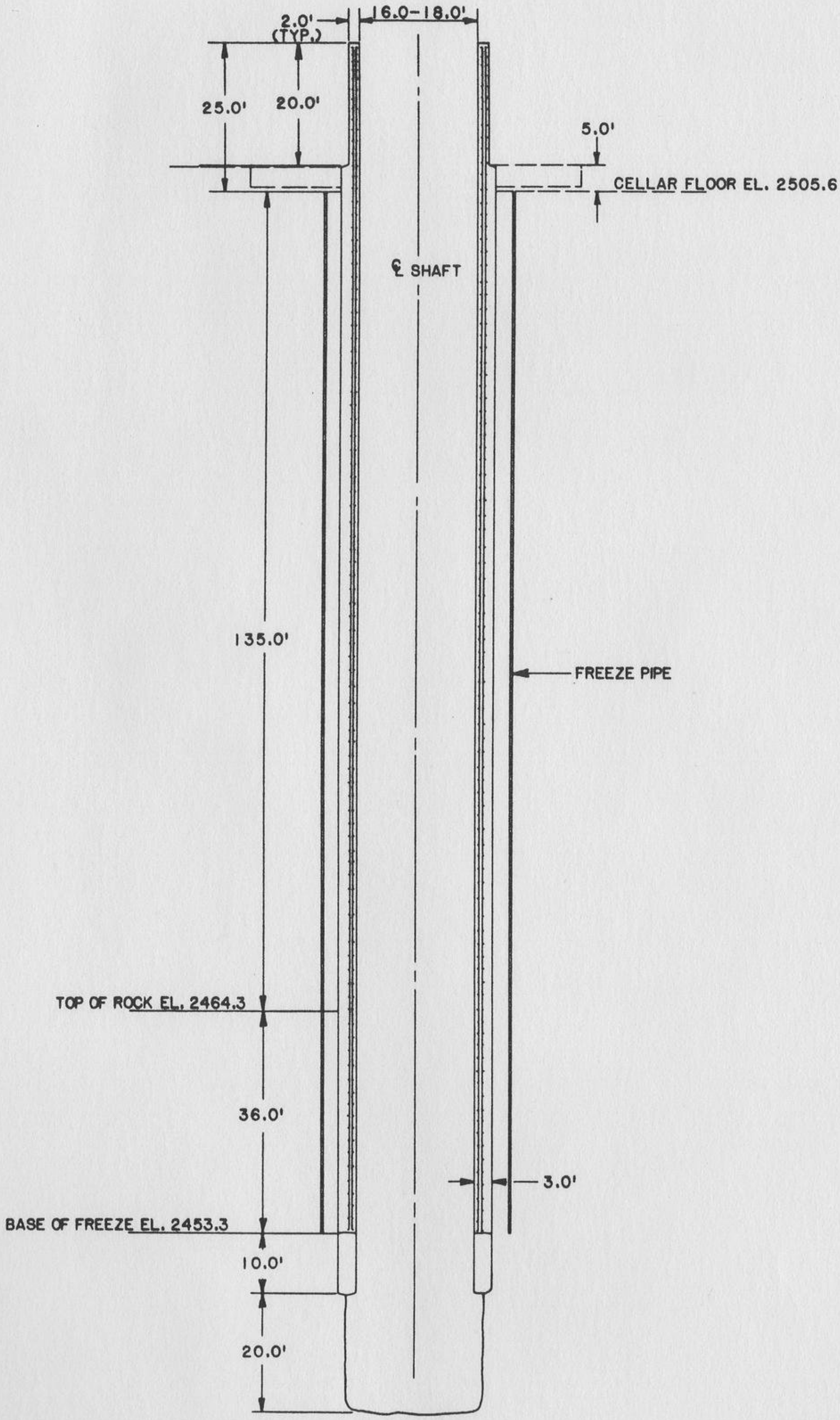
ALL DIMENSIONS ARE IN FEET

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
FREEZING OF THREE SHAFT COLLARS SECTIONS

SCALE NONE	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 9/85	CHECKED BY		DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder		DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. Mc		DATE 11/13/85
DRAWING NO FIGURE 1.3-3		SHEET ___ OF ___		REVISION NO

Typical Representations: Refinements May Be Made During Final Engineering



WEST VENTILATION SHAFT

ALL DIMENSIONS ARE IN FEET

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY CRANDON PROJECT			
TITLE FREEZING OF THREE SHAFT COLLARS SECTION			
SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 9/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON D.F. Mar	DATE 11/1/85
DRAWING NO FIGURE 1.3-4		SHEET ___ OF ___	REVISION NO.

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.

Ground freezing is an established shaft collar construction technique for sites with saturated or unstable soils. Additional technique and application details are presented in Sanger (1968), Sanger and Sayles (1978), and Maishman (1982).

When the collar sections of the main shaft and east vent 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 vent shaft. Conventional sinking through rock will then commence at the main shaft and at the east vent shaft. The west exhaust air shaft will be developed in rock at a later time and by different methods described later in this subsection.

Conventional sinking will involve the drilling of blastholes in the rock at the bottom of the shaft, breaking this rock with suitable explosives, clearing the broken rock from the shaft and hoisting it to the surface. Mechanical equipment operated by compressed air will be used to lift the broken rock and deposit it into a sinking bucket, which will be hoisted to the surface and emptied.

The main production and east vent shafts will be developed concurrently. The main production shaft will be developed at an estimated rate of advance of 6.9 feet in depth per day. This will require an average of two blasts per 24-hour day. Each of these blasts will require approximately 275 to 350 pounds of 40 or 60 percent strength straight-gelatin dynamite initiated by electric blasting caps.

The east vent shaft will be developed at an estimated rate of advance of 8.5 feet in depth per day and require an average of 2.5 blasts per day. Each blast will require approximately 150 to 225 pounds of 40 or 60 percent strength straight-gelatin dynamite initiated by electric blasting caps.

Detonation of explosive charges will be initiated from the surface after all personnel have cleared the shaft. One to three blasts will be initiated per day in each shaft. Each blast will consist of a series of 30 to 45 individual shots fired in sequence within a few seconds. This sequentially delayed blasting will be employed to control fragmentation of the rock, reduce ground vibrations, and minimize detonation air blast. The noise generated by detonation of a blast will be of short duration and directed vertically upward, thus minimizing off-site noise levels. As the shaft advances downward, the noise from blasting will become progressively less audible at the surface, until it will be barely noticeable outside the headframe. Mine construction and development blasting will be controlled to ensure ground vibrations and air blasts are within the recommended U.S. Bureau of Mines limits for avoidance of structural damage and human annoyance.

All blasting will be conducted to comply with the appropriate Department of Industry, Labor and Human Relations Code (i.e., Chapter Ind 5, Explosives and Blasting Agents), in particular sections 5.64, 5.65 and 5.66. All required permits and procedures will be followed prior to undertaking these tasks.

Pumps installed at the shaft bottom and on the sinking workstage will transport to the surface water storage and treatment system any ground water that might seep into the bottom of the shaft from the rock formations. Less than 5 gallons per minute additional water will be used during the drilling operations to flush cuttings from the holes, to suppress dust, and to cool the drill bits.

At specified intervals, openings will be left in the concrete shaft lining, and rock will be excavated from the shaft wall to form mine level stations. These mine level stubs will extend a short distance laterally and will provide access for later mine level development activities.

After similar excavation through the glacial overburden, construction in rock of the west exhaust ventilation shaft will be accomplished by raise boring and slashing methods as compared to the methods described above for the production and east vent shafts. When underground development reaches the shaft location, a raise boring machine will be used to bore a hole about 6 feet in diameter from the bottom of the shaft collar to the uppermost mining level. This opening will then be enlarged to full diameter by drilling and blasting. This exhaust ventilation shaft will not be lined below the concrete collar sections.

During development of the main production and east vent shafts, water will enter the excavations from three sources: (1) precipitation; (2) ground water seepage; and (3) utility water supply. All shaft drainage will be pumped to the surface wastewater lagoons or reclaim pond prior to treatment and discharge as required.

Precipitation gains over the total area of the shafts will be less than 0.5 gallon per minute. Construction plans provide for control of surface runoff around the shaft excavations. Therefore, the effects of precipitation drainage on shaft development are negligible.

Ground water seepage into the shaft excavations will vary from 0 to 15 gallons per minute in each shaft and is estimated to average 4 gallons per minute (Dames and Moore, 1978). During collar excavation and lining, the freezewall methods to be employed will negate ground water influx. When sinking begins in bedrock, ground water quantity will vary with depth, fracture intensity, and reservoir source (overburden aquifer or connate bedrock water). Shaft construction specifications will require rock grouting any time ground water inflow to the excavation exceeds about 15 gallons per minute in sections not yet permanently lined with concrete.

Utility or process water consumption during shaft development will vary from 0 to 6 gallons per minute during different shaft sinking operations. The nominal average use is estimated to be 2 gallons per minute.

Once the east vent 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 reclaim pond's 87,000,000 gallons normal operating capacity would be required to store all the estimated 6,500,000 gallons of shaft excavation drainage, discounting the wastewater lagoon capacity of about 3,000,000 gallons and any treatment and discharge which will be available as an option after month 16 of construction.

1.3.1.4.3 Underground Development

Upon completion of the east vent shaft to below the 350 mine level, horizontal level development will commence. A longitudinal section of the mine is shown on Figure 1.2-7. On the 350 level, horizontal passages termed drifts will be driven westward to intersect the main shaft already completed from the collar section to this level. A mobile equipment ramp decline will be developed toward the 470 mine level. Drift mining on the 470 level will begin upon completion of the main shaft sinking and hoist installations. Preproduction mining on the 350 and 470 main 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 350 level maintenance shop.

Drifting will be done by drilling blastholes into the drift face, loading them with explosives, and blasting. A two- or three-boom mobile drill jumbo will be used to drill the holes. Explosives used will be water gels and ammonium nitrate/fuel oil (ANFO) blasting agents. The broken rock will be removed from the face with load/haul/dump machines powered by diesel engines. Rear-dump haulage trucks may also be used where required because of long haulage distances. Drifts typically will range in width from 11 to 16 feet and in height from 10 to 12 feet. On each of the drawpoint levels, laterals will be driven on both sides of the orebody. These will then be connected with crosscuts through the ore at appropriate intervals to provide access to individual stoping blocks (see Figure 1.2-6).

Initially, air for mine ventilation will be provided by fans on the surface forcing air down through ducts in the shafts and into the various working places. Once the connections have been made between the main shaft and an exhaust vent shaft, main mine exhaust fans will be installed, and fresh air will be drawn down the main production shaft, through the working places, and exhausted up the exhaust vent shafts. Localized ventilation requirements will be provided by auxiliary fans and ducts. Any required heating of air will be done on the surface by natural gas or propane-fired air heaters located at the main shaft air intake portal.

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 (see Figure 1.2-7).

The inflow of ground water to the mine workings will increase during the first few years of underground development to as much as 2,000 gallons per minute. This unmitigated design inflow rate is the potential maximum plus contingency and is more than 50 percent higher than the 1,270 gallons per minute steady state rate expected as a result of extensive site hydrogeologic studies. Temporary water containment and pumping facilities will be installed as needed during early development until the main water handling facilities are completed on the 470 level and the separate ground water interception system is installed on the uppermost mine levels.

Subsequent to any mine inflow controls which may be applied, a residual ground water seepage interception program will be instituted. The purpose of this program will be to intercept and contain ground water inflow before any contamination by exposure to mine operations is possible. To accomplish this, interception must occur above the active mine workings.

Initial mine production has been planned for the 350 to 470 stope horizon, a position well below the base of the weathered bedrock ground water inflow courses. Thus, seepage into the mine workings during the early years of the mine life is expected to be very limited and localized.

The specific design of the ground water interceptor system will begin during pre-operational underground exploration. Diamond drilling techniques will be employed to identify active water courses prior to advance of the mine face.

Conceptually, water encountered on the uppermost mine level will, where possible, be captured in interceptor drill holes and contained to avoid contamination. In most cases, as the mine progresses upward from the initial 350 top level, access for interceptor drilling will be provided by premature development of production drifts temporarily dedicated for mine inflow control. Otherwise, specific mine water control drifts will be developed as required by identification of any area of concentrated seepage. Ultimately, the ground water interceptor system will function as shown on Figure 1.2-13. Rock grouting may be used underground for local inflow control or diversion.

Actual ground water collection will be from exploration or interception drill holes developed from the access and mine water control drifts. These holes will be typically arranged in a conical fan above the drifts, increasing the effective radius of the adit as a line sink drain. As is common mine practice, each water producing hole collar will be sealed and equipped with a pipe manifold.

Collected ground water from the interceptor drill holes will be piped through the drifts to the separate clean water sump and pump station. This permanent facility will be located on an upper mine level near the main shaft.

The clean water surge sumps will consist of downgrade excavations in the wallrock adjacent to the pump station. A bulkhead containing the pump station suction pipes will be constructed at the outlet of the sumps. Twin sumps will be provided for ease of maintenance and reserve capacity.

Clean water sump discharge will be pumped up the main shaft in a dedicated pipeline (see Figure 1.2-14). A bank of stand-by pumps and a second main shaft discharge pipeline will be provided to avoid system interruption. At the surface, the intercepted ground water pipeline will be routed directly to the uncontaminated water holding tank.

Ground water inflow to the mine will not occur in major quantities until mine level development intersects the orebody weathered zones (Prickett & Associates, 1982, 1984). Mining plans provide for construction of intercepted ground water and normal mine drainage sumps and pump stations at the very start of underground development. These facilities will be located near the main shaft, exterior to the orebody weathered zones. They will, therefore, be available for full capacity duty prior to mining entry into any areas of substantial ground water seepage.

1.3.1.4.4 Waste Rock Storage Area

Waste rock generated during shaft sinking operations and preproduction mine development will be stockpiled on the 8-acre drainage controlled 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.

Waste rock haulage to and from the storage pad will be performed using end dump trucks in the 35-ton size range. Spreading and grading will be done by tractor (i.e., CAT D-7). The operation of either of these types of equipment will not jeopardize the integrity or performance of the two 4-inch lifts of bentonite modified soil and 12 inches of drain material cover.

Runoff from the preproduction ore storage area will be collected in a lined drainage ditch that surrounds this facility. Drainage will then be directed to surface drainage basin No. 3 (see Figure 1.2-50) and then to the water treatment plant feed tank. Alternatively, this water could be pumped to the reclaim pond.

1.3.1.5 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 construction sequence of these facilities is presented in subsection 1.3.2. The typical construction equipment required is presented in subsection 1.3.3.2.

1.3.1.6 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 (Table 1.3-1). The maximum disturbed area at any given time will be 285 acres, which is about 60 percent of the ultimate total of 480 acres including the construction support and borrow areas.

The site preparation procedures for the waste disposal and reclaim pond area will be similar to and reflective of those adopted for the mine/mill site described in subsection 1.3.1.1. These procedures 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.

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.

1.3.1.7 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 about 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.

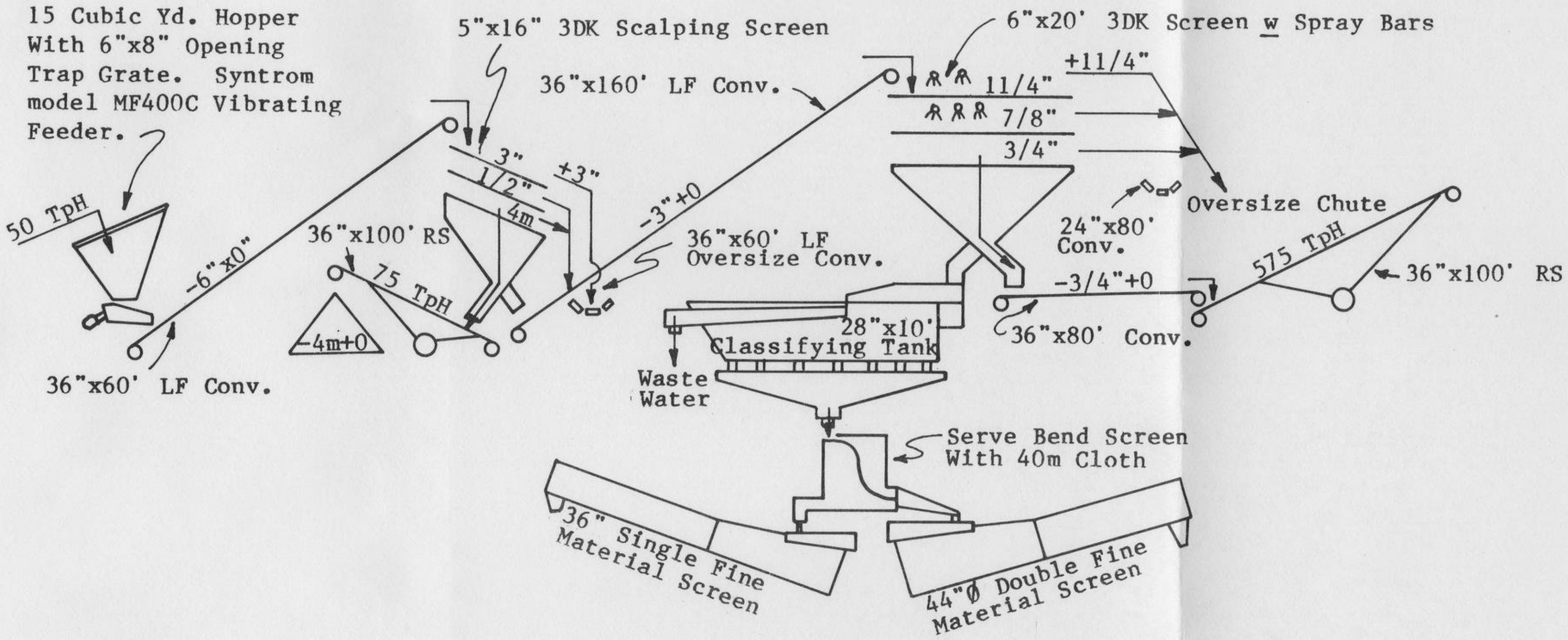
Upon completion of the excavation in a particular area, the subgrade will be brought to grade and proof rolled to be followed by placement of the bentonite modified soil liner. The liner material will be hauled by dump trucks to paving machines for placement followed by compaction. Two separate 4-inch thickness lifts will be placed to construct a final total liner thickness of 8 inches. A suitable loose thickness will be established to assure a minimum compacted

4-inch lift thickness. Liner layers will be generally placed parallel to one another but offset laterally a minimum of 3 feet such that "seams" or construction joints do not coincide.

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 ("pugmill") specially designed for this type of construction.

The construction methods study and planning included a review of material processing requirements. Basic process descriptions and equipment requirements are included in the report by INDECO (1982) entitled "Construction of Waste Disposal Facilities" and the MWDF Feasibility Report. During the course of INDECO's study, various equipment manufacturers were contacted to provide assurance that proposed processes could be efficiently accomplished. The process flowsheets from Universal Engineering Corporation depict an equipment set capable of providing all required soil materials by processing of the glacial till (Figures 1.3-5 through 1.3-7). Equivalent systems could be provided by other manufacturers.

In Universal Engineering Corporation's system (Figures 1.3-5 through 1.3-7), dry processes are used to prepare liner material and reclaim pond membrane liner cushion materials. The only water used is in flowsheet No. 3 (Figure 1.3-7) showing the process to prepare the underdrain material. Brief process descriptions are included with the flowsheets.



Flow Sheet Number 1

No. of Products Being Prduced 2

Primary Product Being Produced Liner Material (-3/4" + 0)

Additional Product Made: Sand Cushion (-4 mesh to + 0)

FLOW SHEET #1

Description: Plant is set up primarily for producing liner material (-3/4" + 0) will produce 75 TPH of sand cushion material (-4 mesh + 0) at the same time. Wet portion of plant is now being used. All material larger than 3/4" is being sent to oversize piles.

Liner material is being produced at rate of 525 TPH.

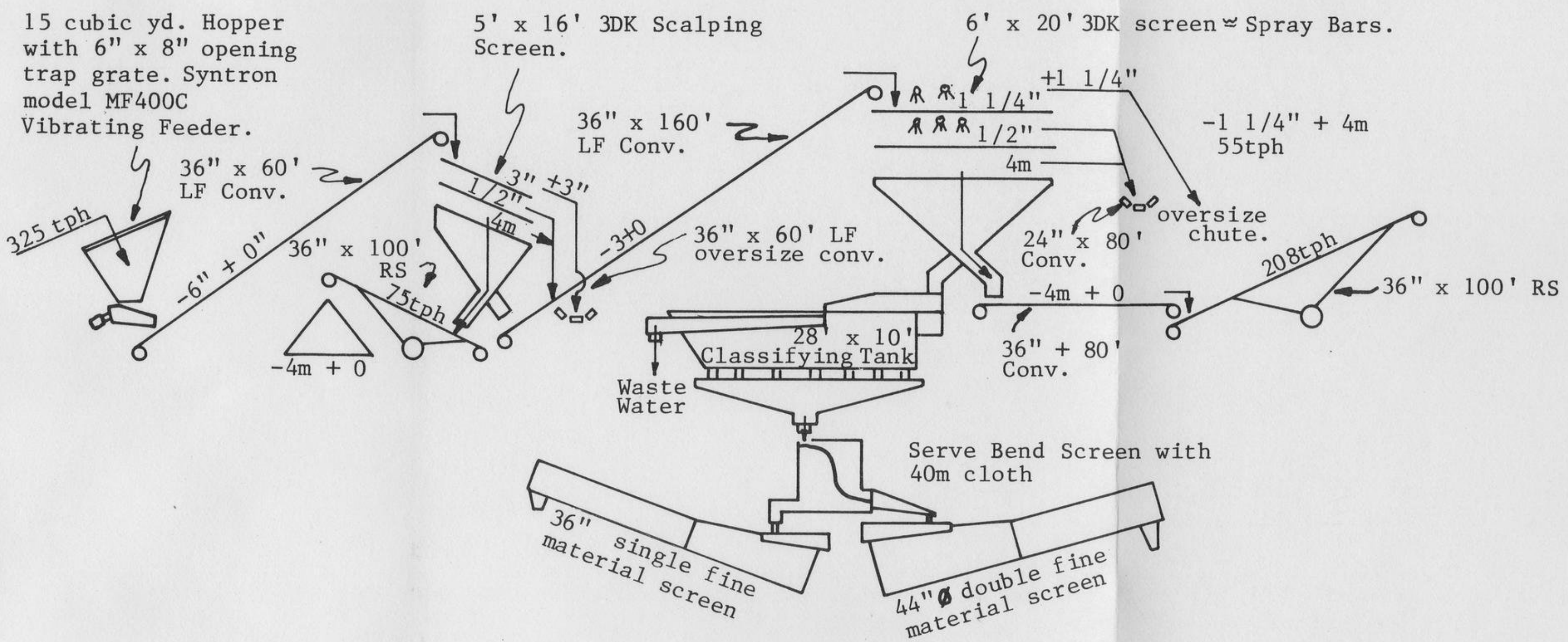
For: INDECO
By: Universal Engr. Corp.

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
SEEPAGE CONTROL SYSTEM
MATERIAL PREPARATION
PROCESS FLOW SHEET #1

SCALE	STATE	COUNTY	
NONE	WISCONSIN	FOREST	
DRAWN BY: DR SPRINGBORN	DATE: 9/85	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 1.3-5		SHEET ___ OF ___	REVISION NO.



Flow sheet number. 2

No. of products being produced. 2

Primary porduct being produced:

Sand Cushion (-4 mesh + 0)

Transition material
(-1 1/4" + 4 mesh)

FLOW SHEET #2

Description: By changing screen cloth on 6' x 20' screen, the balance of the cushion sand (-4 mesh + 0) will be produced. Product will be made at two locations on plant. 75 TPH will be produced at Scalping Screen and 208 TPH at the Finish Screen.

Transition material (-1-1/4 + 4 mesh) will be screened off at the same time.

Transition material being produced at 55 TPH.
Sand Cushion material being produced at 283 TPH.

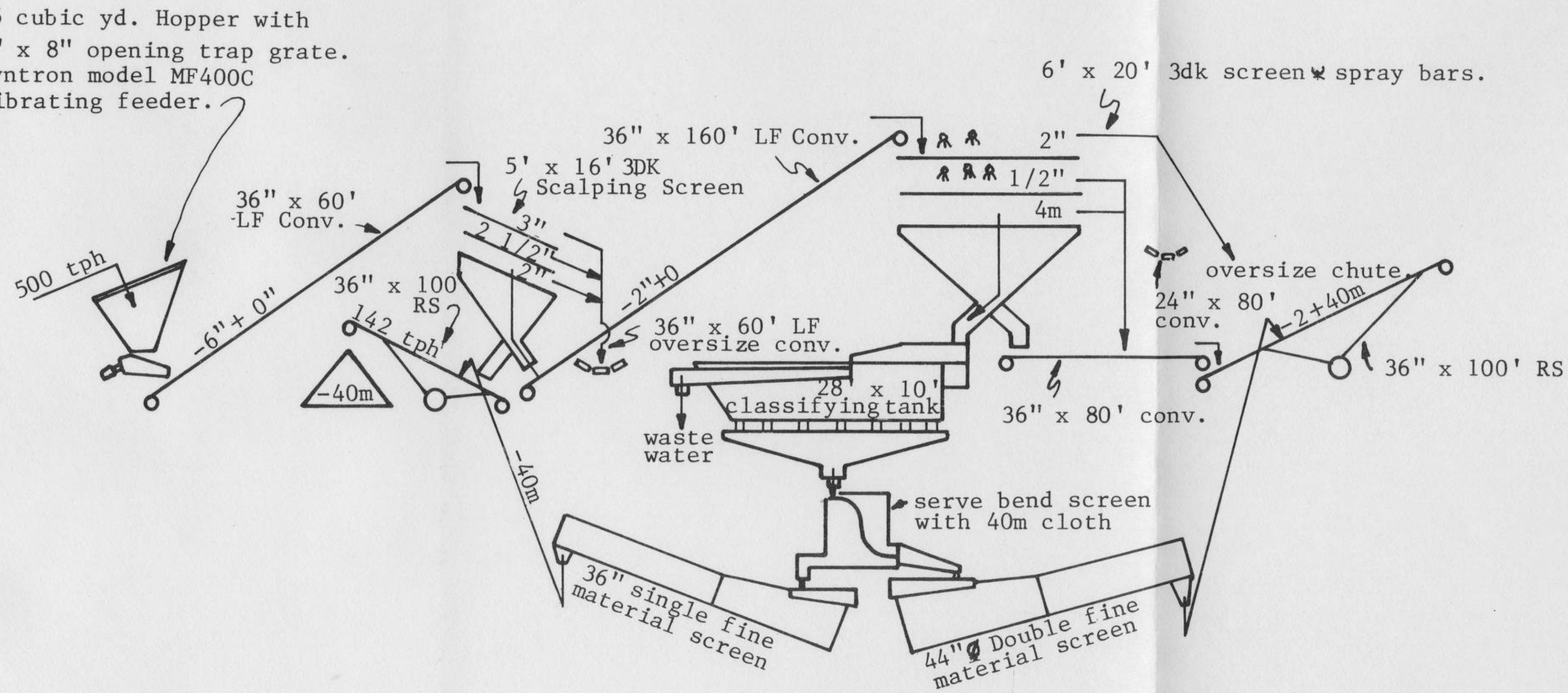
Wash system not being used.

For: INDECO
By: Universal Engr. Corp.

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: SEEPAGE CONTROL SYSTEM MATERIAL PREPARATION PROCESS FLOW SHEET #2			
SCALE: NONE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: D.R. SPRINGBORN	DATE: 9/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY: C.C. Schroeder	DATE: 11/13/85
APPROVED BY	DATE	EXXON: D. E. Moe	DATE: 11/ /85
DRAWING NO: FIGURE 1.3-6		SHEET ___ OF ___	REVISION NO.



Flow sheet number. 3

No. of products being produced. 1

Primary product being produced:

Drain material (-2" + 40 mesh)

Additional product made. none

Notes: 36" x 100' radial stacker may be moved to 36" fine

FLOW SHEET #3

Description: Plant is set up to produce drain material (-2 + 40 mesh). Approximately 140 TPH of 40 mesh material will be produced which could be added to the sand cushion material. During this operation is the only time that water is used. We are now using the spray bars and sending the -4 mesh material along with the water the classifying tank. The tank will do the majority of splitting the 40 mesh, but due to the high percentage of -100 mesh (Approx. 25%) in the material, a Seive Bend static screen will be incorporated to give a more positive split at 40 mesh. All the +40 mesh is blended back with the -2" + 4 mesh material coming off the screen.

Estimate production of -2" + 40 mesh at 330 TPH.

For: INDECO

By: Universal Engr. Corp.

Typical Representation : Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY				
CRANDON PROJECT				
TITLE: SEEPAGE CONTROL SYSTEM MATERIAL PREPARATION PROCESS FLOW SHEET #3				
SCALE: NONE	STATE: WISCONSIN		COUNTY: FOREST	
DRAWN BY: DR SPRINGBORN	DATE: 9/85	CHECKED BY		DATE
APPROVED BY	DATE	APPROVED BY: C.C. Schwecher		DATE: 11/85
APPROVED BY	DATE	EXXON: D F Moe		DATE: 11/1?/85
DRAWING NO: FIGURE 1.3-7		SHEET ___ OF ___		REVISION NO.

Water requirements in flowsheet No. 3 (Figure 1.3-7) for the underdrain material preparation 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 (-200 mesh), 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 all the fines (-200 mesh) 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 (i.e., pugmill-batch process) as required to bring the mixture to the required moisture content before placement and compaction.

The overall 8-inch thickness defined for the two lift liner is a total compacted layer thickness at a moisture content targeted at 2 to 4 percent above optimum. A bentonite product similar to Enviro gel

200 manufactured by Wyo-Ben Inc. has been assumed for preliminary design. This pulverized bentonite has a minimum of 98 percent passing a No. 80 mesh and 80 percent maximum passing a No. 200 mesh for its typical grain size distribution.

Liner construction for an individual tailing pond will be completed within a single construction season. For each tailing pond, this period will range from 4 to 6 months and include installation of the liner, underdrain, filter, and rock protection of the inside embankments.

To minimize the potential for damage to the liner or underdrain, the seepage control system will be developed sequentially within the pond area as opposed to constructing each component as separate phases.

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.

The use of a bentonite amended soil liner and the other seepage control system elements has been successfully used in a number of other waste disposal facilities. The following list includes sites where either similar concepts, in part or in total, have been implemented, are under construction, or have recently been designed:

SITE	LOCATION	TYPE OF WASTE	STATUS
Eastern Sanitary Landfill	Baltimore Co., MD	Municipal Waste	Operating
Westmoreland Co., Landfill	Westmoreland Co., VA	Municipal Waste	Operated From 1981 - 1983
Oswego Co., Landfill	Oswego Co., N.Y.	Municipal Waste	Operating and Currently Under Expansion Const
Aloe Hazardous Waste Landfill	Findlay Township, PA	Chemical Wastes	Operating
Orlando Util. Comm. Power Plant	Orlando, Florida	Coal Storage Pile Liner	Designed
CIBA-Geigy Landfill	Queensbury, N.Y.	Industrial Wastes	Operating
Getty Mining Co.	Mercur, Utah	Gold Mine Tailings	Operating
Montana Power Company	Colstrip, MT	Power Plant Fly Ash	Constructed

SITE	LOCATION	TYPE OF WASTE	STATUS
Mill Services Landfill	Bulgar, PA	Industrial Waste	Constructed
Broward Co. Landfill	Broward County, FL	Municipal Waste	Constructed (Vertical expan. of existing facility)
Key Lake	Saskatchewan, Canada	Uranium Tailings	Operating

To date, all Exxon sponsored studies related to the underdrain have been submitted to the DNR including Golder Associates (1981a,b,c; 1982a,b,c) and Exxon Minerals Company (1985).

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. The underdrain and filter will be placed by end dumping from dump trucks and by pushing the drain material over the liner and the filter material over the geotextile. In this manner the construction equipment operates on the drain or filter material and not directly on the liner. 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 MWDF Feasibility Report. The detailed specifications will be developed to assure a final liner permeability of 1.6×10^{-9} feet/second or less.

The material and mix specifications will assure uniformity of liner mix and specifications for placement and compaction operations will assure the uniformity and integrity of the installed liner. A quality control plan including inspection and testing will verify that specifications and design are being followed.

Rip-rap, which consists of mine waste rock, will also be placed on the embankment upstream slopes by a dump and spread operation.

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 the 1.5 feet thick sand cushion. An additional layer of transition material, approximately 1-foot thick, will be placed on the upper portions of the reclaim pond slopes where rip-rap 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 support area will be an earth pad approximately 25 acres in size. 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.

Bulk 3,000-pound bags will probably be used for bentonite shipments. Bags would be top loaded into the hopper using an "elephant trunk" prefabricated on the bottom of each bag to avoid release of bentonite powder to the atmosphere.

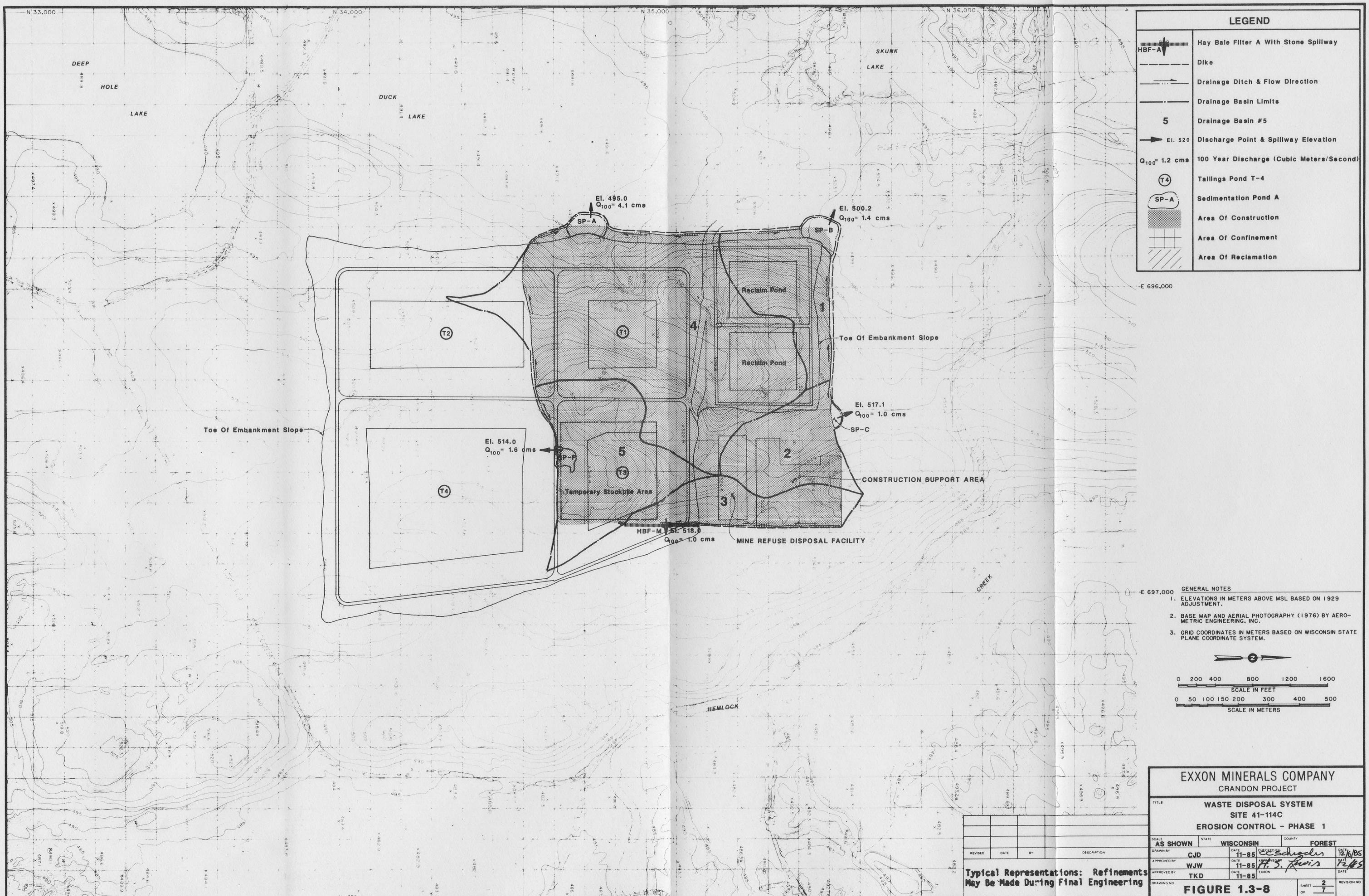
A list of equipment representative of that required for the construction of the MWDF and reclaim pond is included in subsection 1.3.3.2.

During each phase of construction, control of surface runoff will be accomplished by constructing a series of ditches, dikes, and retention ponds. The drainage patterns and location of required control features for each phase of construction are presented on Figures 1.3-8 through 1.3-13. Surface runoff with the potential for high levels of suspended solids will be directed through sedimentation ponds with overflow weirs prior to being discharged into the natural drainage. Straw bales or filter fabric silt fences will be used as needed to provide small dikes for control of drainage or erosion in localized areas.

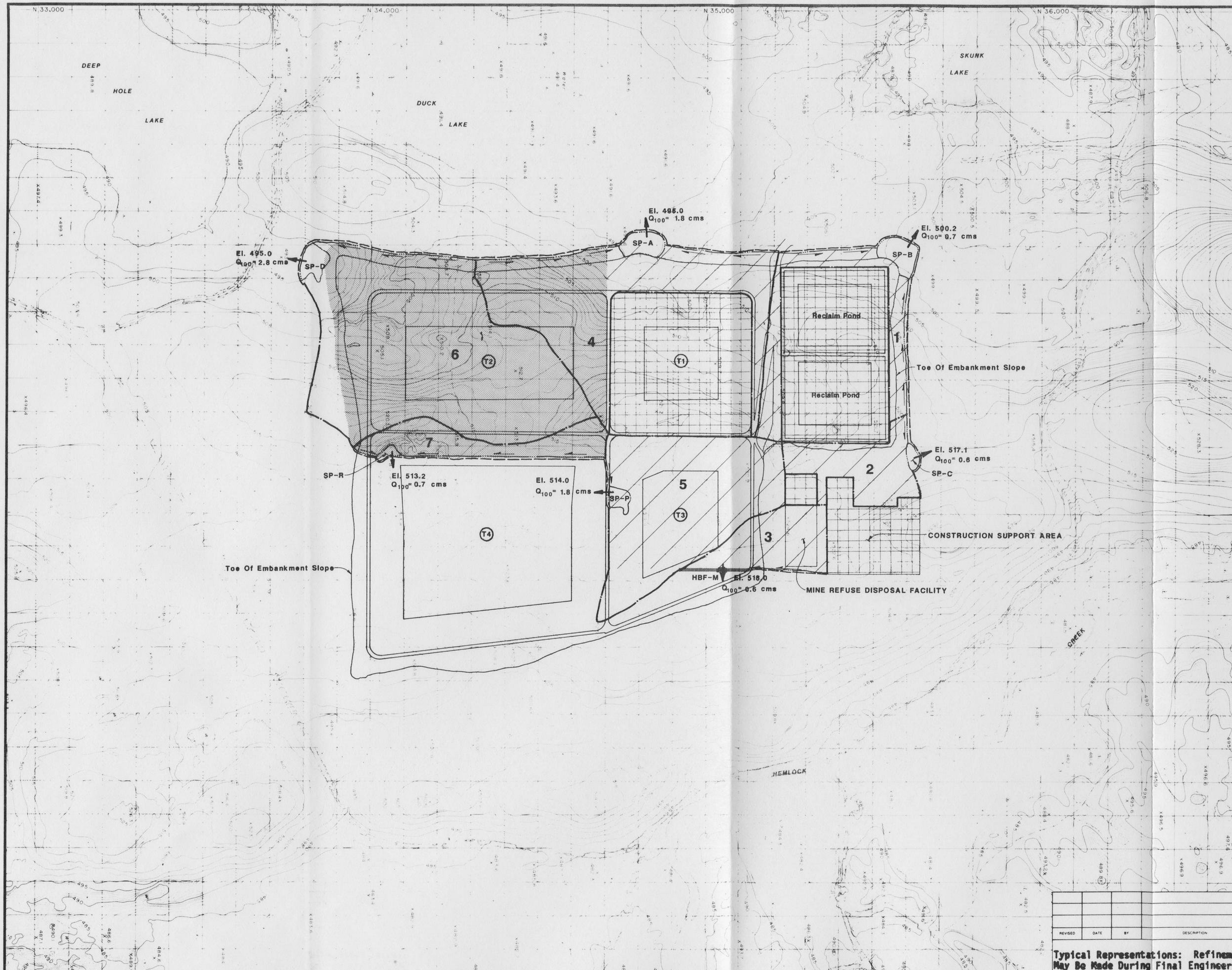
1.3.1.8 Pipeline and Discharge Structure Construction

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. Where appropriate, pipelines will be buried below the frost line to avoid frost damage and for improved visual effect.

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. The trench will be backfilled with till.



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
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
Q100= 4.1 cms
SP-A
El. 500.2
Q100= 1.4 cms
SP-B
Reclaim Pond
Reclaim Pond
Toe Of Embankment Slope
Toe Of Embankment Slope
El. 517.1
Q100= 1.0 cms
SP-C
El. 514.0
Q100= 1.6 cms
SP-F
T1
T2
T3
T4
1
2
3
4
5
Temporary Stockpile Area
CONSTRUCTION SUPPORT AREA
HBF-M
El. 518.0
Q100= 1.0 cms
MINE REFUSE DISPOSAL FACILITY
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
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
APPROVED BY WJW
DATE 11-85
APPROVED BY TKD
DATE 11-85
EXXON
DATE 12/6/85
DATE 12/4/85
DRAWING NO
FIGURE 1.3-8
SHEET 2 OF 7
REVISION NO
REVISED
DATE
BY
DESCRIPTION
Typical Representations: Refinements May Be Made During Final Engineering



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

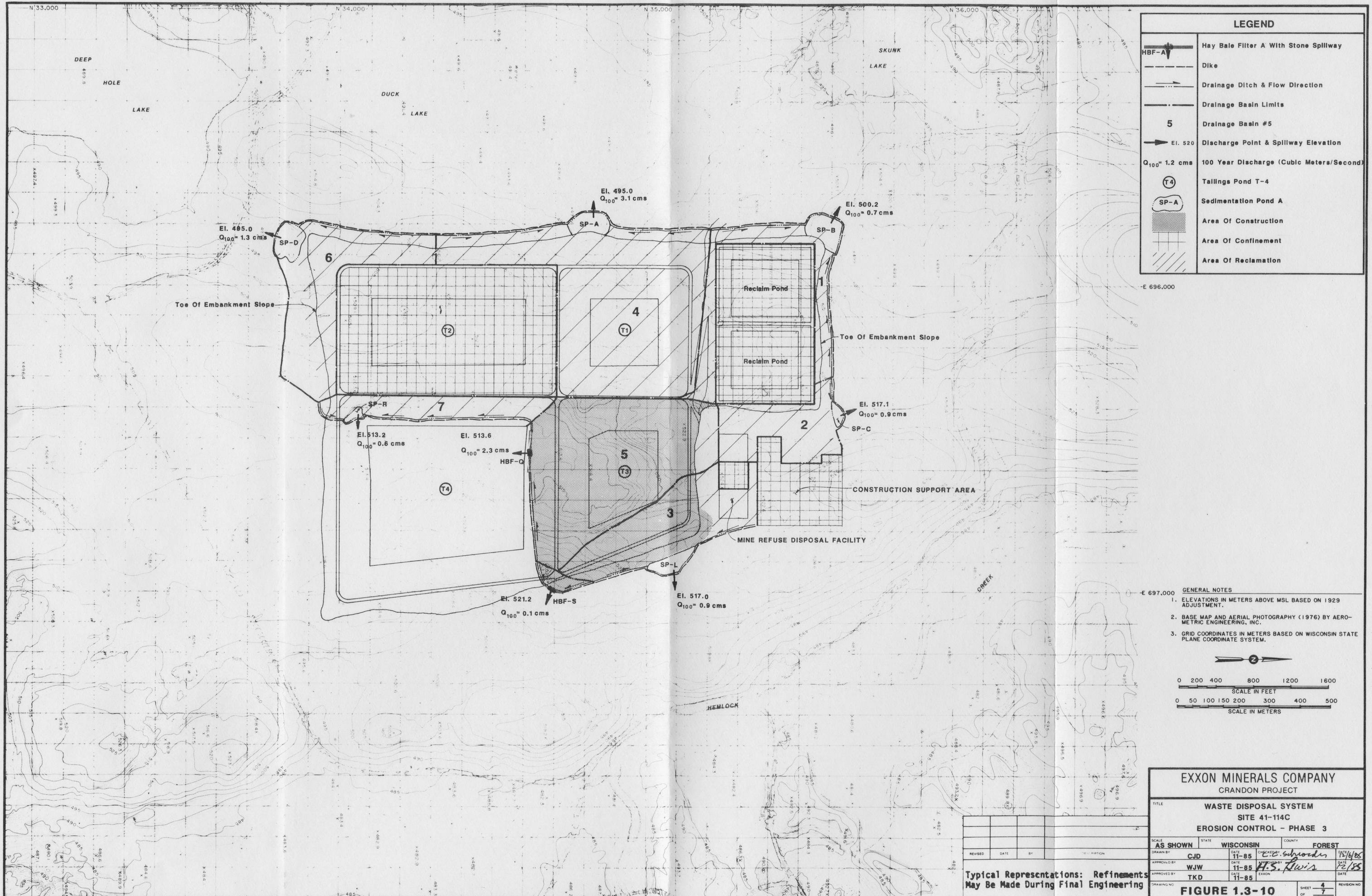
EXXON MINERALS COMPANY
CRANDON PROJECT

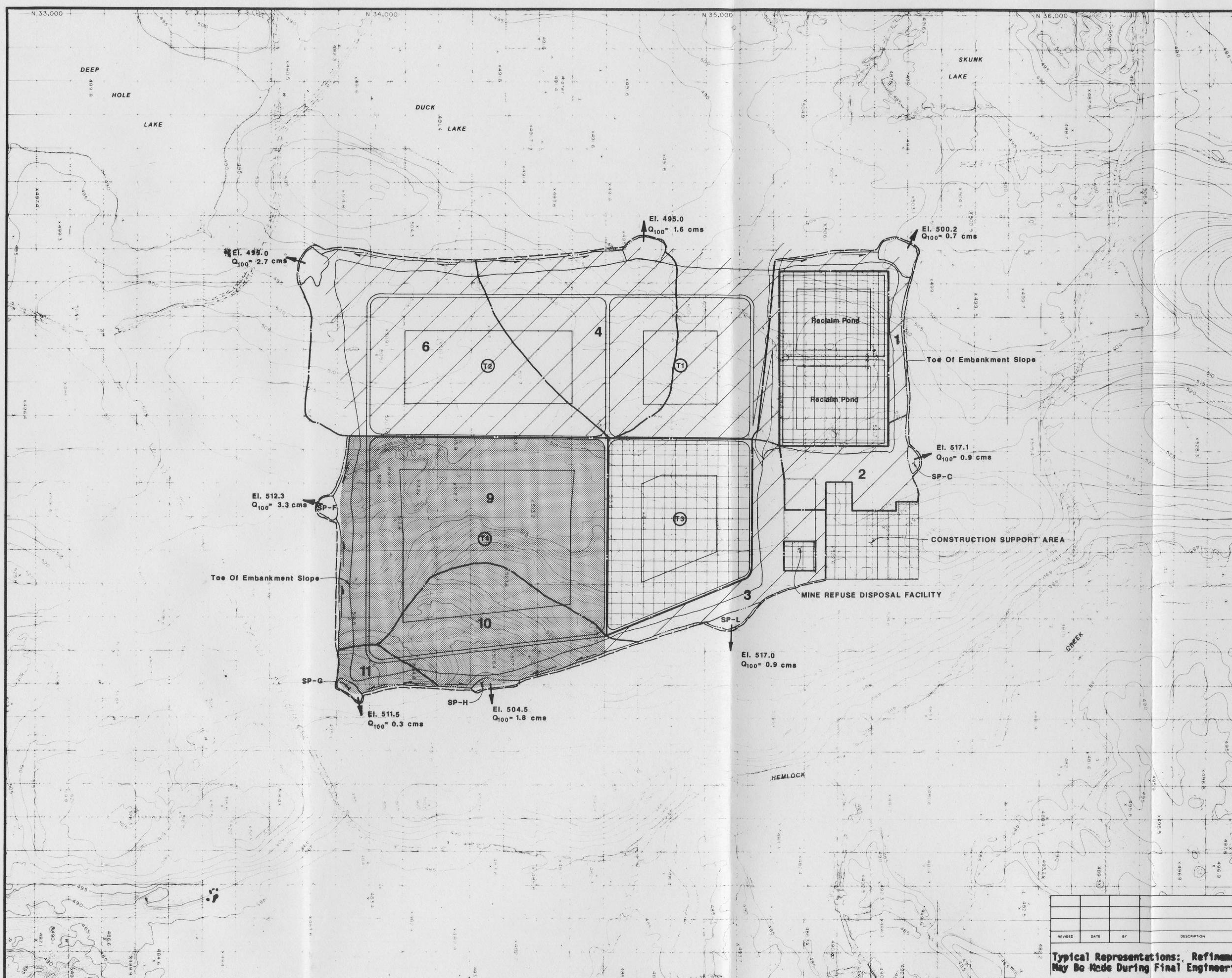
TITLE: WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 2

SCALE	STATE	COUNTY
AS SHOWN	WISCONSIN	FOREST

		DATE			DATE
DRAWN BY	CJD	11-85	CHECKED BY	C.C. Schroeds	12/6/85
APPROVED BY	WJW	11-85	APPROVED BY	F. S. Lewis	12/85
APPROVED BY	TKD	11-85	EXXON		DATE

DRAWING NO: FIGURE 1.3-9
SHEET 3 OF 7
REVISION NO


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
DEEP HOLE LAKE
DUCK LAKE
SKUNK LAKE
HEMLOCK
CREEK
N 33,000
N 34,000
N 35,000
N 36,000
E 696,000
E 697,000
El. 495.0
Q100= 3.1 cms
El. 485.0
Q100= 1.3 cms
El. 500.2
Q100= 0.7 cms
El. 517.1
Q100= 0.9 cms
El. 513.2
Q100= 0.6 cms
El. 513.6
Q100= 2.3 cms
El. 521.2
Q100= 0.1 cms
El. 517.0
Q100= 0.9 cms
SP-A
SP-B
SP-C
SP-D
SP-L
SP-R
HBF-Q
HBF-S
Reclaim Pond
Reclaim Pond
Toe Of Embankment Slope
Toe Of Embankment Slope
CONSTRUCTION SUPPORT AREA
MINE REFUSE DISPOSAL FACILITY
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
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 3
SCALE AS SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY CJD 11-85
APPROVED BY WJW 11-85
APPROVED BY TKD 11-85
FIGURE 1.3-10
SHEET 4 OF 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
(shaded)	Area Of Construction
(grid)	Area Of Confinement
(hatched)	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

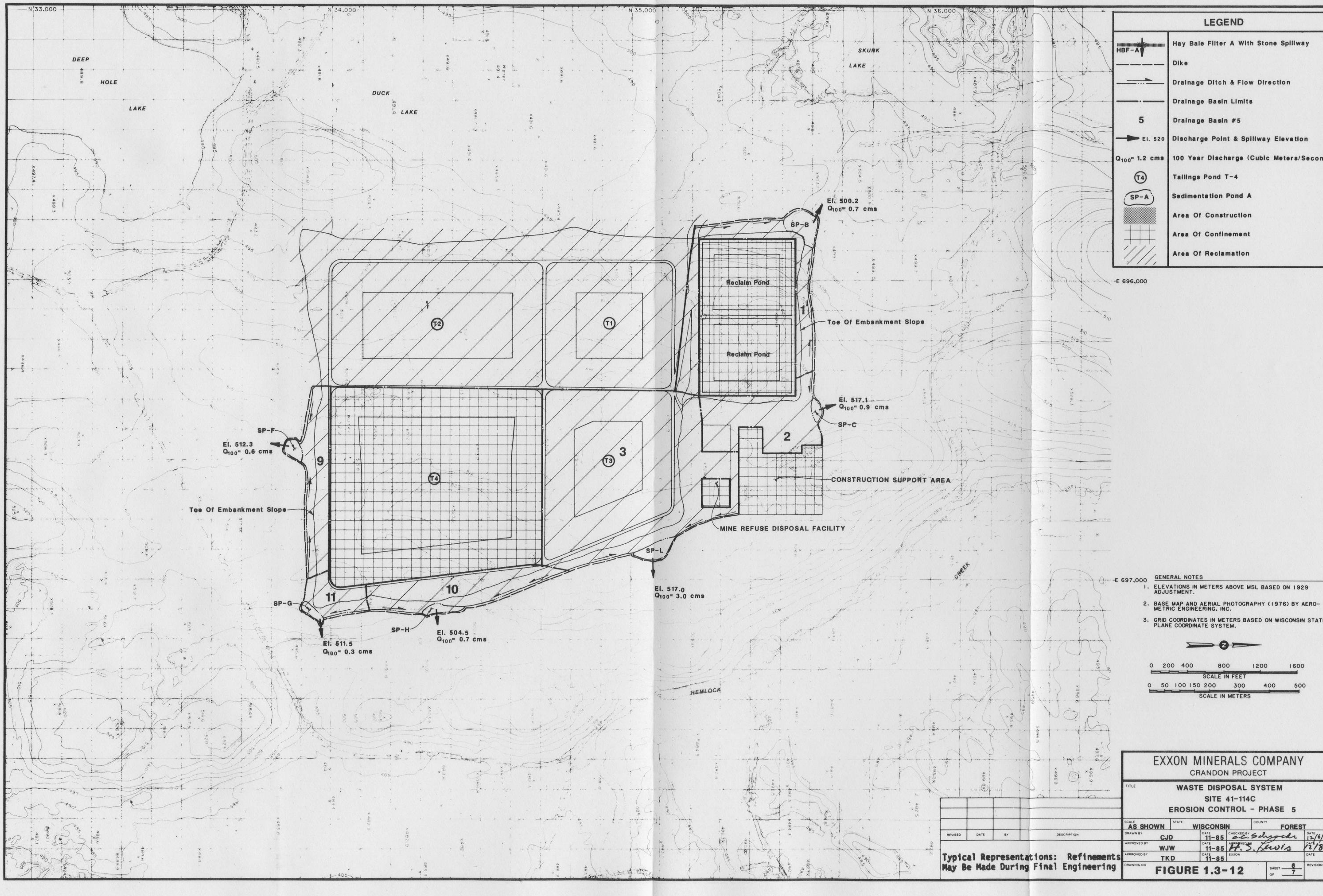
Typical Representations; Refinements May Be Made During Final Engineering

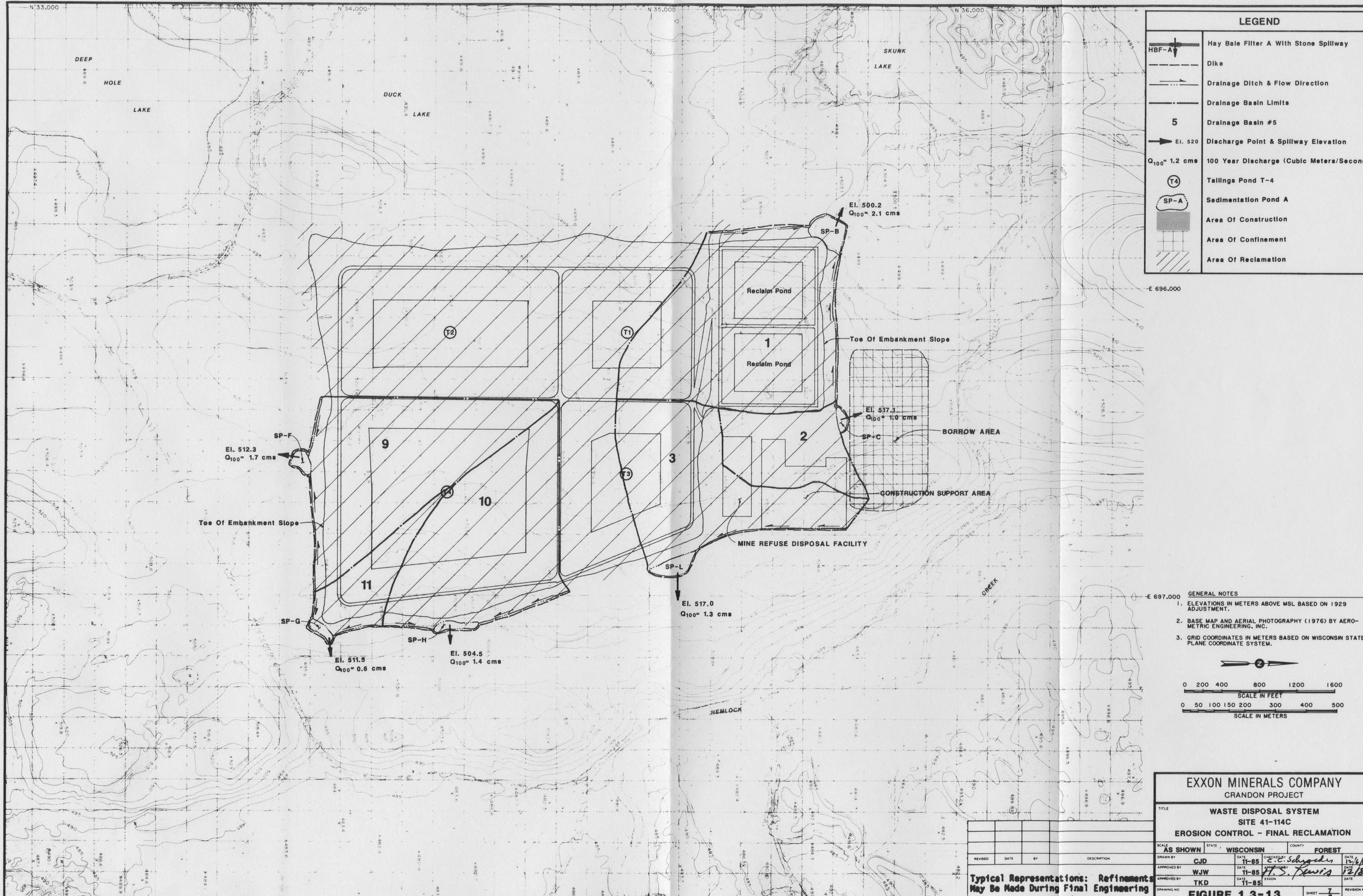
EXXON MINERALS COMPANY
CRANDON PROJECT

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 1/6/86		
APPROVED BY WJW	DATE 11-85	APPROVED BY H. S. Lewis	DATE 12/85		
APPROVED BY TKD	DATE 11-85	EXXON	DATE		
DRAWING NO	FIGURE 1.3-11	SHEET 5 OF 7	REVISION NO		

DESIGN PRODUCTS CO —


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
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
Reclaim Pond
Reclaim Pond
T1
T2
T3
T4
1
2
3
9
10
11
SP-B
El. 500.2
Q100= 0.7 cms
Toe Of Embankment Slope
El. 517.1
Q100= 0.9 cms
SP-C
CONSTRUCTION SUPPORT AREA
MINE REFUSE DISPOSAL FACILITY
SP-L
El. 517.0
Q100= 3.0 cms
SP-F
El. 512.3
Q100= 0.6 cms
Toe Of Embankment Slope
SP-G
El. 511.5
Q100= 0.3 cms
SP-H
El. 504.5
Q100= 0.7 cms
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
APPROVED BY WJW
DATE 11-85
APPROVED BY TKD
DATE 11-85
DRAWING NO.
FIGURE 1.3-12
SHEET 6 OF 7
REVISION NO.


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
DEEP HOLE LAKE
DUCK LAKE
SKUNK LAKE
HEMLOCK
CREEK
Reclaim Pond
Reclaim Pond
Toe Of Embankment Slope
BORROW AREA
CONSTRUCTION SUPPORT AREA
MINE REFUSE DISPOSAL FACILITY
Toe Of Embankment Slope
El. 500.2 Q_{100}= 2.1 cms
El. 517.1 Q_{100}= 1.0 cms
El. 512.3 Q_{100}= 1.7 cms
El. 517.0 Q_{100}= 1.3 cms
El. 511.5 Q_{100}= 0.6 cms
El. 504.5 Q_{100}= 1.4 cms
SP-B
SP-C
SP-F
SP-G
SP-H
SP-L
T1
T2
T3
T4
1
2
3
9
10
11
N 33,000
N 34,000
N 35,000
N 36,000
E 696,000
E 697,000
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
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. Schroeder
DATE 12/6/85
APPROVED BY WJW
DATE 11-85
APPROVED BY H.S. Lewis
DATE 12/85
APPROVED BY TKD
DATE 11-85
EXXON
DRAWING NO.
FIGURE 1.3-13
SHEET 7 OF 7
REVISION NO.
REVISED DATE BY DESCRIPTION
Typical Representations: Refinements May Be Made During Final Engineering

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.

The water discharge pipeline to Swamp Creek will be constructed following procedures similar to those used for the other buried pipelines. This pipeline will be buried below the frost line within a 50-foot right-of-way. 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. The discharge structure at Swamp Creek will be constructed using a backhoe for excavation, minor grading, and placement of rip-rap. During construction 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 structure.

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.

The pipelines will be fabricated from an extra-high molecular weight high density polyethylene (HDPE). This material has been selected on the basis of its resistance to abrasion and corrosion.

The pipe material will be high density HDPE rated for 220 pounds per square inch internal design pressure. The hydraulic gradients proposed for the system are identified in the report entitled "Tailings Slurry and Solution Transport Pipeline Systems" by Pipeline Systems, Inc. (1982). The rated allowable pressure for the HDPE pipeline systems, especially the tailing transport line, is well above the expected pipeline pressures. For the tailings line, it is proposed to use a wall thickness of 1.04 inches and an internal diameter of 6.54 inches. The hydraulic gradient data for the other pipe systems indicate that, in each case, the pipe is specified to sustain an operating pressure considerably in excess of the expected pressure.

The pipe will be received in 38-foot lengths. All pipe will be inspected for damage on-site. Sections of pipe with cuts or gouges will be rejected.

Each piece of pipe will be fusion butt welded to form a continuous pipeline from the pumping station in the mine/mill site to the discharge point. Butt fusion welding involves heating both ends of the pipes to be joined, making contact between the two molten ends and joining them together under pressure. The operation is performed using commercially available equipment designed for this purpose. The equipment is easily transported and may be used at any point along the pipeline during the installation of new pipe or the repair of old pipe. The joint which is formed is stronger than the pipes it joins.

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.

Tailings pipelines and other pipes handling process water will be buried at a depth of 6 feet below ground to avoid damage by freezing or external hazards. The trench will be over-excavated by 6 inches. The trench volume below the pipes will be backfilled with sand, gravel or other select material to support the pipe. Generally, the pipe bed material will be free of rock greater than 0.5 inch in size and will contain no jagged or soft rock.

After the pipe has been laid, it will be surrounded with compacted sand, gravel, or other select material and then backfilled with glacial till derived from trench excavation. Backfill will be compacted to about 85 percent of the maximum dry density as determined by ASTM D-698 (Standard Proctor).

When a pipe is buried, it is subjected to external loads such as soil pressure and the pressure of surface loads. The performance limits due to internal pressure are related simply to hoop tension in the pipe wall. The performance limit due to external pressure could be wall crushing, wall buckling, or ring deformation, depending on the applied loads and the physical properties of the soil and the pipe. These aspects of pipe design will be considered in final engineering.

Instrument cable will be buried with the pipe. The cable will be used as a metal source for pipeline locating instruments.

Typically, HDPE pipe can be cold bent to a minimum radius of 25 times the pipe diameter. This allows gradual direction changes to be made, reduces the possibility of pipe wall erosion and minimizes the potential for leaks.

The current anticipated capacities of the pumps for the pipeline systems are as follows:

	Gallons Per Minute
Tailings slurry pumps	555*
Reclaim water pumps	3,440
Thickener overflow pumps	3,460
Water discharge pumps	2,000

*Includes gland seal water.

1.3.1.9 Railroad Construction

The construction activities planned for the railroad spur are similar to those for the access road. 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. In the preliminary engineering study, 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. Estimated waste wood quantities from the railroad spur construction are presented in Table 1.3-2.

Bridge construction will start when the access corridor has been cleared sufficiently to allow men and equipment into the area. Sheet piling will be driven to form a wingwall on each side along the creek banks to protect the creek while the bridge abutments are under construction. Once the abutments are completed, the rip-rap placed, and the construction material removed, the sheet piling also will be removed.

Temporary sheet piling, diversion dikes, ditches and settling basins will be constructed during clearing and grubbing operations to collect disturbed area runoff. Temporary revegetation will be used to provide interim stability to slopes when weather conditions or construction delays preclude immediate establishment of permanent vegetation. The specific activities and detailed plans for these temporary erosion control measures will be completed in the final engineering phase of the work.

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.

The equipment required for the railroad construction is presented in subsection 1.3.3.2.

1.3.1.10 Powerline Construction

Electrical power for the mine/mill facility will be supplied at 115 kV by the Wisconsin Public Service Corporation (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. Several potential routes for the 115-kV transmission line have been identified and studied by WPSC and are included as part of their Certificate of Public Convenience and Necessity submission to the Wisconsin Public Service Commission.

The detail design of the 115-kV transmission line is not known at this time, but it is anticipated that it will be on wood poles constructed to WPSC standards.

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.

1.3.1.11 Water Supply

A new potable water well will be drilled southwest of the mine/mill site area during the first 2 months of construction (see Figure 1.2-1). This well will be used to furnish potable and construction water to the mine/mill site. As this well is expected to yield potable water without treatment, no distinction will be made between potable and construction water. Additionally, a second well will be constructed in the MWDF area and will be used to supply water for construction and dust suppression purposes in this area. The location and construction details for the water supply wells are presented in the High Capacity Well Approval Application.

Water use during construction will be for supplying human needs, occasional sprinkling of site roads as required, compaction of fill, and for use in making concrete, soil-bentonite liner and preparing pond drain materials. The heaviest water demand will occur in the summer months when an estimated peak demand of 411,300 gallons per day will be reached.

This peak water consumption is estimated as follows:

	Gallons
Drain material preparation - 400 gpm x 60 min/hr x 12 hr/day	288,000
Compaction - 3,300 yd^3/day x 1.5 ton/yd^3 x 0.06 yd^3/ton of water addition x 202 gal/yd^3	60,000
Soil-bentonite liner moisture conditioning - 600 tons/hr x 2% moisture addition x 12 hr/day x 240 gal/ton	35,000
Batch plant - 400 yd^3 concrete/day x 0.2 yd^3 water/yd^3 of concrete x 202 gal/yd^3	16,000
Road sprinkling - 4 x 3,000 gallon trucks	12,000
Human consumption	300
Total consumption per working day	411,300

Average demand for the above-mentioned period will be less depending on the amount of rainfall, moisture content of the soil being compacted, and the actual rates and hours of daily production of concrete, soil-bentonite liner, and drain material.

1.3.1.12 Equipment Storage and Laydown

During the mine and mill construction phase, temporary equipment storage and laydown areas will be needed adjacent to the various buildings for materials and equipment. These areas are shown on Figure 1.3-1. All such areas will be within the mine/mill site.

1.3.1.13 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. Portable toilets will be used throughout the site from initial construction until sewer lines and permanent restrooms are constructed. 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.

With portable toilets approximately 4 gallons of sewage will be generated per person per week. With a restroom/shower trailer approximately 50 gallons of sewage will be generated per person per day.

During the first 6 months of construction, assuming a peak work force of 600 people with 50 having access to a restroom/shower trailer, approximately 17,500 gallons of sewage would be generated weekly, or approximately 3,500 gallons of sewage daily.

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.

1.3.1.14 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. A dividing berm will ensure that vehicular traffic is confined to that portion of the alignment not occupied by the pipelines. Construction methods employed in building the haulage road will be similar to those used in construction of the mine/mill site access road described in subsection 1.3.1.3.

1.3.1.15 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.

The MRDF has many similarities with the MWDF and water reclaim pond in the design and construction of the lining and leachate collection systems. The schedule for 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.

1.3.2 Construction Schedule

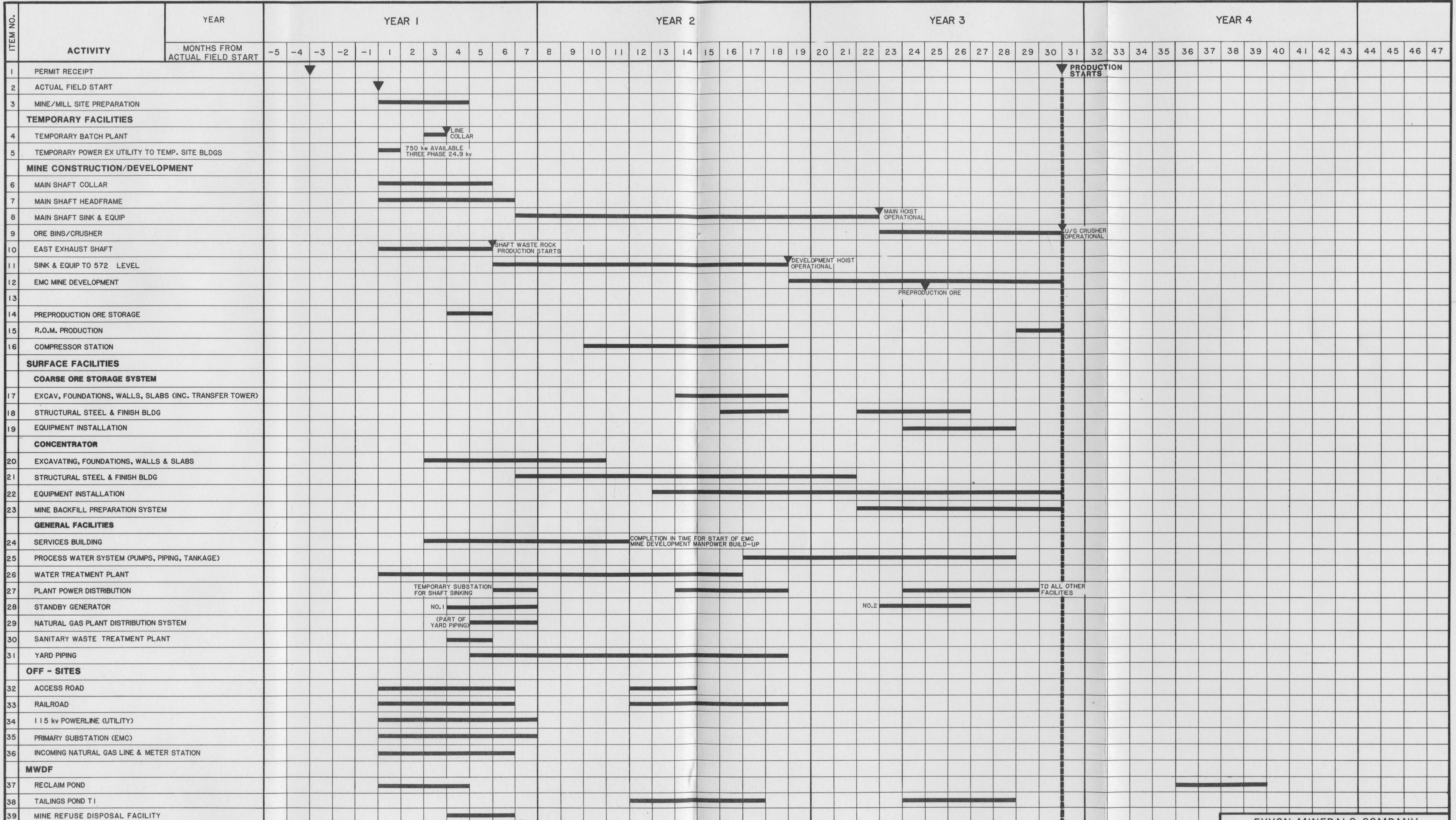
The duration of the construction phase is controlled by the time required to develop the main shaft and headframe, the east exhaust shaft, and to perform the requisite underground mine development. The sequence of critical activities for mine development consists of the main and east vent shafts sites 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 described below. Activity sequencing and duration may change somewhat as schedules are optimized during final engineering. The schedule for the surface facilities construction activities is presented on Figure 1.3-14. Figures 1.3-15 through 1.3-17 illustrate graphically the yearly construction progress.

During the first year of construction, clearing, grubbing, and rough-grading will be performed in a continuous operation. Approximately 305 acres will be disturbed during this period. Following rough-grading of the entire site, those areas not scheduled for immediate development will be seeded to control erosion. A storm water drainage system will be extended to each construction zone before work is initiated in that area.

Construction of the access road will be initiated during Year 1 with work being started simultaneously from both State Highway 55 and the mine/mill site. This will eliminate the need for a temporary bridge



NOTE: SCHEDULE MAY VARY DEPENDING UPON THE SEASON OF YEAR WHEN CONSTRUCTION IS INITIATED.

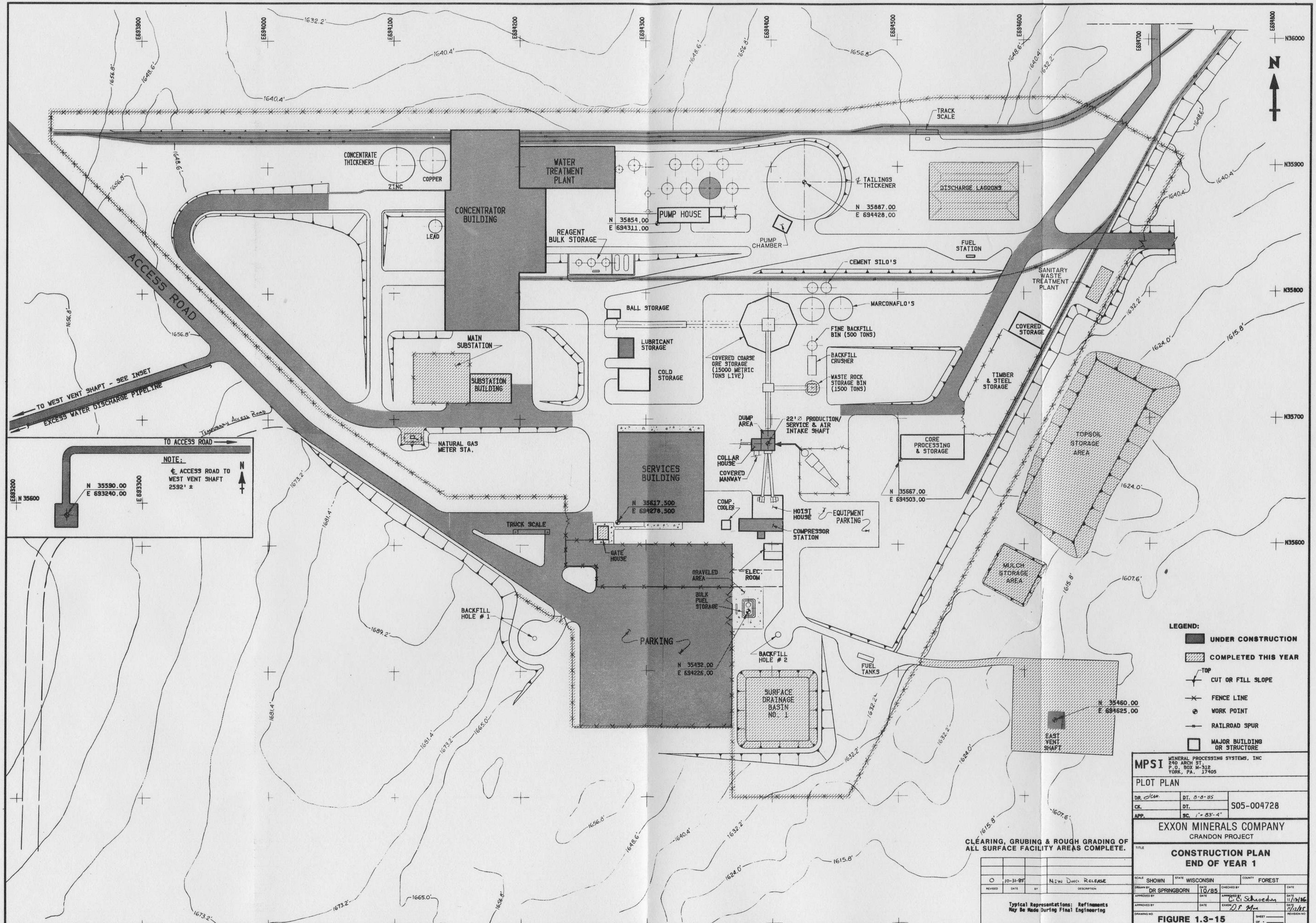
Typical Representation: Refinements May Be Made During Final Engineering

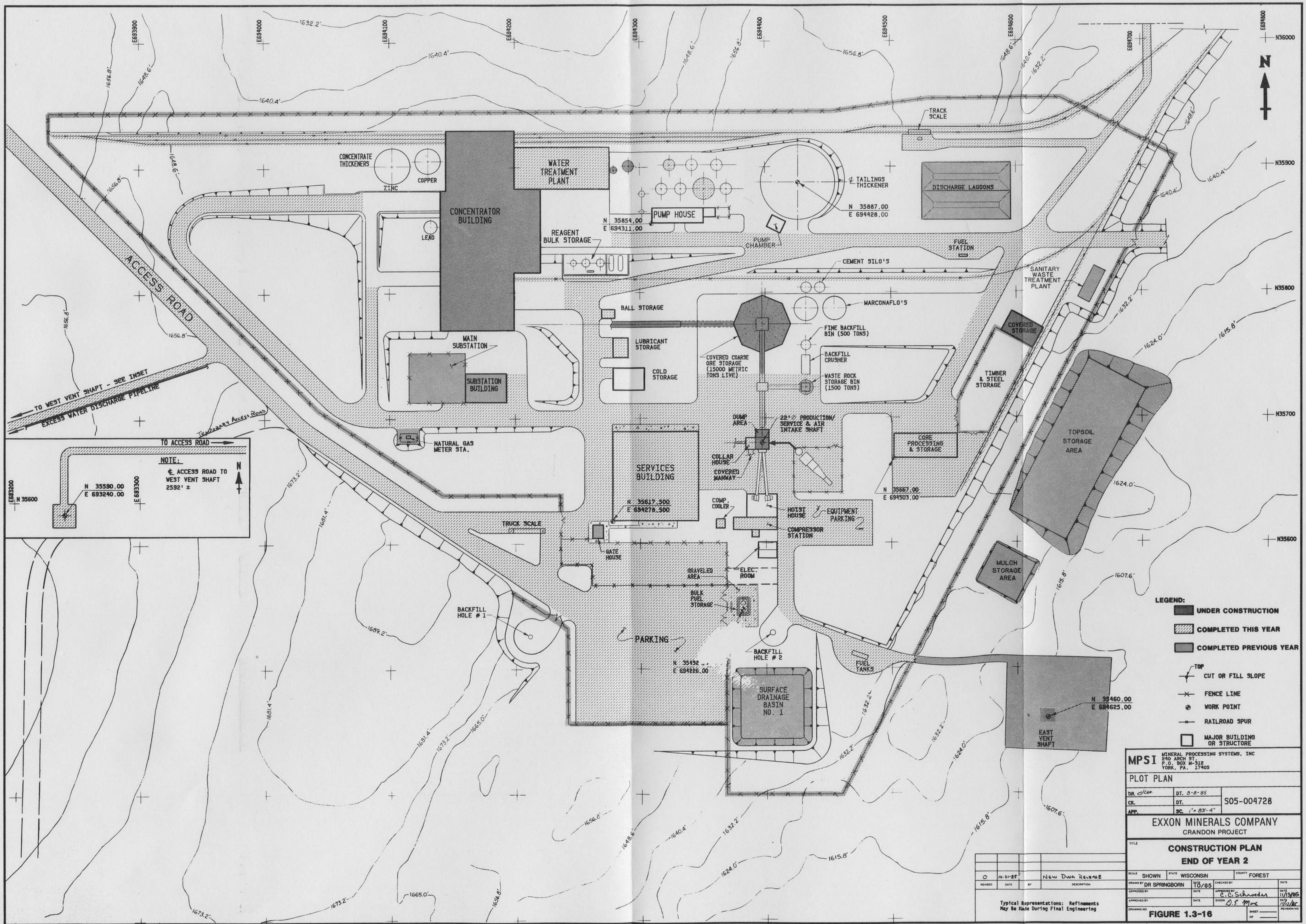
EXXON MINERALS COMPANY
CRANDON PROJECT

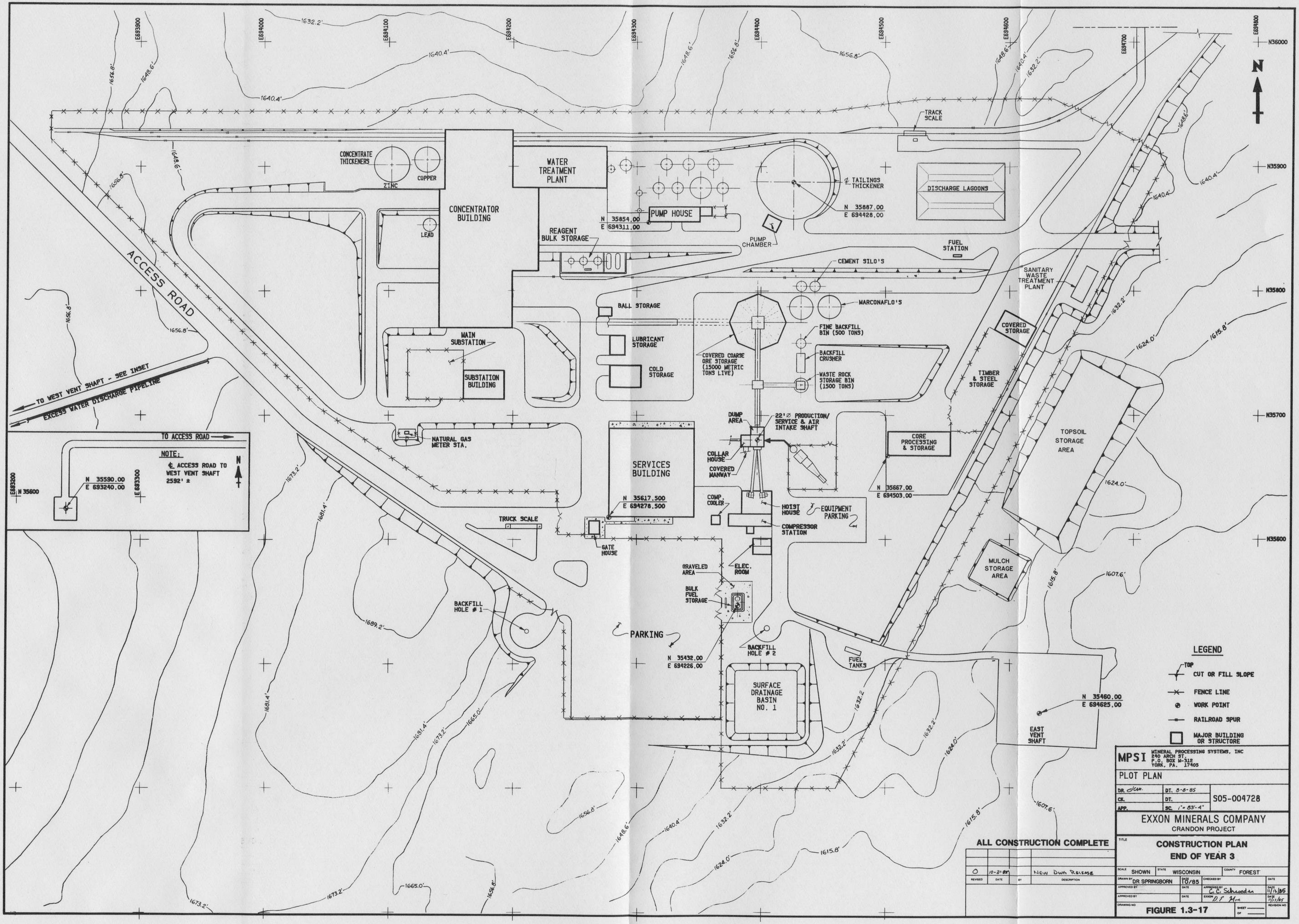
TITLE
CRANDON PROJECT CONSTRUCTION SCHEDULE

SCALE NONE	STATE WISCONSIN	COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 4/84	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schwede	DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. Moe	DATE 11/13/85
DRAWING NO. FIGURE 1.3-14	SHEET OF	REVISION NO. 6

G88 5/1981


ACCESS ROAD
CONCENTRATE THICKENERS
ZINC
COPPER
LEAD
CONCENTRATOR BUILDING
WATER TREATMENT PLANT
REAGENT BULK STORAGE
PUMP HOUSE
N 35854.00
E 694311.00
PUMP CHAMBER
TAILINGS THICKENER
N 35887.00
E 694428.00
DISCHARGE LAGOONS
TRACK SCALE
FUEL STATION
CEMENT SILO'S
SANITARY WASTE TREATMENT PLANT
MARCONAFLO'S
BALL STORAGE
LUBRICANT STORAGE
COLD STORAGE
FINE BACKFILL BIN (500 TONS)
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN (1500 TONS)
COVERED COARSE ORE STORAGE (15000 METRIC TONS LIVE)
COVERED STORAGE
TIMBER & STEEL STORAGE
MAIN SUBSTATION
SUBSTATION BUILDING
TO WEST VENT SHAFT - SEE INSET
EXCESS WATER DISCHARGE PIPELINE
TEMPORARY ACCESS ROAD
NATURAL GAS METER STA.
DUMP AREA
22' Ø PRODUCTION/ SERVICE & AIR INTAKE SHAFT
COLLAR HOUSE
COVERED MANWAY
CORE PROCESSING & STORAGE
N 35667.00
E 694503.00
TOPSOIL STORAGE AREA
SERVICES BUILDING
N 35617.500
E 694276.500
COMP. COOLER
HOIST HOUSE
EQUIPMENT PARKING
COMPRESSOR STATION
TO ACCESS ROAD
NOTE:
℄ ACCESS ROAD TO WEST VENT SHAFT 2592' ±
N 35590.00
E 693240.00
TRUCK SCALE
GATE HOUSE
GRAVELED AREA
ELEC. ROOM
BULK FUEL STORAGE
MULCH STORAGE AREA
BACKFILL HOLE # 1
PARKING
BACKFILL HOLE # 2
N 35432.00
E 694226.00
FUEL TANKS
SURFACE DRAINAGE BASIN NO. 1
N 35460.00
E 694625.00
EAST VENT SHAFT
LEGEND:
UNDER CONSTRUCTION
COMPLETED THIS YEAR
TOP
CUT OR FILL SLOPE
FENCE LINE
WORK POINT
RAILROAD SPUR
MAJOR BUILDING OR STRUCTORE
CLEARING, GRUBING & ROUGH GRADING OF ALL SURFACE FACILITY AREAS COMPLETE.
0 | 10-31-85 | | NEW DWG. RELEASE
REVISED | DATE | BY | DESCRIPTION
Typical Representations: Refinements May Be Made During Final Engineering
MPSI MINERAL PROCESSING SYSTEMS, INC 240 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
TITLE CONSTRUCTION PLAN END OF YEAR 1
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
DATE 10/85
CHECKED BY
APPROVED BY
DATE 11/13/86
EXXON
DATE 11/13/85
DRAWING NO. FIGURE 1.3-15
SHEET OF
REVISION NO


N
CONCENTRATE THICKENERS
ZINC
COPPER
LEAD
CONCENTRATOR BUILDING
WATER TREATMENT PLANT
PUMP HOUSE
N 35854.00
E 694311.00
TAILINGS THICKENER
N 35887.00
E 694428.00
DISCHARGE LAGOONS
TRACK SCALE
REAGENT BULK STORAGE
PUMP CHAMBER
FUEL STATION
CEMENT SILO'S
SANITARY WASTE TREATMENT PLANT
BALL STORAGE
MARCONAFLO'S
FINE BACKFILL BIN (500 TONS)
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN (1500 TONS)
COVERED COARSE ORE STORAGE (15000 METRIC TONS LIVE)
LUBRICANT STORAGE
COLD STORAGE
COVERED STORAGE
TIMBER & STEEL STORAGE
TOPSOIL STORAGE AREA
MAIN SUBSTATION
SUBSTATION BUILDING
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 35590.00
E 693240.00
N 35600
E693200
E693300
NATURAL GAS METER STA.
DUMP AREA
22' ⌀ PRODUCTION/ SERVICE & AIR INTAKE SHAFT
COLLAR HOUSE
COVERED MANWAY
CORE PROCESSING & STORAGE
N 35667.00
E 694503.00
SERVICES BUILDING
N 35617.500
E 694278.500
COMP. COOLER
HOIST HOUSE
EQUIPMENT PARKING
COMPRESSOR STATION
TRUCK SCALE
GATE HOUSE
GRAVELED AREA
ELEC. ROOM
BULK FUEL STORAGE
MULCH STORAGE AREA
BACKFILL HOLE # 1
PARKING
N 35492.00
E 694226.00
BACKFILL HOLE # 2
FUEL TANKS
SURFACE DRAINAGE BASIN NO. 1
N 35460.00
E 694625.00
EAST VENT SHAFT
E693900
E694000
E694100
E694200
E694300
E694400
E694500
E694600
E694700
E694800
N36000
N35900
N35800
N35700
N35600
1632.2'
1640.4'
1648.6'
1656.8'
1615.8'
1624.0'
1607.6'
1665.0'
1673.2'
1681.4'
1689.2'
LEGEND:
UNDER CONSTRUCTION
COMPLETED THIS YEAR
COMPLETED PREVIOUS YEAR
TOP
CUT OR FILL SLOPE
FENCE LINE
WORK POINT
RAILROAD SPUR
MAJOR BUILDING OR STRUCTURE
MPSI
MINERAL PROCESSING SYSTEMS, INC
240 ARCH ST.
P.O. BOX M-312
YORK, PA. 17405
PLOT PLAN
DT. 8-8-85
SC. 1" = 83'-4"
S05-004728
EXXON MINERALS COMPANY
CRANDON PROJECT
CONSTRUCTION PLAN
END OF YEAR 2
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
10/85
C. C. Schroeder
11/13/85
D.S. Moe
0
10-31-85
New Dwg Release
REVISED DATE BY DESCRIPTION
Typical Representations: Refinements May Be Made During Final Engineering
FIGURE 1.3-16



ACCESS ROAD
TO WEST VENT SHAFT - SEE INSET
EXCESS WATER DISCHARGE PIPELINE
TO ACCESS ROAD
NOTE:
℄ ACCESS ROAD TO WEST VENT SHAFT 2592' ±
N 35590.00
E 693240.00
CONCENTRATE THICKENERS
ZINC
COPPER
LEAD
CONCENTRATOR BUILDING
WATER TREATMENT PLANT
REAGENT BULK STORAGE
PUMP HOUSE
N 35854.00
E 694311.00
PUMP CHAMBER
TAILINGS THICKENER
N 35887.00
E 694428.00
DISCHARGE LAGOONS
TRACK SCALE
FUEL STATION
CEMENT SILO'S
MARCONAFLO'S
SANITARY WASTE TREATMENT PLANT
COVERED STORAGE
BALL STORAGE
LUBRICANT STORAGE
COLD STORAGE
COVERED COARSE ORE STORAGE (15000 METRIC TONS LIVE)
FINE BACKFILL BIN (500 TONS)
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN (1500 TONS)
TIMBER & STEEL STORAGE
TOPSOIL STORAGE AREA
MAIN SUBSTATION
SUBSTATION BUILDING
NATURAL GAS METER STA.
SERVICES BUILDING
N 35617.500
E 694278.500
DUMP AREA
22'Ø PRODUCTION/ SERVICE & AIR INTAKE SHAFT
COLLAR HOUSE
COVERED MANWAY
CORE PROCESSING & STORAGE
N 35667.00
E 694503.00
HOIST HOUSE
COMPRESSOR STATION
COMP. COOLER
EQUIPMENT PARKING
TRUCK SCALE
GATE HOUSE
GRAVELED AREA
ELEC. ROOM
BULK FUEL STORAGE
MULCH STORAGE AREA
BACKFILL HOLE # 1
PARKING
N 35432.00
E 694226.00
BACKFILL HOLE # 2
FUEL TANKS
SURFACE DRAINAGE BASIN NO. 1
N 35460.00
E 694625.00
EAST VENT SHAFT
LEGEND
TOP
CUT OR FILL SLOPE
FENCE LINE
WORK POINT
RAILROAD SPUR
MAJOR BUILDING OR STRUCTURE
ALL CONSTRUCTION COMPLETE
MPSI
MINERAL PROCESSING SYSTEMS, INC
240 ARCH ST.
P.O. BOX M-312
YORK, PA. 17405
PLOT PLAN
S05-004728
EXXON MINERALS COMPANY
CRANDON PROJECT
CONSTRUCTION PLAN
END OF YEAR 3
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
10/85
0 10-31-85 NEW DWG RELEASE
FIGURE 1.3-17

or culvert to allow passage over Swamp Creek. Construction of the railroad spur also will be started during Year 1. Both of these facilities will be completed during Year 2. Other major facilities that will be started in Year 1 and completed during Year 1 or Year 2 include installation of the 115-kV powerline and the natural gas line, the sewage treatment facilities, water treatment facilities, reclaim pond, the services building, mine shaft headframes, hoist and compressor buildings, a perimeter fence, and the fire protection and water storage system. Several of the miscellaneous storage buildings will also be built and will be available for use by the construction forces.

Sinking of the east vent and main shafts will be initiated immediately upon completion of the collar excavations and headframe installations and will be completed in Years 2 and 3, respectively.

The preproduction ore storage pad will be prepared during the summer of Year 1 so that it will be available when shaft waste rock production starts. During Year 1, foundations will be started for the concentrator. During Years 2 and 3, the coarse ore storage facilities will be constructed.

Mechanical, electrical, and instrumentation work will increase late in Year 2 as the civil and structural work decreases. Excavation of tailing pond T1 will be started. The principal above-ground structures will be completed during Year 3.

During Year 3, the final year of construction activities, sufficient underground development will be completed so that mine production activities can be initiated on a limited scale. Construction of tailing pond T1 will be completed during Year 3 and the tailings and recirculation water lines will be installed. Cleanup and landscaping activities, which will have been ongoing throughout the construction phase, will be completed.

Many factors have potential for extending the construction schedule. These factors include: inclement weather, labor problems, delays in equipment/material deliveries, design modifications, and localized mine water inflows higher than anticipated.

Inclement weather may cause problems and schedule delays only during the first winter. Most work areas will be under temporary or permanent cover by the second winter which will allow the inside work of equipment and material installation to proceed without delay.

Equipment and material deliveries may delay installation and thereby extend the schedule. A well defined procurement and expediting plan will be prepared to minimize delays in ordering and securing delivery of equipment and materials. Those pieces of equipment which have long delivery times will be identified and the purchase orders will be placed well in advance to avoid schedule impacts.

Design modifications will occur as construction progresses. Delays will be minimized by having an engineering office on-site to make field changes to construction drawings.

Short duration, higher than expected mine water inflows in the development headings may affect the mine development schedule. Mine water inflow will be constantly monitored and probes ahead of development headings will be made to identify sources of excess water flow. If excess water flows are identified, grout will be injected to seal the leaking areas ahead of excavation.

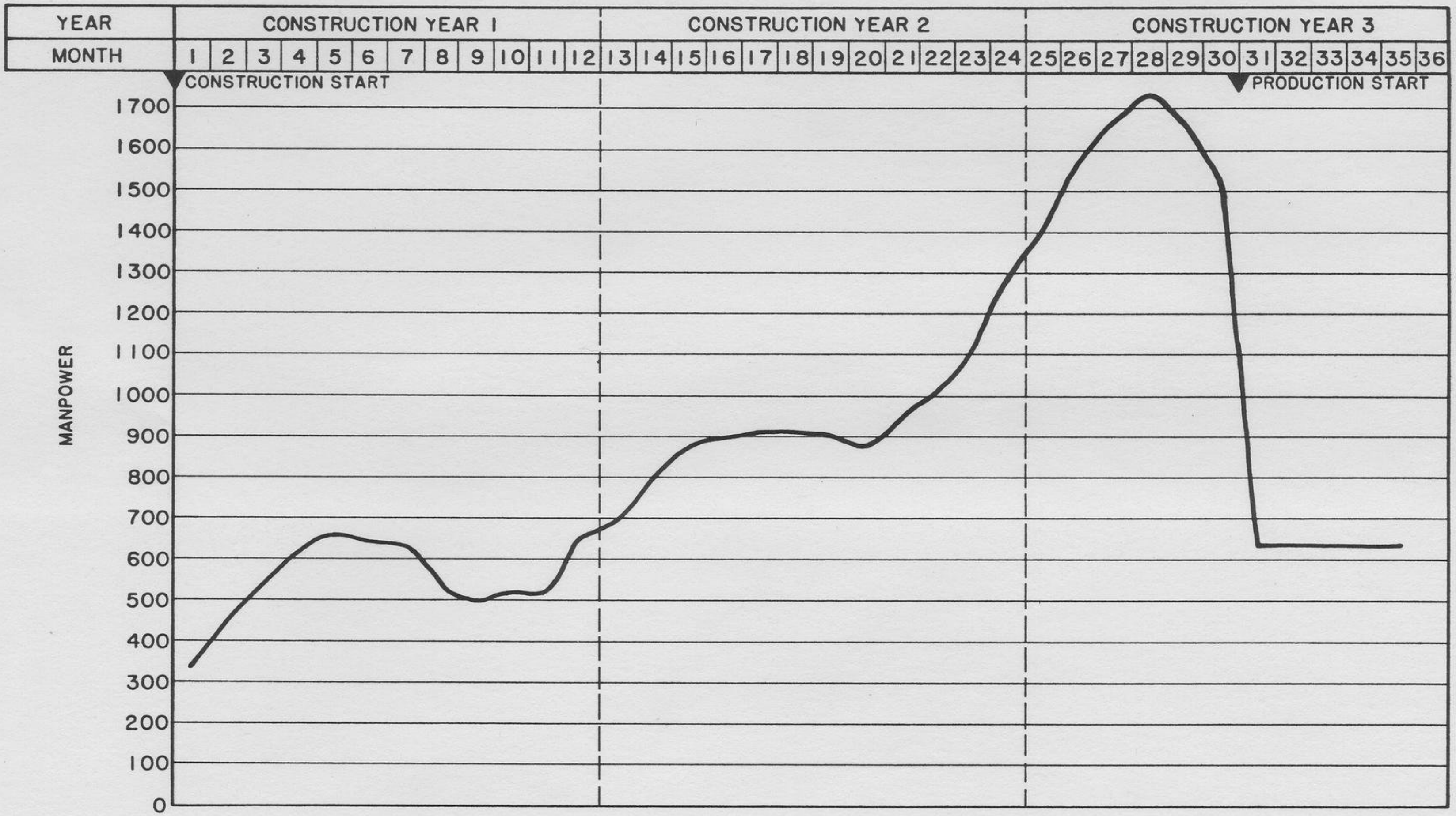
1.3.3 Construction Operations

1.3.3.1 Manpower

The estimated manpower required during the various phases of construction is shown on Figure 1.3-18 and presented in Table 1.3-3. Sequencing of construction activities was planned to minimize large fluctuations in manning levels. Seasonal fluctuations, however, cannot be entirely eliminated.

During surface facilities construction, there will be a progressive change in the craft skills required. For approximately the first 2 years, the work will emphasize site preparation, excavation, construction of building foundations, and construction of ancillary facilities. Accordingly, emphasis will be upon the skills required for these tasks, including equipment operators, concrete forming and pouring workers, and light steel building constructors. During the second year of construction, emphasis will begin to shift toward the need for iron workers, carpenters, and millwrights. The emphasis during the final year of construction will be toward the need for millwrights, electricians, and painters.

For the initial development of the mine shaft collar, the labor force will consist of relatively small numbers of specialized trades (drillers, pipefitters, mechanics). Miners, shaftsinkers, and other underground workers will begin to phase into the construction work force during the second year and will form most of the work force starting the latter part of Year 2. Where feasible, construction employees will be drawn from the local area.



Typical Representation: Refinements May Be Made During Final Engineering. Final Estimate To Be Within ±15% Of This Estimate.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CONSTRUCTION PHASE MANPOWER COMPOSITE CURVE ESTIMATED LOADING

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY DR SPRINGBORN	DATE 8/85	CHECKED BY		DATE	
APPROVED BY	DATE	APPROVED BY C.C. Schroeder		DATE 11/13/85	
APPROVED BY	DATE	EXXON DE Moe		DATE 11/13/85	
DRAWING NO FIGURE 1.3-18			SHEET OF	REVISION NO	

TABLE 1.3-3

OVERALL MAN-LOADING SUMMARY

	Surface Facilities Contractors			Mine Facilities Contractors			EMC				
Months From Construction Start	Direct	Indirect	Construction Supervision	Direct	Indirect	Supervision	Direct	Indirect (Construction Staff)	Owner's Organization	Project Management Team	Total
1	151	26	33	72	14	12	-	0	6	20	334
2	227	38	50	76	14	12	-	0	6	25	448
3	276	47	62	82	16	12	-	0	11	26	532
4	321	55	67	99	19	15	-	2	12	28	618
5	331	56	68	104	20	17	1	4	23	28	652
6	304	51	68	110	21	17	2	6	33	28	640
7	286	48	63	107	21	17	2	8	49	28	629
8	205	35	46	110	21	17	2	10	54	28	528
9	182	31	40	107	21	17	2	12	54	28	494
10	190	32	42	109	21	17	2	14	54	28	509
11	198	34	44	99	19	17	2	14	54	29	510
12	292	50	65	105	20	17	3	14	57	30	653
13	326	55	72	101	19	17	3	15	57	30	695
14	397	67	88	101	19	17	3	18	61	30	801
15	448	76	100	101	19	17	3	18	61	32	875
16	439	75	100	103	20	17	22	20	62	34	892
17	426	72	100	103	20	17	48	23	64	36	909
18	409	69	97	98	19	17	74	23	65	38	909
19	376	64	94	92	18	17	108	23	67	42	901
20	348	59	79	87	17	17	120	24	79	44	874
21	368	62	82	89	17	17	133	27	106	46	947
22	388	66	86	91	17	17	145	27	119	50	1,006
23	431	73	96	89	17	17	174	27	132	52	1,108
24	510	87	113	89	17	17	200	27	145	52	1,257
25	599	102	133	83	16	17	214	27	149	55	1,395
26	681	115	151	96	16	17	244	27	156	55	1,558
27	728	124	161	98	16	17	262	27	173	58	1,664
28	745	126	165	92	18	17	295	27	191	58	1,734*
29	667	113	148	96	18	17	308	27	217	60	1,671
30	545	93	125	96	18	17	320	27	223	60	1,524

*Peak labor.

During the first year, site preparation earthwork will be conducted throughout the daylight hours. This is required to maximize progress to the point where buildings can be erected to provide work areas during periods of severe weather.

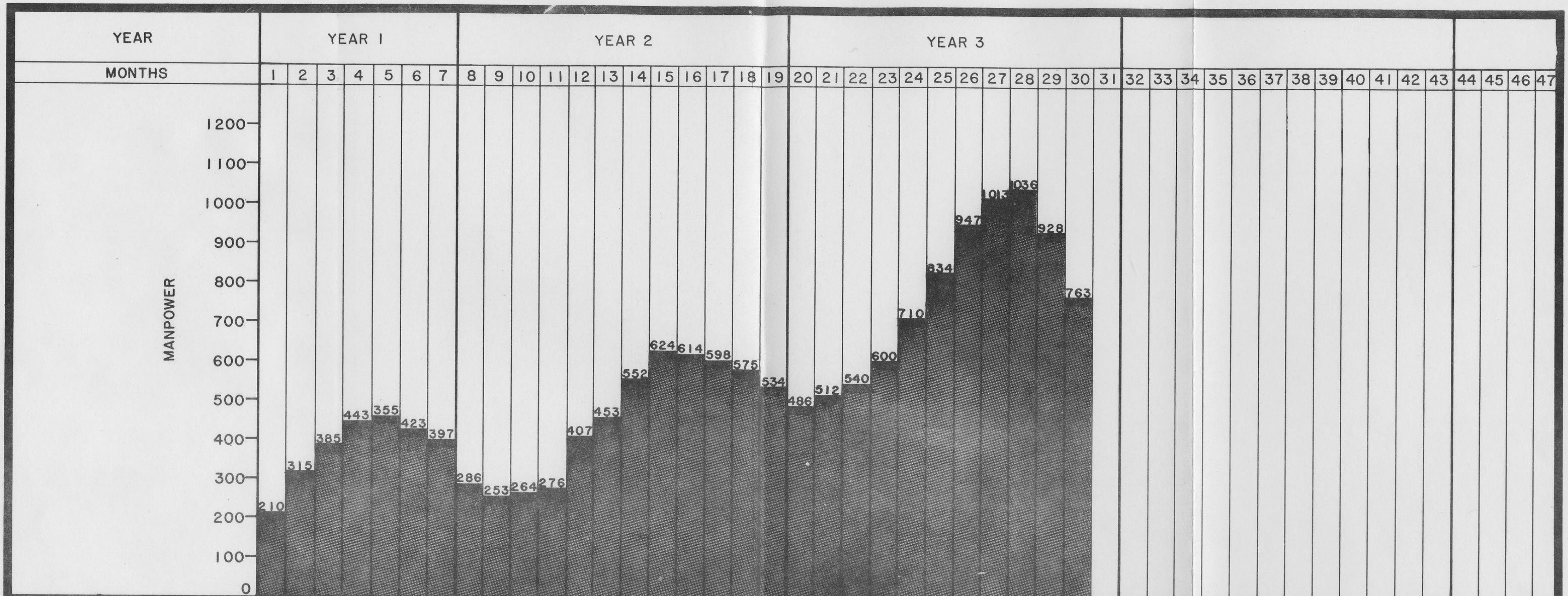
Construction of the main shaft headframe will be done on 3 shifts, 24 hours per day, 7 days per week. By the second year most of the construction activities will be performed on an 8-hour day, 40-hour week. Overtime for construction will be limited to emergency conditions and for purposes of schedule makeup.

Tables 1.3-4 and 1.3-5 provide data on non-Exxon construction workers and Exxon personnel, respectively, by Standard Occupational Classification (SOC) code.

Figures 1.3-19 through 1.3-21 provide the manpower buildup for surface construction, underground mine construction, and Exxon personnel. A composite illustration of both contractor and Exxon personnel during construction is presented on Figure 1.3-22. For manpower planning and cost estimating purposes, all manpower numbers presented include a 20 percent contingency allowance.

A composite curve illustrating total manpower requirements during construction and into the production phase is presented on Figure 1.3-18. This curve depicts manpower requirements for three major areas: surface facilities, shaft and underground facilities, and Exxon permanent employees. Assumptions for the development of manpower requirements for each major area follow:

1) Contractor construction manpower - surface facilities (see Figure 1.3-19). Contractor manpower will be engaged in the construction of the railroad, access roads, tailing



MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
SUPERVISION	151	227	276	321	331	304	286	205	182	190	198	292	326	397	448	439	426	409	376	348	368	388	431	510	599	681	728	745	667	545
INDIRECT LABOR	26	38	47	55	56	51	48	35	31	32	34	50	55	67	76	75	72	69	64	59	62	66	73	87	102	115	124	126	113	93
DIRECT LABOR	33	50	62	68	68	68	63	46	40	42	44	65	72	88	100	100	100	97	94	79	82	86	96	113	133	151	161	165	148	125

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **SURFACE FACILITIES CONSTRUCTION MANPOWER LOADING: DIRECT, INDIRECT & CONSTRUCTION SUPERVISION**

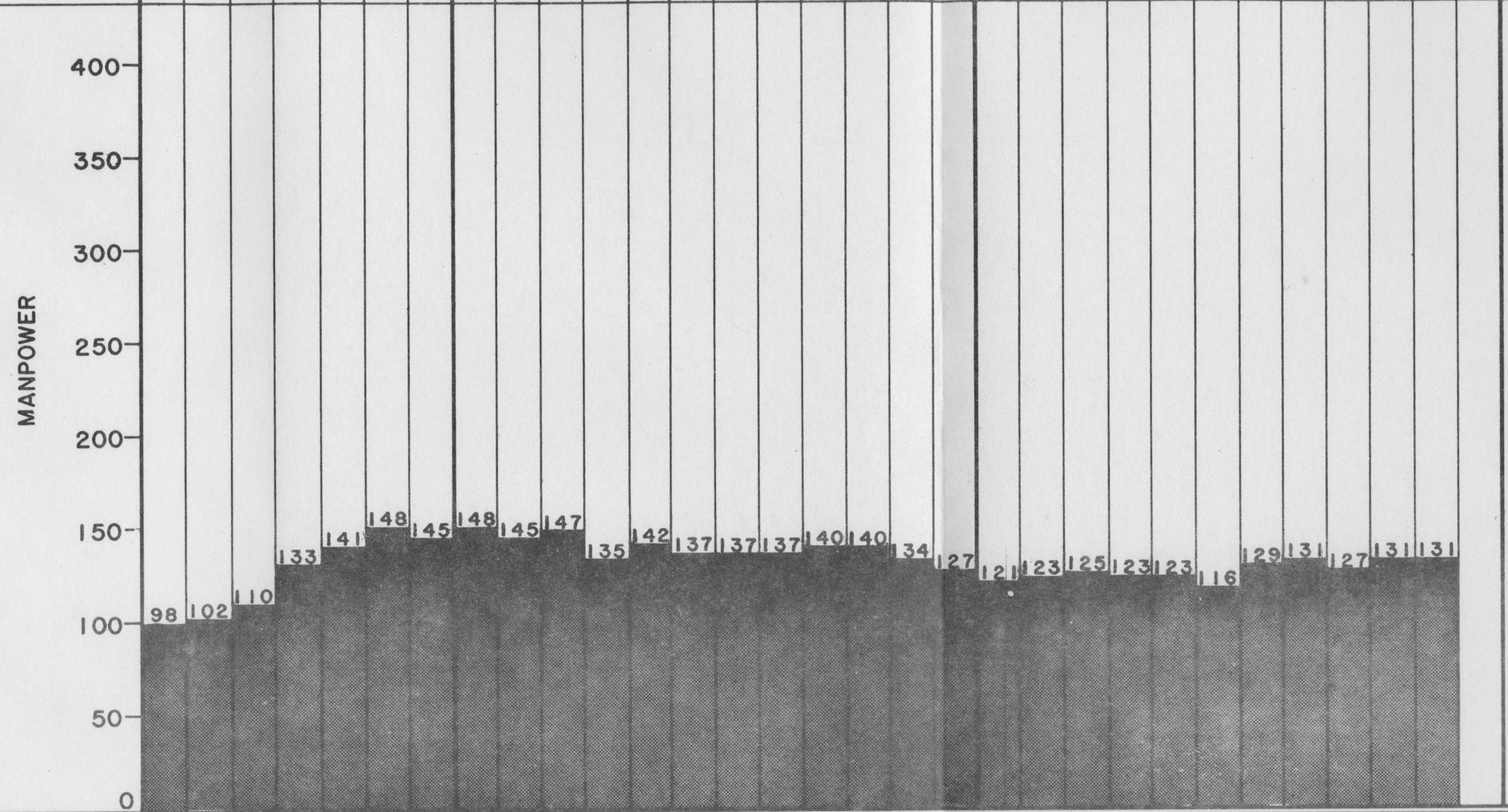
SCALE: NONE | STATE: WISCONSIN | COUNTY: FOREST

DRAWN BY: DR SPRINGBORN | DATE: 5/84 | CHECKED BY | DATE

APPROVED BY | DATE | APPROVED BY: C.G. Schroeder | DATE: 11/13/85

APPROVED BY | DATE | EXXON: D.E. M-e | DATE: 11/13/85

DRAWING NO: **FIGURE 1.3-19** | SHEET ___ OF ___ | REVISION NO.



YEAR	YEAR 1							YEAR 2							
MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MINE DIRECT LABOR	72	76	82	99	104	110	107	110	107	109	99	105	101	101	101
MINE INDIRECT LABOR	14	14	16	19	20	21	21	21	21	21	19	20	19	19	19
MINE SUPERVISION	12	12	12	15	17	17	17	17	17	17	17	17	17	17	17

YEAR	YEAR 2				YEAR 3											
MONTHS	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MINE DIRECT LABOR	103	103	98	92	87	89	91	89	89	83	96	98	92	96	96	
MINE INDIRECT LABOR	20	20	19	18	17	17	17	17	17	16	16	16	18	18	18	
MINE SUPERVISION	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	

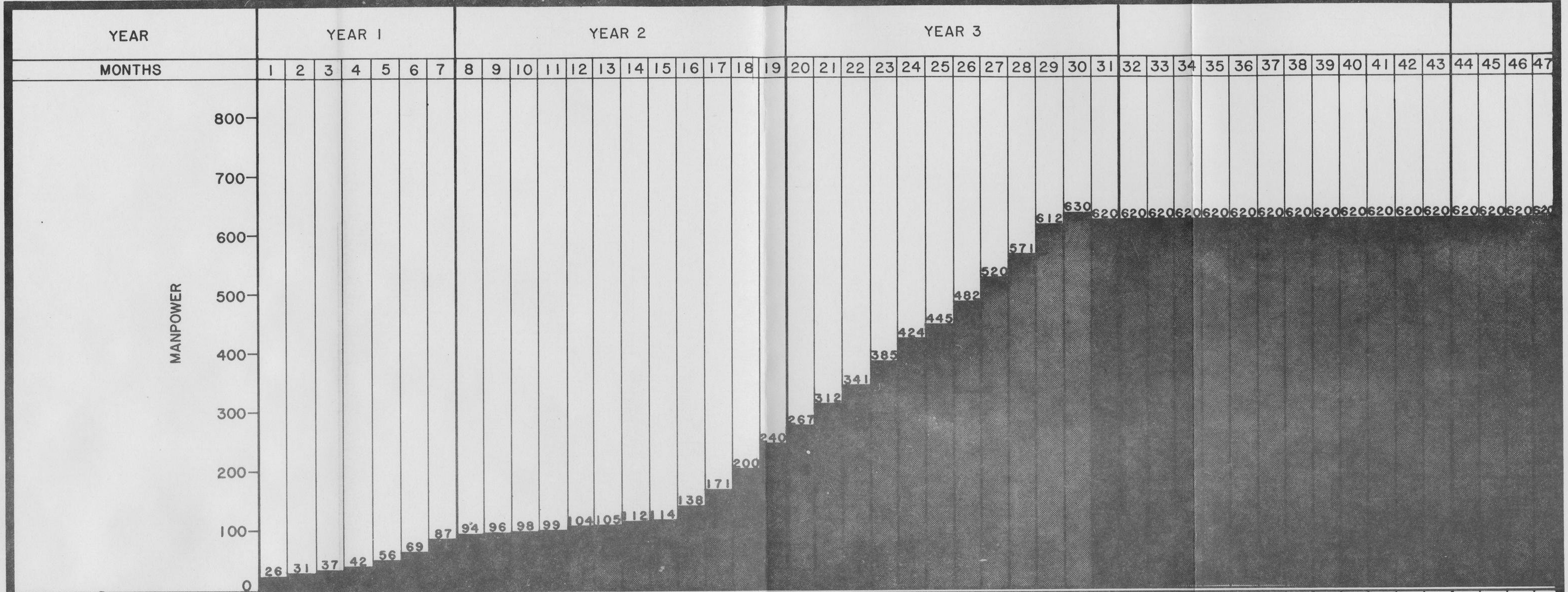
MONTHS	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
MINE DIRECT LABOR																
MINE INDIRECT LABOR																
MINE SUPERVISION																

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE **UNDERGROUND FACILITIES CONSTRUCTION MANPOWER LOADING: DIRECT, INDIRECT & CONSTRUCTION SUPERVISION**

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 5/84	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY G.C. Schwoch	DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. Moe	DATE 11/13/85
DRAWING NO **FIGURE 1.3-20**		SHEET ___ OF ___	REVISION NO.



MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
MINE DIRECT LABOR					1	2	2	2	2	2	2	3	3	3	3	22	48	74	108	120	133	145	174	200
MINE CONSTRUCTION STAFF				2	4	6	8	10	12	14	14	14	15	18	18	20	23	23	23	24	27	27	27	27
PROJECT MANAGEMENT TEAM	20	25	26	28	28	28	28	28	28	28	29	30	30	30	32	34	36	38	42	44	46	50	52	52
OWNERS ORGANIZATION	6	6	11	12	23	33	49	54	54	54	54	57	57	61	61	62	64	65	67	79	106	119	132	145
OPERATIONS																								

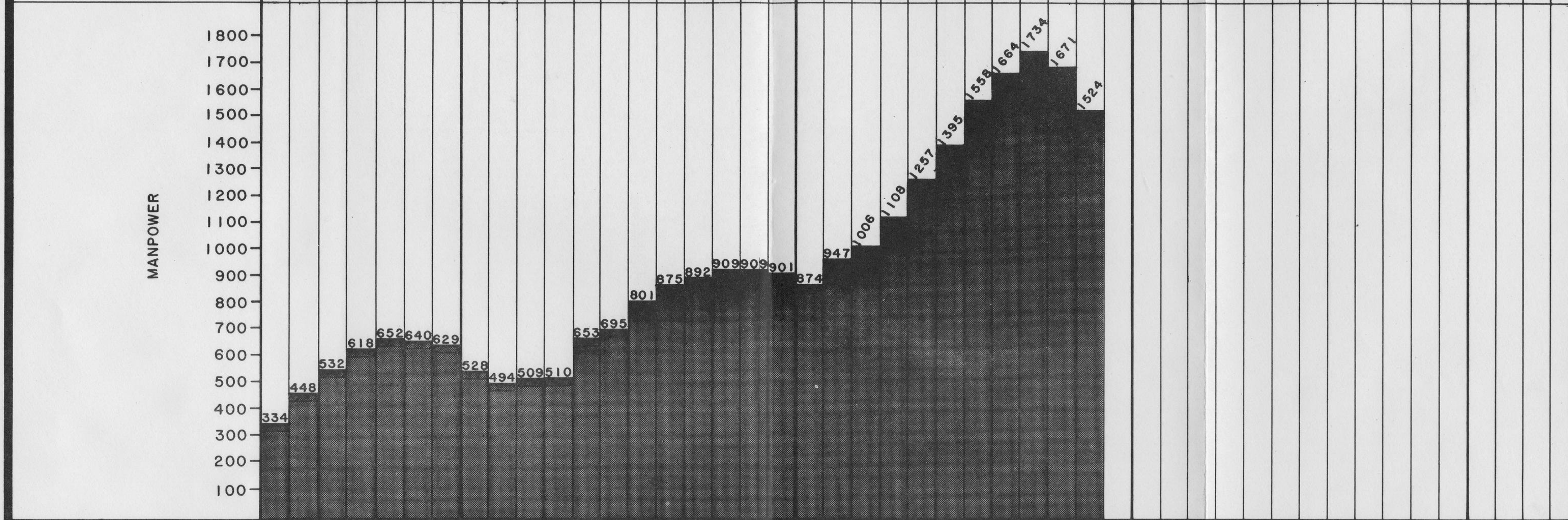
MONTHS	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
MINE DIRECT LABOR	214	244	262	295	308	320																	
MINE CONSTRUCTION STAFF	27	27	27	27	27	27																	
PROJECT MANAGEMENT TEAM	55	55	58	58	60	60																	
OWNERS ORGANIZATION	149	156	173	191	217	223																	
OPERATIONS							620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620

Typical Representation : Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE **EMC MANPOWER LOADING: MINE DIRECT & INDIRECT MANPOWER, OWNERS ORGANIZATION, PROJECT MANAGEMENT TEAM, OPERATIONS MANNING**

SCALE NONE | STATE WISCONSIN | COUNTY FOREST
DRAWN BY DR SPRINGBORN | DATE 5/84 | 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 1.3-21** | SHEET | OF | REVISION NO



YEAR	YEAR 1							YEAR 2							
MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MINE CONTRACTORS	98	102	110	133	141	148	145	148	145	147	135	142	137	137	137
SURFACE FACILITIES CONTRACTORS	210	315	385	443	455	423	397	286	253	264	276	407	453	552	624
EXXON PERSONNEL	26	31	37	42	56	69	87	94	96	98	99	104	105	112	114

YEAR	YEAR 2					YEAR 3											
MONTHS	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MINE CONTRACTORS	140	140	134	127	121	123	125	123	123	116	129	131	127	131	131	
SURFACE FACILITIES CONTRACTORS	614	598	575	534	486	512	540	600	710	834	947	1013	1036	928	763	
EXXON PERSONNEL	138	171	200	240	267	312	341	385	424	445	482	520	571	612	630	

YEAR																
MONTHS	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
MINE CONTRACTORS																
SURFACE FACILITIES CONTRACTORS																
EXXON PERSONNEL																

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
TOTAL CONTRACTOR & EXXON PERSONNEL DURING CONSTRUCTION

SCALE NONE	STATE WISCONSIN		COUNTY 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 D.E. M—		DATE 11/13/85
DRAWING NO FIGURE 1.3-22		SHEET ___ OF ___		REVISION NO

TABLE 1.3-4

ESTIMATED CONTRACTOR CONSTRUCTION PHASE WORK FORCE

JOB CATEGORY	SOC[a]	NO. OF WORKERS[b]	EDUCATION[c]	EXPERIENCE[d]
Shaft and Underground Facilities				
Pipefitters	6450	5	V	Y
Welders	7710	5	V	Y
Electricians	6430	10	V	Y
Millwrights	6178	10	V	Y
Mechanics	6140	15	H	Y
Equipment Operators	8310	10	H	Y
Ironworkers	6472 & 6473	15	V	Y
Carpenters	6420	10	H	Y
Laborers	8710	15	H	N-Y
Cement Masons	6463	10	H	Y
Shaft and Drift Miners/ Rock Drillers	6530	30	H	Y
Hoistmen	8314	10	H	Y
Surveyors	1640	5	V	Y
Supervisors	6310	10	H-C	Y
Engineers	162 & 163	5	C	Y
Surface Facilities				
Boilermakers	6814	70	V	Y
Carpenters	6420	65	H	Y
Electricians	6430	195	V	Y
Laborers	8710	210	H	N-Y
Operating Engineers	8310	70	H	Y
Millwrights	6178	60	V	Y
Painters	6440	20	H	Y
Pipefitters	6450	160	V	Y
Ironworkers	6472 & 6473	70	V	Y
Drivers/Mechanics/Oilers	6140	70	H	Y
Cement Masons/Finishers	6463	5	H	Y
Surveyors (Rodmen)	1640	5	V	Y
Supervisors	6310	135	H-C	Y
Engineers	162 & 163	25	C	Y

[a] Standard Occupational Classification Code (SOC) - U.S. Department of Commerce.

[b] Numbers reflect maximum employment needs within job categories rounded to the nearest 5. Due to timing differences, totals may not agree with Project employment totals.

[c] Education: H - High School
V - Vocational Technology
C - College

[d] Y - yes; N - none required; N-Y - some employees will need prior experience and others will be trained on the job.

Note: Typical representation for the purpose of socioeconomic analysis. Refinements may be made during final engineering. Final estimate expected to be within ± 15% of this estimate.

TABLE 1.3-5

EMC EMPLOYEES

JOB CATEGORY	SOC[a]	NO. OF EMP.[b]	EDUCATION[c]	EXPERIENCE[d]
	Administration	77		
Secretaries/Clerks	46-47	17	H	N-Y
Janitors	5240	7	H	N-Y
Security	5140	8	V	Y
Accountants	1412	2	C	Y
Warehouse	8724	9	H	N-Y
Purchasing	1449	2	H	Y
Paramedics	5236	4	V	Y
Employee Relations/ Safety/Training	1430	9	C	Y
Environmental	1849	5	C	N-Y
Supervision	12-13	8	C	Y
Engineers	162 & 163	4	C	Y
Public Affairs	3320	2	C	Y
	Mine Technical	26		
Supervisors/Engineers	162 & 163	6	C	N-Y
Geologists	1847	3	C	N-Y
Draftsmen	3720	2	V	N-Y
Engineers/Geology Technicians	3710	8	V	N-Y
Surveyors	1640	5	V	Y
Clerks	46-47	2	H	N-Y
	Mine Operations	267		
Secretaries/Clerks	46-47	4	H	N-Y
Miners	6530	80	H	N-Y
Equipment Operators	6540	88	H	N-Y
Laborers	6560	65	H	N
Supervisors	6320	26	V	Y
Hoistmen	8314	4	H	Y

[a] Standard Occupational Classification Code (SOC) - U.S. Department of Commerce.

[b] Numbers reflect employment needs within job categories. Due to timing differences, totals may not agree with Project employment totals.

[c] Education: H - High School
V - Vocational Technology
C - College

[d] Y - yes; N - none required; N-Y - some employees will need prior experience and others will be trained on the job.

Note: Typical representation for the purpose of socioeconomic analysis. Refinements may be made during final engineering. Final estimate expected to be within ± 15% of this estimate.

TABLE 1.3-5 (Continued)

JOB CATEGORY	SOC[a]	NO. OF EMP.[b]	EDUCATION[c]	EXPERIENCE[d]
	Mine Maintenance	86		
Equipment Mechanics	6110	50	H	N-Y
Pump/Fan Mechanics	6130	1	H	Y
Welders	7710	4	V	Y
Electricians	6430	8	V	Y
Maintenance	6179	10	H	N-Y
Clerks	46-47	4	H	N-Y
Supervisors	6000	9	V	Y
	Mill Operations	57		
Secretaries/Clerks	46-47	2	H	N-Y
Mill Operators	6960	37	H	N-Y
Laborers	8650	11	H	N-Y
Supervisors	6320	7	H	Y
	Mill Technical	22		
Lab Technicians	3831	12	V	N-Y
Metallurgists/Chemists/ Engineers	162 & 163	7	C	N-Y
Technicians	3710	2	V	N-Y
Typist/Clerks	46-47	1	H	N-Y
	Mill Maintenance	28		
Supervisors	6000	2	V	Y
Mechanics/Oilers	6140	18	H	N-Y
Welders	7710	4	V	Y
Instrument Repairs	6170	4	V	Y
	Central Maintenance	57		
Supervisors	6000	6	V	Y
Machinists	6813	2	V	Y
Electricians	6430	13	V	N-Y
Mobile Equip Maintenance	6110	23	H	N-Y
Draftsmen	3720	1	V	N-Y
Welders/Fabricators	7710	6	V	Y
Carpenters	6420	1	H	Y
Secretaries/Clerks	46-47	2	H	N-Y
Maintenance Planners	4750	2	H	Y
Engineers	162 & 163	1	C	Y

pond T1, reclaim pond, and all other surface facilities. These include coarse ore storage, concentrator building and all facilities therein, services building, water treatment plant, plant water systems, main substation and electrical distribution, yard piping systems, all in-plant roads and parking areas, and all other ancillary surface facilities.

2) Mine contractor construction manpower - the detailed construction manpower requirements for the shaft and underground facilities are shown on Figure 1.3-20. Activities include sinking and equipping the main and east exhaust shafts, headframe erection, and development of the underground crushing station including equipment installation. Manpower assessments were developed for construction of the headframe, main shaft and east exhaust air shaft. These estimates were used to evaluate crew sizes based upon shift requirements and schedule demands. The remainder of the activities were developed similarly through analysis of each construction task, determination of required equipment and materials, and development of crews for each task.

3) Exxon permanent employees. Exxon permanent employees who will be involved in construction, operations, maintenance, and technical support for the mine and mill facilities are included on Figure 1.3-21. These personnel will be engaged in underground mine development work and prestart-up of the surface production facilities. They will also fulfill construction management requirements for administration of various contracts for surface and underground work prior to mine and mill start-up. During start-up many of these people will assume their permanent positions as operations, maintenance, and technical support staff. Positions were first identified on an overall Crandon Project organization chart. All positions were then staged through the construction phase, and into the production phase, to meet schedule demands for mine/mill start-up, construction management requirements, and reasonable rates for effective employee assimilation and training.

Material requirements were prepared from preliminary engineering drawings for such items as excavation, concrete, structural steel, piping, and painting and were used to derive the estimated field manhours. Equipment installation manhour estimates were obtained from the vendors with manhour estimates and costs for field representation during installation and start-up. A productivity adjustment was included to account for Crandon Project specifics and to reflect actual manhours to be expended on-site. An analysis was then completed for the areas of construction, the construction schedule, and the Project contracting plan. A determination of equipment and materials necessary for each task was generated, and manpower curves were developed for each skill classification. These curves were checked against historical curves for peak manpower requirements, duration of peak, phased entry into the Project and total scheduled duration.

The contractor estimates, organization charts, and engineering drawings are based on preliminary engineering which inherently lacks the degree of detail necessary for precise construction material quantity determinations. As these quantities govern the manpower computations, actual manpower requirements during construction may deviate from our present projections. This is particularly true with respect to any one specific craft or in any one specific area. However, in the aggregate the overall manning requirements are expected to track the present curve within acceptable limits.

1.3.3.2 Equipment

The types of equipment which will be used for the construction of the surface facilities are described in Tables 1.3-6 and 1.3-7. These tabulations are for illustrative purposes only. Actual needs, while anticipated to be similar, will vary from contractor to contractor. The sequence in which the equipment is deployed according

TABLE 1.3-6

CONSTRUCTION EQUIPMENT-SURFACE FACILITIES*

DESCRIPTION	MODEL	ENGINE	HORSE-POWER
Chain Saws	CS400 EVL	40cc	3
Feller Buncher	PM 850	GMC 6V53	180
Hydro Mower	PM 800	GMC 6V53	180
Front End Loader	CAT 988B	D333 6 CYL	375
Bull Dozer	D9 Series H	D353T	410
Bull Dozer	D8 Series H	D342T	270
Bull Dozer	D7 Series G	D3306T	200
Bull Dozer	D6 Series D	D3306	140
Backhoe	CAT 235	D3306	195
Backhoe Combo	John Deer 9500	4 CYl	160
Motor Grader	CAT 16G	D3406	325
Gradall	G1000	(2) GM4-71N	136/ea
Compactor	Buffalo Bomag 90SL	E09FG	15
Wacker	I.R. BPG24	Diesel	5.1
Compactor	I.R. BPG9	Gas	4
Compactor 815	CAT 815	D3406	325
Compactor Sheepsfoot	D6 Series D	D3306	140
Roller Compactor Vibratory	Buffalo Bomag 210	GMC 453	120
Compactor V30	Essick V30-WR	Diesel	12
Motor Scraper 21/30 Yd.	CAT 631	Diesel Cat 5908	450
Crane (100 Ton) Crawler	Manitowoc 3900	Diesel	363

DESCRIPTION	MODEL	ENGINE	HORSE-POWER
Crane 90T Truck Crane	American 7460	(2) GM6-71N	---
Crane 65T Truck Crane	Link Belt TM650	GM8V-71N GM6V-53N	304 178
Crane 50T Truck Crane	Lorain MC540	NHC 250 C 160	250 160
Crane 30T Mobile Crane	Grove RT 635	V5046	210
Crane 18T Mobile Crane	P&H T180	V8-210	202
Telecrane 15 Ton Mobile	Bantam S 488	GM 6V53	136
Super Lift	Pettibone PC200	6-354	200
Forklift	Pettibone PC150	6-354	150
Forklift	Pettibone GS 60	F-227	60
Front End Loader	CAT 966	CAT 3306	170
Dump Trucks 5 yd^3	F 700	351 CID	250
Dump Truck 35 yd^3	Terex 33-09	16V-71T	665
Front End Loader	992C	CAT D348	550
Concrete Pumper Truck Mounted	Thomsen HP845	CAT Diesel	225
Sedans, 4-door	Granada	302 CID	200
Pickups	F150	302 CID	200
Flatbed 10T	International	185Y	185
Flatbed 8T	International	185Y	185
Mobile Lubrication Units	F600	400 CID	350
Vacuum Trucks	F600	D-8 CYL	127

DESCRIPTION	MODEL	ENGINE	HORSE-POWER
Water Truck (3000 Gal)	6773	0333	200
Fuel Truck (4000 Diesel/1000 Gas)	International	185Y	185Y
Transit Mix Trucks 9 1/2 yd^3	MACK DM 60065X	END673E	180
Tractor/Low Boy 60T	GMC 6000	D3406	326
Generator	250 kW	Diesel	385
Generator	30 kW	Diesel	61
Diesel Compressor	150 CFM	Diesel	65
Diesel Compressor	300 CFM	Diesel	97
Diesel Compressor	750 CFM	Diesel	228

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

CONSTRUCTION EQUIPMENT-MINE WASTE DISPOSAL FACILITIES*

DESCRIPTION	MODEL	ENGINE	HORSE-POWER
Scraper	CAT 631	CAT 3408 Diesel	450
Water Wagon	CAT 631	CAT 3408 Diesel	450
Bull Dozer	CAT D9	CAT 3412 Diesel	460
Bull Dozer	CAT D8	CAT D342	300
Bull Dozer	CAT D6	CAT 3306 Diesel	140
Wheel Tractor	CAT 824	CAT 3406 Diesel	310
Front End Loader	CAT 988	CAT 3408 Diesel	375
Front End Loader	CAT 966	CAT 3306 Diesel	200
Crane 75T	AMER 5530 TM	GM DD 4-71N Diesel GM DD 6171N Diesel	115 Upper 238 Carrier
Crane 25T	1 Grove RT 625	Cummins V504 Diesel	156
Motor Grader	CAT 16 G	CAT 3406 Diesel	250
Motor Grader	CAT 14 G	CAT 3306 Diesel	195
Excavator	CAT 235	CAT 3306 Diesel	195
Backhoe	J.D. 410	JD 4-291D Diesel	62
Compactor	DYNAPAC CA-25	CT 3208 Diesel	125
Off-Road Truck	TEREX 33-07	GM DD 12V-71T Diesel	493
Belly Dump Truck & Trailer	Ford LT-9000 Tractor	240 Cummins Dsl	240
Dump Truck Tandems	Ford LT-9000	240 Cummins Dsl	240
PD Trailer & Tractor	Ford LT-9000 Tractor	240 Cummins Dsl	240
Flatbed Truck	International	185T	185
Pickup Truck	Chev 13/4 Ton	GM 305 V8 Gas	180

DESCRIPTION	MODEL	ENGINE	HORSE-POWER
JD Hydroseeder With CAT Powered	---	JD 6 CYL Diesel	110 (Hydroseeder)
Tandem Truck		CAT 3208 Diesel	210 (Truck)
Tractor	J.D. 4240	JD 6 CYL Diesel	110
Tractor	J.D. 2640	JD 4 CYL Diesel	65
LoBoy Truck & Trailer 60T	GMC 6000	CAT D3406 Diesel	326
Processing Plant	---	---	---
Batch Plant	---	---	---
Bentonite Unloading System	---	---	---
Paver	Barber-Greene SB-170	CAT D-3304 Diesel	152
42" Conveyor	Universal	Electric	---
Generator	335 kW	CAT D346	---
Generator	250 kW	CAT 3408 Diesel	385
Generator	90 kW	CAT 3404 Diesel	---
Generator	30 kW	Homelite Diesel	61
Sump Pump	---	---	15
Flowmaster Pump	---	---	---
Power Ram Packer	Kelly 10KR7	---	---
Power Auger	---	---	---
Chain Saws	Homeline 925 24"	Homelite 5.0 Cu In 2 Cycle	3
Compressor 1200	CAT 1200 C.F.M.	CAT 3046 Diesel	325

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

to the construction schedule is presented in Table 1.3-8. 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.

1.3.3.3 Fuel and Energy

Fuels and lubricants for the construction equipment will be hauled to the site by trucks. To reduce the need for on-site storage during construction, fuels will be obtained from a commercial source and stored in the tanker trailer used for delivery. When the on-site bulk fuel storage area is completed during the second year of construction, it will supply fuel for the shaft sinking and mine development operation. Waste oils resulting from oil changes and solid waste, such as oil filters and air cleaners, will be transported off-site and disposed at an approved disposal area.

The estimated fuel and energy requirements during the 3 years of construction activities are presented in Table 1.3-9.

1.3.3.4 Traffic Control

The flow of vehicles and equipment into and out of the construction site will be controlled for safety and security purposes and to avoid congestion on public roads. The sequencing of construction activities is such that heavy traffic movements will be avoided and peak flows will not cause major inconvenience to public traffic.

The transport of major loads into or out of the Project site area will be coordinated with the appropriate authorities as necessary.

DESCRIPTION										YEAR 1											
MONTHS FROM CONSTRUCTION	-9	-8	-7	-6	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12
Lumbering Equipment (Mine/Mill Site)																					
Chain Saws										20	20	20	20								
Feller Buncher										3	3	3	3								
Hydro Mower										3	3	3	3								
Construction Equipment - Earth Moving (Mine/ Mill Site)																					
Front End Loader 988B										1	1	1	1	1	1	1					
Bulldozer D9										3	3	2	1								
Bulldozer D8										2	3	2	2								
Bulldozer D7												1	1	1	1	1	1	1	1	1	1
Bulldozer D6																					
Backhoe 235										1	1	2	2	2	1	1	1				1
Backhoe 245										1	2	3	4	4	2		1	1	1	2	2
Backhoe Combo FD5600												2	2	2	2	1	1	1	1	2	2
Motor Grader 16G										1	1	1	1	1	1					1	1
Gradall G1000											1	1	1	1	1					1	1
Compactor SP48										2	2	2	1	1	1						
Wacker BPG24										2	4	4	4	4	2					3	3
Compactor BPG 9													2	2	2						2
Compactor 815										2	2	2	2	1	1	1					
Compactor Sheepfoot W/D6											3	3	3	3	3	3					
Compactor V1B DA50											1	1	1	1	1						1
Compactor V30																					
Motor Scraper 21/304										4	4	4	4	4							
Construction Equipment - Lifting (Mine/Mill Site)																					
Crane 150T																					
Crane 90T													1	1	1	2	2	2	2	2	2
Crane 65T																					
Crane 50T												1	2	2	2	2	1				2
Crane 30T												1	1	2	2	1	1				2
Crane 18T																					1
Forklift 15000#																					1
Forklift 6000#																				1	1
Headframe Equipment																					
Crane 30T										1	1	1	1	1	1						
Concrete Pumpers										1	1	1	1	1	1						
Crane 4100 Manitoc											1	1	1								
Automotive Equipment																					
Sedans, 4-door							1	1	2	3	4	4	4	4	4	4	4	4	4	4	4
Pickups							1	3	3	3	3	10	10	10	10	10	10	10	10	10	10

DESCRIPTION	YEAR 2												YEAR 3																		
MONTHS FROM CONSTRUCTION	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Lumbering Equipment (Mine/Mill Site)																															
Chain Saws																															
Feller Buncher																															
Hydro Mower																															
Construction Equipment - Earth Moving (Mine/ Mill Site)																															
Front End Loader 988B	1	1	1	1	1	1																									
Bulldozer D9	1	1																													
Bulldozer D8	1	1																													
Bulldozer D7	1	1	1	1	1	1																									
Bulldozer D6											1	1	1	1	1																
Backhoe 235	2	2	2	1	1	1					1	1	1	1																	
Backhoe 245	2	2	2	2	2	2																									
Backhoe Combo FD5600	2	2	2	2	2	2						2	2	2	2	2															
Motor Grader 16G	1	1	1	1	1	1							1	1	1	1	1														
Gradall G1000	1	1	1	1	1							1	1	1	1	1	1														
Compactor SP48																															
Wacker BPG24	3	3	3	3	3	3						1	1	1	1	1	1														
Compactor BPG 9	2	2	2	2	2	2																									
Compactor 815	1	1	1	1																											
Compactor Sheepfoot W/D6	3	3	3	3	3	3																									
Compactor V1B DA50	1	1	1	1	1	1																									
Compactor V30																															
Motor Scraper 21/304	3	3	3																												
Construction Equipment - Lifting (Mine/Mill Site)																															
Crane 150T				1	1	1	1	1	1																						
Crane 90T	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1													
Crane 65T											2	2	2	2	2	2	2	2													
Crane 50T	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1													
Crane 30T	2	1	1	1						1	1	1	1	1	1	1	1	1													
Crane 18T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1													
Forklift 15000#	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1													
Forklift 6000#	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1													
Headframe Equipment																															
Crane 30T																															
Concrete Pumpers																															
Crane 4100 Manitoc																															
Automotive Equipment																															
Sedans, 4-door	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4													
Pickups	14	14	14	14	14	14	14	14	14	14	18	18	18	18	18	18	18	18													

Note: Equipment based on 8-hr. day.

Note: Support equipment is included with automotive equipment.

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **CONSTRUCTION EQUIPMENT LOADING SCHEDULE**

SCALE: ~ STATE: WISCONSIN COUNTY: FOREST

DRAWN BY: DR SPRINGBORN DATE: 5/84 CHECKED BY: DATE:

APPROVED BY: DATE: APPROVED BY: C.C. Schroeder DATE: 11/13/85

APPROVED BY: DATE: EXXON: D.P. Moe DATE: 11/13/85

DRAWING NO: TABLE 1.3 - 8 SHEET 1 OF 4 REVISION NO: 2

GBB 5/1981

DESCRIPTION										YEAR 1												YEAR 2												YEAR 3																		
MONTHS FROM CONSTRUCTION	-9	-8	-7	-6	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Flatbed 10T										1	1	2	2	2	2	2	1	1	1	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2													
Flatbed 8T																		1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1													
Mobile Lub. Units										1	1	1	1	1	1					1	1	1	1	1																												
Vacuum Trucks																																																				
Pump Trucks 5Y																																																				
Concrete Pumper													1	1	1					1	1	1	1	1	1	1	1	1																								
Water Truck (3000 Gal.)										4	4	4	4	2	2					1	1	1	1	1	1	1	1																									
Fuel Truck (4000 Diesel 1000 Gas)										1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1															
Tran-Mix Trucks 9-1/2 Y										4	4	6	6	6	6	4	2	2	4	6	8	8	8	8	8	8	8	2	2	2	2	2	2																			
Tractor/Low Boy 60T																				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1													
Fire Truck (3000 Gal. HP)										1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1													
Road Equipment																																																				
Chain Saws										5	5	5	5	5	5																																					
Hydro Mowers										1	1	1	1	1	1																																					
Chipper										1	1	1	1	1	1																																					
Front End Loader 988B										1	1	1	1	1	1																																					
Front End Loader 977L										1	1	1	1	1	1																																					
Bulldozer D9										1	1	1	1	1	1																																					
Bulldozer D6										1	1	2	2	2	1																																					
Backhoe (Comb.) FD 5600										1	1	1	2	2	2																																					
Motor Grader 16G										1	1	1	2	2	2						2	1	1																													
Gradall G1200										1	1	1	1	1	1																																					
Dump Trucks 5Y										5	5	8	12	12	8						8	4	4																													
Compactors 815											2	2	2	2	2						2	2																														
Compactors W/D6 Sheepfoot											2	2	2	2	2						2	2																														
Compactor DA 50											1	1	1	1	1						1	1																														
Wacker BPG 24											2	2	2	2	2						2	2																														
Crane 65T													1	1	1																																					
Crane 30T												1	1	1	1																																					
Railroad Equipment																																																				
Chain Saws										5	5	5	5	5	5																																					
Hydro Mower										1	1	1	1	1	1																																					
Chipper										1	1	1	1	1	1																																					
Front End Loader 988B											1	1	1	1	1						1	1	1	1	1																											
Front End Loader 992C											1	1	1	1	1						1	1	1	1	1	1	1																									
Bulldozer D9											1	1	1	1	1						1	1																														
Bulldozer D6										1	1	2	2	2	2						1	1																														
Backhoe (Comb.) FD 5600										1	1	1	1	1	1						1	1																														
Backhoe 235												1	1	1	1																																					
Motor Grader 16G											1	1	1	1	1						1	1				1	1																									
Dump Trucks 5Y										2	4	6	8	8	6						4	2	2	2	2	2	2																									
Compactor 815											2	2	2	2	2						1	1	1	1	1	1	1																									
Compactor W/D6 Sheepfoot											2	2	2	2	2						1	1	1	1																													

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **CONSTRUCTION EQUIPMENT LOADING SCHEDULE**

SCALE: NA | STATE: WISCONSIN | COUNTY: FOREST

DRAWN BY: DR SPRINGBORN | DATE: 5/84 | CHECKED BY: | DATE:

APPROVED BY: C.C. Schroeder | DATE: 11/13/85

EXXON: D.E. Moe | DATE: 11/13/85

DRAWING NO: TABLE 1.3 - 8 | SHEET 2 OF 4 | REVISION NO. 2

GBS 5/1981

DESCRIPTION										YEAR 1												YEAR 2												YEAR 3																		
MONTHS FROM CONSTRUCTION	-9	-8	-7	-6	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Compactor DA 50																					1	1	1	1	1	1	1																									
Crane 30T																					1	1	1	1																												
Note: Support equipment included with automobile equipment																																																				
Construction Support Equipment																																																				
Generators 385 HP 250 kW										2	2	2	4	4	4	4																																				
Diesel Compressor 97 HP 300 CFM										2	2	2	2	2	2	2																																				
Mine Waste Disposal & Reclaim Pond Area Equipment																																																				
CAT 631 Scraper										8	11	10	10	10	7	5					10	10	10	10	10	10								10	10	10	10	8	6													
CAT 631 W Water Wagon										2	3	3	3	2	1						2	2	2	2	2	2								2	2	2	2	2	2													
CAT D9 Dozer										2	3	2	2	2	1						2	2	2	2	2	2								2	2	2	2	2	2													
CAT D8 Dozer										5	5	4	4	4	4	2					4	4	4	4	4	4								3	3	3	3	4	4													
CAT D6 Dozer												1	2	2	2																					3	3															
Rake (D8)										5											5													5																		
Disc (D8)													1										1													1																
CAT 988 Loader											2	2	2	1	1						2	2	2	1	1	1									2	2	2	2	3													
CAT 966 Loader										3					2	1																		2			1	1														
CAT 235 Excavator										2	1			1	1	1							1	1	1									1		1	1	1														
CAT 16G Motor Grader												1	1											1	1	1										1																
CAT 14G Motor Grader										2	3	3	4	4	4	2					2	2	2	3	3	3								3	3	4	4	4	4													
CA 25 Compactor										2	3	3	3	2	2	1					2	2	2	2	2	2								3	3	6	4	2	2													
Tandem Dump Truck										3			9	9	9																			3	6	6	6	4	4													
Flatbed Truck										1	3	1	1	1	1	1					1	1	1	1	1	1								1	1	1	1	1	1													
Pickup Truck										5	5	5	6	6	6	3					5	5	5	5	5	5								5	5	6	6	5	4													
PD Trailer & Tractor													2	2	2																					2	2															
Batch Plant & Pug Mill													1	1	1								1	1	1	1										1	1	1	1													
Processing Plant											1	1	1	1	1						1	1	1	1	1	1									1	1	1	1	1													
Bentonite Unloading System													1	1	1																					1	1	1	1													
Lowboy Trailer & Tractor										10	10	2	10	10																				10	10	10	3	1														
Generator 335 kW											1	1	1	1	1	1																																				
Generator 250 kW													1	1	1	1																																				
Generator 90 kW										1	1	1	1	1	1	1																																				
Generator 30 kW													1	1	1	1																																				
42" Belt Conveyor													1	1	1	1								1	1												1	1														
Pump 15 HP													1	1	1	1																		7	7		7	7														
Truck Crane 25 Ton										1	1		1																					1																		
J D Hydroseeder													1																									1	1													
J D Tractor with Disc													1																									1	1													
J D Diesel Mulcher													1																										1													
Flowmaster Pump										1	1	1	1		1																	1	1	1	1		1	1	1													
Chainsaw										2																						2																				
Portable Ram Packer													2	2	2																			2	2																	
Belly Dump Trailer & Tractor												5	5	5	5								5	5	5	5												5	5													

Typical Representation : Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: CONSTRUCTION EQUIPMENT LOADING SCHEDULE

SCALE	STATE	COUNTY
—	WISCONSIN	FOREST
DRAWN BY: DR SPRINGBORN	DATE: 5/84	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. TABLE 1.3 - 8	SHEET 3 OF 4	REVISION NO. 2

GBB 5/1981

DESCRIPTION										YEAR 1											
MONTHS FROM CONSTRUCTION	-9	-8	-7	-6	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12
CAT 824 Wheel Tractor														I	I						
Compressor 1200 CFM																					
J D 410 Backhoe										I	I										
Truck Crane 75 Ton										I	I										
Power Auger										I	I	I	I	I	I						
Water Discharge Pipeline																					
Bulldozer D7																					I
Backhoe CAT 235																					
Front End Loader 988B																					
Dump Trucks 5Y																					
Flatbed 8T																					
Trencher																					

DESCRIPTION	YEAR 2												YEAR 3																		
MONTHS FROM CONSTRUCTION	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
CAT 824 Wheel Tractor																															
Compressor 1200 CFM																															
J D 410 Backhoe																															
Truck Crane 75 Ton																															
Power Auger																															
Water Discharge Pipeline																															
Bulldozer D7	I	I																													
Backhoe CAT 235	I	I																													
Front End Loader 988B	I	I																													
Dump Trucks 5Y	I	I																													
Flatbed 8T	I	I																													
Trencher																															

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE **CONSTRUCTION EQUIPMENT LOADING SCHEDULE**

SCALE NA	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 5/84	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 TABLE 1.3 - 8	SHEET 4 OF 4	REVISION NO 2	

GBB 5/1981

TABLE 1.3-9

ESTIMATED FUEL/ENERGY USES DURING PROJECT CONSTRUCTION[a]

CONSTRUCTION YEAR	AVERAGE DAILY USE[a]				AVERAGE YEARLY USE[a]			
	DIESEL FUEL GALLONS	GASOLINE GALLONS	NATURAL GAS SCF	ELECTRICAL kWh Thousands	DIESEL FUEL GALLONS Thousands	GASOLINE GALLONS Thousands	NATURAL GAS SCF Thousands	ELECTRICAL kWh Thousands
1	6,100	130	-	2[b]	2,150	50	-	7,800
2	4,500	140	4800	120[c]	1,600	60	1,700	43,000
3	4,000	150	5000	250	1,400	50	1,800	90,000

[a]The fuel/energy uses for the Crandon Project construction as shown in this table are estimated only. The quantities shown may change with actual type of equipment utilized, variances in schedules, weather conditions, and other factors.

[b]Electrical power supplied from on-site generation in this year of construction.

[c]All electrical power supplied from utility company starting in this year.

Anticipated truck and passenger vehicle traffic during the construction phase will be:

Vehicles	Vehicle Round Trips Per Day Construction Year		
	1	2	3
Workmen Private Vehicles	220	340	720
Buses	5	6	9
Service Truck	12	12	10
Equipment Delivery Truck	3	5	5
Staff Vehicles	30	30	100

Note: All estimated traffic loads are based on the yearly peaks; yearly averages would be considerably less. Includes traffic due to both construction workers and Exxon personnel.

The units in the table are the number of vehicles making a round trip to the Project site per day. The employee vehicles were estimated assuming an average of 2.6 people per vehicle and that 80 percent of the construction work force would travel by private vehicle. The estimate also assumed that a bus transportation system would develop and that 20 percent of the construction work force would use the bus service. With 20 to 30 people per bus, approximately 9 buses would be used for the peak travel periods. Buses, in addition to the private vehicles, account for all transportation of the work force. The traffic associated with Exxon personnel was estimated by assuming an average of 1.6 people per vehicle.

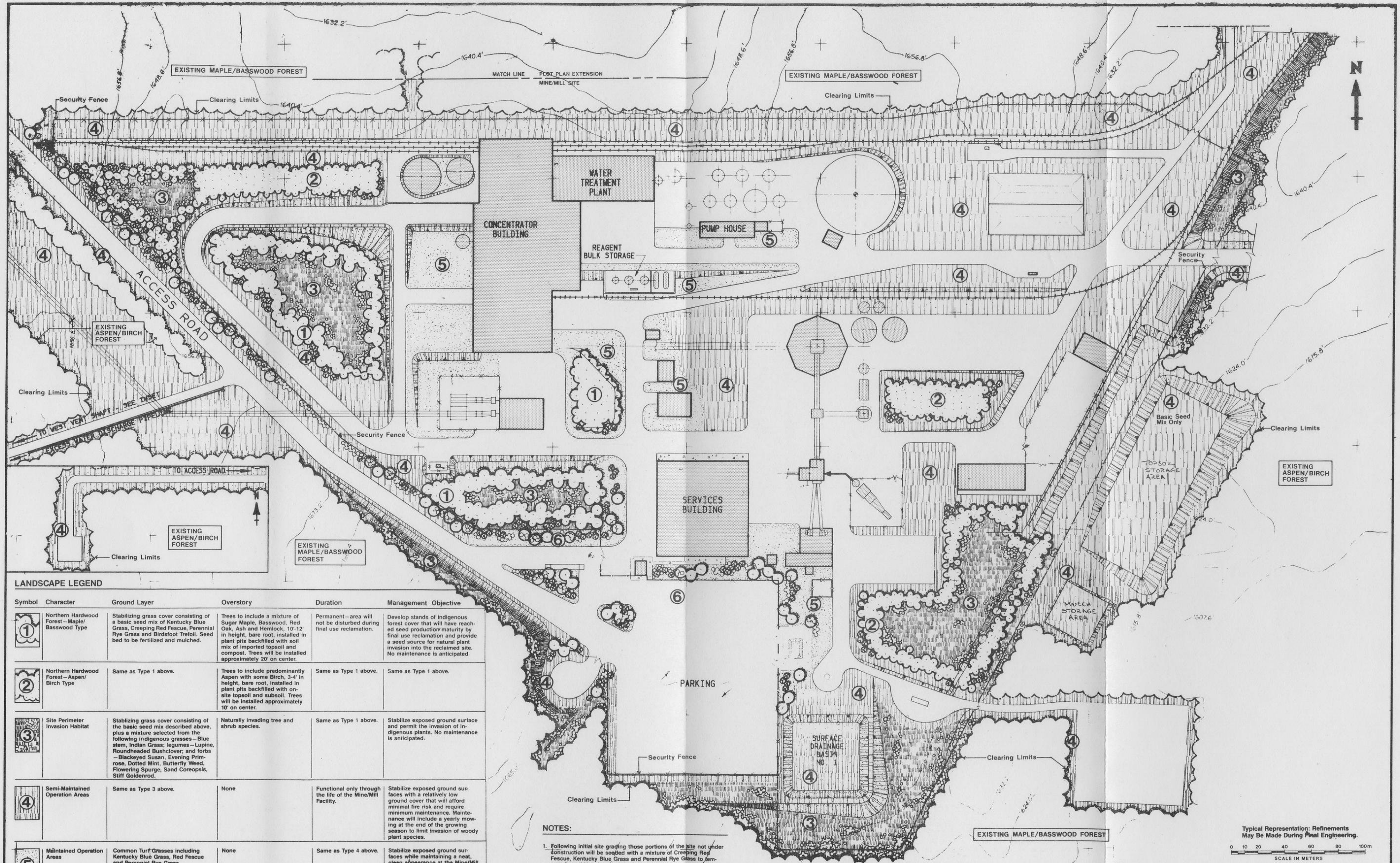
Staff vehicles are for Exxon and contractor construction management personnel and were estimated at 1.0 person per car. The service trucks and delivery trucks are estimates based on the size and type of the project. These estimates were developed by Exxon with input from various contractors regarding employee levels and vehicle occupancy.

1.3.4 Landscape Plan

Site landscaping will occur throughout the construction period and will be primarily concentrated in the mine/mill site area. The purpose of the landscape plan is to revegetate the mine/mill site in a manner compatible with the functional, aesthetic, and environmental character of the surrounding landscape. Indigenous plant species will be used to maintain site character and to aid in long-term reclamation of the mine/mill site to its natural state. Landscaping will focus on establishing seed colonies as well as general ground cover capable of stabilizing soils, improving soil fertility, and providing an environment for invasion of native woody and herbaceous species.

Plant species will be selected that are compatible with specific soil conditions. Representative landscape plans for the mine/mill area are presented on Figures 1.3-23 and 1.3-24. Revegetation of the site will occur through a phased landscape implementation program. Phasing of the landscaping activities will follow the schedule for construction of surface facilities presented in subsection 1.3.2. The phased implementation plans for landscaping the mine/mill site are shown on Figures 1.3-25 and 1.3-26.

Ground layer vegetation will be established following site grading in those areas that are not required in the early phases of construction. This measure will be the primary method of soil



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 Kentucky Blue Grass, Creeping Red Fescue, Perennial Rye Grass and Birdsfoot Trefoil. Seed bed to be fertilized and mulched.	Trees to include a mixture of Sugar Maple, Basswood, Red Oak, Ash and Hemlock, 10'-12' in height, bare root, installed in plant pits backfilled with soil mix of imported topsoil and compost. Trees will be installed approximately 20' on center.	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 to include predominantly Aspen with some Birch, 3-4' in height, bare root, installed in plant pits backfilled with on-site topsoil and subsoil. Trees will be installed approximately 10' on center.	Same as Type 1 above.	Same as Type 1 above.
3	Site Perimeter Invasion Habitat	Stablizing 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.	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. 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 Blue Grass, Red Fescue and Perennial Rye Grass.	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 included will be selected from the Dogwood 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 a mixture of imported topsoil and compost.	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 Creeping Red Fescue, Kentucky Blue Grass and Perennial Rye Grass to temporarily stabilize the soil surface.
2. Topsoil salvaged from initial site grading operations will be replaced to a 6" 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.
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

REVISED	DATE	BY	DESCRIPTION
	10-9-85		Landscape Layout

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
LANDSCAPE PLAN
MINE/MILL SITE

SCALE SHOWN · STATE WISCONSIN · COUNTY FOREST

DRAWN BY · DATE · CHECKED BY · DATE
APPROVED BY · DATE · APPROVED BY C. C. Schroeder · DATE 11/85
APPROVED BY · DATE · ERION D. E. Moe · 11/7/85

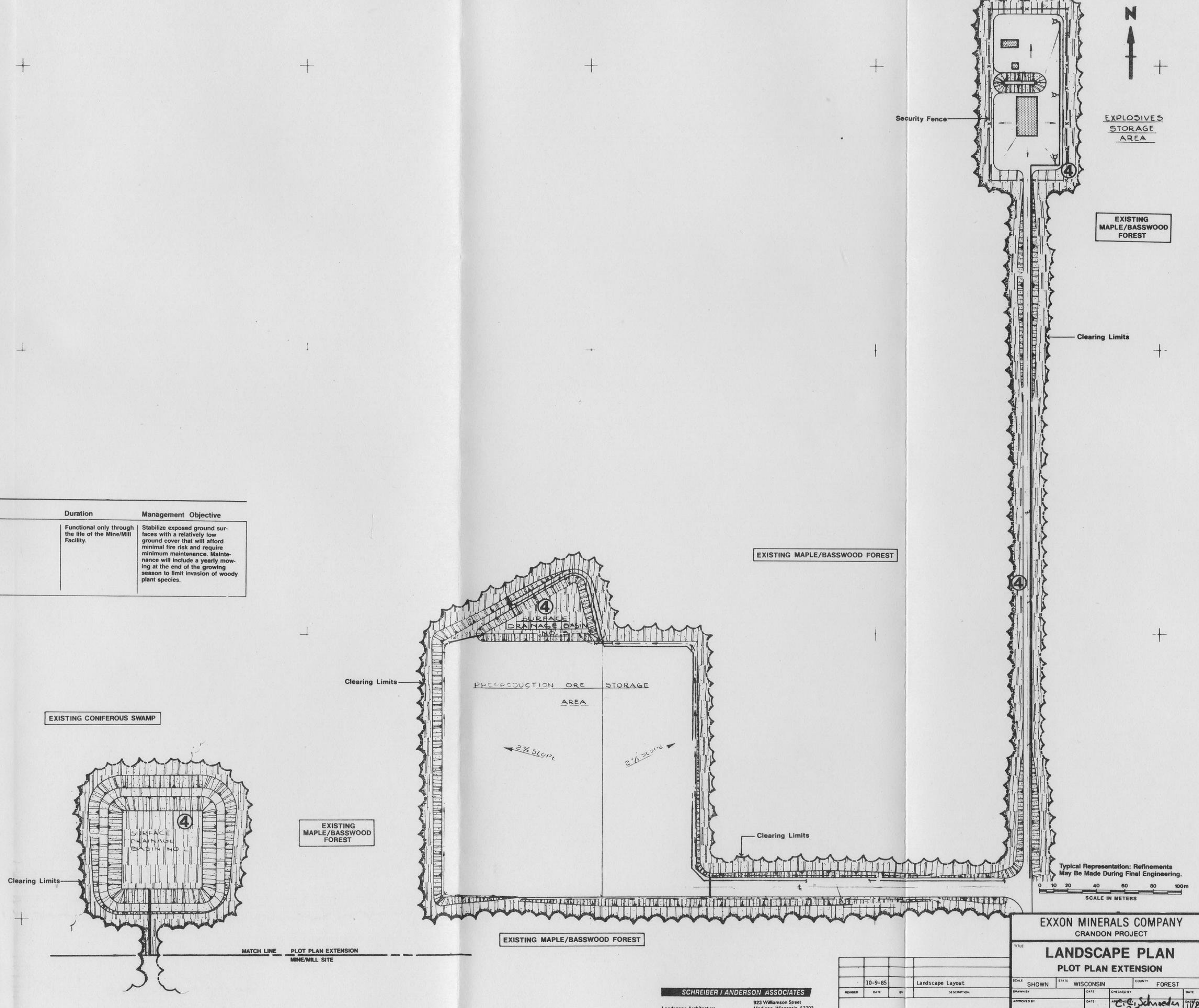
DRAWING NO. FIGURE 1.3-23 · SHEET · OF · REVISION NO.

LANDSCAPE LEGEND

Symbol	Character	Ground Layer	Overstory	Duration	Management Objective
(4)	Semi-Maintained Operation Areas	Stablizing 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

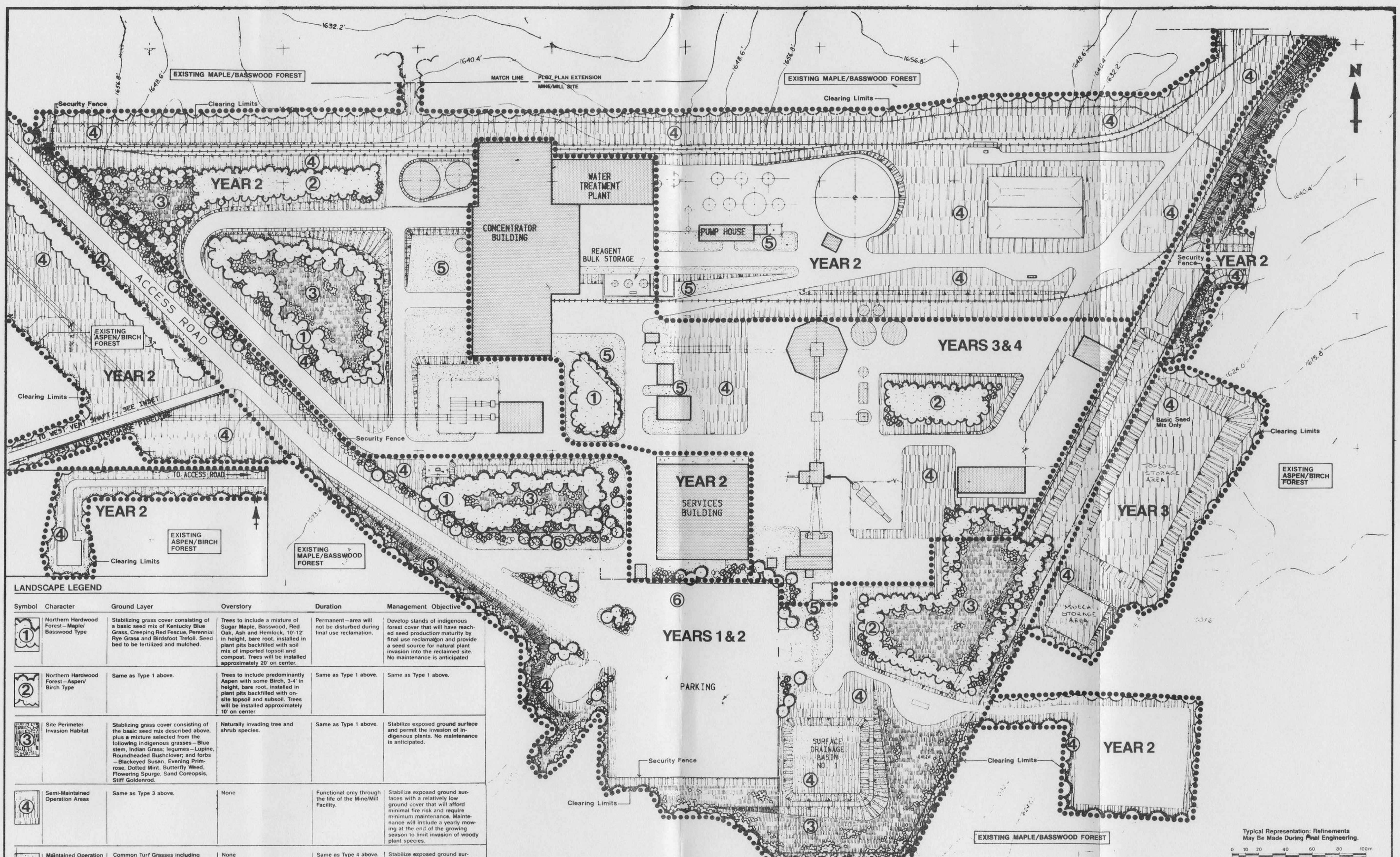
923 Williamson Street
Madison, Wisconsin 53703
Phone 608 255 0800

REVISED	DATE	BY	DESCRIPTION
	10-9-85		Landscape Layout

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
LANDSCAPE PLAN
PLOT PLAN EXTENSION

SCALE SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY	DATE	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C. C. Schroeder	DATE 11/85
APPROVED BY	DATE	EXXON D. T. [illegible]	DATE 11/13/85
DRAWING NO. FIGURE 1.3-24	SHEET ___ OF ___		REVISION NO.



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 Kentucky Blue Grass, Creeping Red Fescue, Perennial Rye Grass and Birdsfoot Trefoil. Seed bed to be fertilized and mulched.	Trees to include a mixture of Sugar Maple, Basswood, Red Oak, Ash and Hemlock, 10'-12' in height, bare root, installed in plant pits backfilled with soil mix of imported topsoil and compost. Trees will be installed approximately 20' on center.	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 to include predominantly Aspen with some Birch, 3-4' in height, bare root, installed in plant pits backfilled with on-site topsoil and subsoil. Trees will be installed approximately 10' on center.	Same as Type 1 above.	Same as Type 1 above.
3	Site Perimeter Invasion Habitat	Stablizing 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.	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. 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 Blue Grass, Red Fescue and Perennial Rye Grass.	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 included will be selected from the Dogwood 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 a mixture of imported topsoil and compost.	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. The Landscape Phasing Plan identifies the construction year(s) when the permanent landscape will be installed in the Mine/Mill site. Facilities scheduled for completion early in the construction phase (eg, vehicular, rail and utility corridors and drainage basins) are generally located on the Mine/Mill site perimeter and will be landscaped in Years 1 and 2. Facilities related to the mine production shaft and ore processing will require longer construction periods and are grouped at the center of the site. These facilities will be completed in Year 3 and landscaping will be initiated in Year 3 and extended into Year 4.
2. The Landscape Phasing Plan is based on the assumption that landscape construction will only occur during the months of May thru October. Seasonal weather conditions at the end of the growing season may necessitate the carryover of some landscaping work into the following construction year. In areas designated for permanent or temporary landscape cover, seeding/planting programs will be implemented within approximately 30 days after grading to minimize the exposure time for uncovered areas.
3. The permanent landscape type to be installed in each construction year is identified by number and is described in the Landscape Legend.
4. Following completion of major earthwork and grading in Year 1, all areas not scheduled for permanent landscaping will be temporarily seeded with a grass mixture such as creeping red fescue, Kentucky bluegrass and perennial rye grass. The temporary landscape cover will be replaced by permanent seeding/plantings when construction activities have been completed in these areas.
5. Application of salvaged topsoil will only occur at the time of permanent landscaping.

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 Phasing Plan

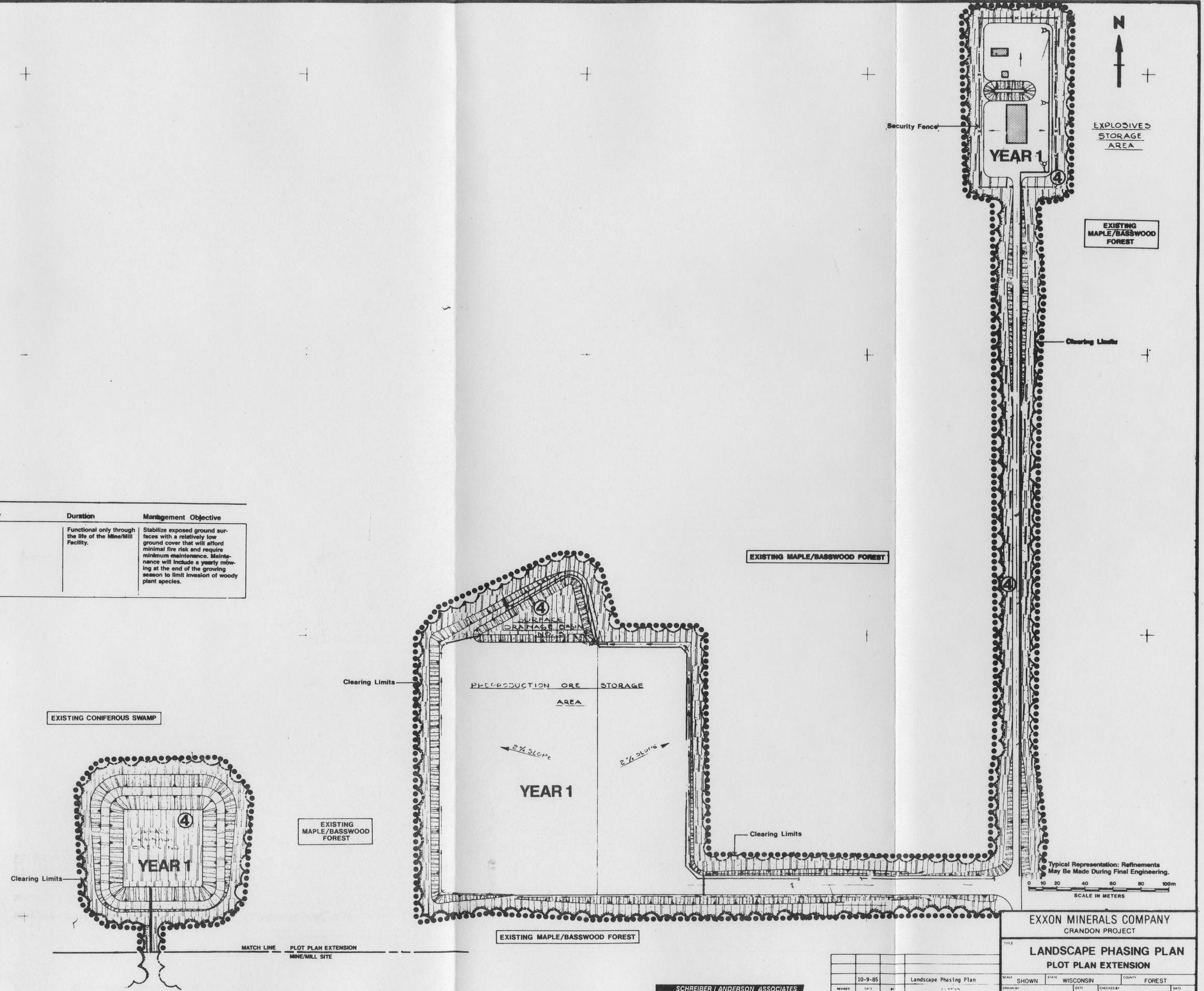
EXXON MINERALS COMPANY
CRANDON PROJECT

LANDSCAPE PHASING PLAN
MINE/MILL SITE

SHOWN | WISCONSIN | FOREST

E. E. Schoeder 11/85
D. E. [illegible]

FIGURE 1.3-25



LANDSCAPE LEGEND

Symbol	Character	Ground Layer	Overstory	Duration	Management Objective
(4)	Semi-Maintained Operation Areas	Stablizing 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 Phasing Plan — Mine/Mill Site for applicable notes.

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Phone 608 255 0800

REVISED	DATE	BY	
	10-9-85		Landscape Phasing Plan

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **LANDSCAPE PHASING PLAN**
PLOT PLAN EXTENSION

SCALE: SHOWN | STATE: WISCONSIN | COUNTY: FOREST

DRAWN BY | DATE | CHECKED BY | DATE
APPROVED BY | DATE | APPROVED: C. G. Schroeder | DATE: 11/85
APPROVED BY | DATE | EXXON: D E Moe | DATE

DRAWING NO. **FIGURE 1.3-26** SHEET ___ OF ___ REVISION NO.

stabilization and erosion control and will be concentrated in the construction and perimeter zones and in the area of the entrance zone to the mine/mill site.

In the entrance zone area, species representative of plant communities in the site area will be planted (Figure 1.3-23). Plant associations will be selected and located to conform with soil moisture conditions, drainage patterns, and exposure. Turf grasses will be maintained around the gate house and the services building.

In the operations zone of the mine/mill site, placement of landscape plantings will be more functional and will concentrate on site stabilization, revegetation of the site perimeter, and establishment of seed colonies for future site reclamation (Figure 1.3-23).

The following criteria were employed in the screening and selection of suitable plantings for application in the mine/mill site landscape plan:

1) Woody species selected had to be indigenous to the site area and compatible with the final reclamation plan.

2) Herbaceous species used to provide rapid stabilization of slopes and prevention of erosion could be either indigenous or introduced to the site area.

3) Plant species for specific areas in the mine/mill site were selected based on their ecological characteristics and known adaptability to the projected environmental conditions, such as slope, exposure, soil type and soil moisture, that will be created at the completion of Project construction.

1.3.5 Pollution Control, Emissions and Effluents

The potential effects of large construction projects upon the immediate surroundings can be substantially mitigated by careful planning and the use of controls. These control methods include water application for dust suppression, reseeding and planting for erosion control, the use of retention basins to control surface water drainage, the use of suppression devices for equipment noise, filters and insertable collectors to control air emissions, and treatment of contaminated water.

1.3.5.1 Mine/Mill Site, Reclaim Pond and Mine Waste Disposal Facility Development

Air Emissions - The activities estimated to produce air contaminant emissions are construction of the mine/mill surface facilities and the reclaim pond, roadways to and within the surface facilities and the MWDF, respectively. Earthmoving activities (e.g., clearing, grubbing, cutting and filling, and loading and dumping) constitute the major source of emissions during construction of the surface facilities.

The type of air emissions from the Project which will be the largest is total suspended particles (TSP) of various sizes. However, the estimated controlled total TSP emissions are less than 250 tons per year during construction indicating that the Project is classified as a minor source for air emissions under Wisconsin regulations (Table 1.3-10).

TABLE 1.3-10

SCHEDULE ASSOCIATED WITH PROJECT ACTIVITIES DURING THE CONSTRUCTION AND OPERATION PHASES AND THE ESTIMATED TSP AIR EMISSIONS FROM THE PROPOSED SOURCES (tons/year).

Project Activities	CONSTRUCTION			OPERATION																						
	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23-29
Site Preparation (trees & brush)																										
1. Mine Shafts	17.6																									
2. Mine/Mill Site	74.9																									
3. MWDF Area	36.0	36.0				114.0							84.0							48.0	120.0					
4. Access Road/Powerline	2.7	2.8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5. Railroad Spur	4.2	0.14	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
6. Haul Road	6.0																									
7. Water Discharge Pipeline	10.3																									
8. In-Plant Roads	4.7	49.1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
9. Concrete Batch Plant	0.4	*	*																							
Construct Mine Support Facilities																										
1. Sink Main Shaft	0.5	5.3																								
3. Construtt East Exhaust Shaft		4.0																								
4. Construct West Exhaust Shaft								4.0																		
5. Power Generation	1.9	0.2	*																							
Underground Mine Development																										
1. Develop Drifts and Stopes			1.3																							
2. Mine Air Heating		0.22	*																							
3. Mine Vehicles		3.1	*																							
Construct Major Surface Facilities																										
1. Construct Reclaim - Cell A	54.0																									
2. Construct Reclaim - Cell B			36.0																							
3. Mobile Sources	0.7																									
4. Construct Preproduction Ore (and Waste Rock) Storage Pad	Included in Mine Shafts																									
5. Waste Rock Handling																										
a. Loading and Dumping		0.01	0.05	0.01	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
b. Hauling	0.1	2.4	2.3				1.7	*						1.1	*							1.6	*			

TABLE 1.3-10 (continued)

Project Activities	CONSTRUCTION 1	2	3	OPERATION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23-29
Construct MWDF Facilities (Operation)																										
1. Construct Tailing Pipeline		6.0	6.0																							
2. Construct Construction Support Area	24.0																									
3. Construct Tailing Pond T1		96.8	99.2																							
4. Construct Tailing Pond T2							104.4	106.8																		
5. Reclaim Tailing Pond T1									36.0	36.0																
6. Construct Tailing Pond T3														91.4	93.8											
7. Reclaim Tailing Pond T2							24.5									44.6	44.6									
8. Construct Tailing Pond T4																						151.0	153.4			
9. Reclaim Tailing Pond T3																								33.1	33.1	
10. Mobile Sources		0.1	*				*	*	*	*				*	*	*	*					*	*	*	*	
11. Install Liner		1.3	*				*	*	*	*				*	*	*	*					*	*	*	*	
a. Hauling of Bentonite to MWDF			0.9				*	*	*	*				*	*	*	*					*	*	*	*	
Mine Operation (Production)																										
1. Full (Total Estimated Underground Emissions)																										
a. Drilling & Blasting (Rock Handling)				26.8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
b. Mine Air Heating				0.4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
c. Mobile Equipment				6.4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Mill/Concentrator Operations																										
1. Coarse Ore Transport			3.2	2.8	1.4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2. Concrete Batch Plant				0.4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3. Facility Heating				0.5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
4. Emergency Diesel Generators				0.2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
TOTAL	239.3	206.6	206.3	89.1	87.7	200.3	219.2	201.1	124.6	124.6	86.3	86.3	170.3	181.1	183.5	133.2	133.2	86.3	86.3	134.3	206.3	241.2	243.6	121.7	121.7	86.3

* Means previous annual estimate is used for this year.

Minor emissions (i.e., CO, HC, NO_x, SO_2) result from vehicle travel, fuel transfer and storage, concrete batch plant operations, and blasting for the underground mine facilities. All air emission sources will be controlled as required by conditions of the air permit. A complete listing of construction activities, control methods, and emission rates are presented in the air permit application.

The main access road will be constructed and paved during the first 12 months, thus eliminating fugitive dust (i.e., TSP) from this source. Certain high use in-plant roads will also be paved early in the construction program to reduce fugitive dust emissions. On-site unpaved roads and excavation sites will be watered as required to control fugitive dust emissions. Speed controls will reduce emissions from haulage vehicles, and minimizing drop distances will also reduce TSP emissions from loading and dumping operations.

Once land surface grades have been established on exposed soil, temporary vegetation will be planted for prompt soil stabilization and dust control; permanent vegetation will also be planted as appropriate. The revegetation process will begin promptly following availability of the areas during the first year of construction and continue through final construction.

To control potential cement dust emissions, the storage silo and weigh hopper associated with the concrete batch plant at the mine/mill site will be supplied with insertable collectors. Pre-washed concrete aggregate will be used by the batch plant to minimize dust emissions. The aggregate loading and discharge points will be vented to a baghouse. Water will be added at the transit mix truck loading location to further minimize dust. Similar controls will be used on the batch plant and process plant at the MWDF.

During construction, vehicles and equipment will be refueled directly from trucks. Equipment refueling and temporary gasoline storage, tank loading or filling constitute the hydrocarbon losses associated with the transfer and storage of fuel.

Noise Emissions - Most construction will be conducted during daylight, 5 days per week. The primary sources of noise after daylight will be intermittent and of short duration resulting from sinking of mine shafts and headframe construction, and any overtime work involved in mine/mill site preparation. Most of this after daylight noise will be from temporary fans, air compressors and refrigeration systems. Blasting will be conducted to minimize noise emanations from shaft sinking activities, and surface noise effects from these sources will decrease as the shafts are deepened.

Construction activities will occur in several phases, which include: site clearing, grading and excavation, equipment operation, facility fabrication, and finish work and landscaping. The excavation portion is estimated to have the noisiest activities for all construction phase sources. However, for the predictive modeling, all noise sources were assumed to operate every day of the year.

The predictive noise modeling technique, described in Chapter 4, sums the noise contribution from individual sound sources and calculates the total A-weighted sound pressure level in decibels at the designated receptor locations throughout the site area. Since decible (dB) levels are logarithmic quantities, they are not simply additive.

The following equation was used to sum the sound contributions of various sources:

$$Lp_3 = 10 \log [10^{Lp_1/10} + 10^{Lp_2/10} ... + 10^{Lp_n/10}]$$

where: Lp_3 = resulting sound pressure level in dB,

Lp_1, Lp_2, Lp_n = sound pressure levels from number of sound sources in dB, and

log = common base 10 logarithm.

For example, if one source has an emanating sound level of 30 dB (e.g., $Lp_1 = 30$) and another noise source is in or added to the area at 35 dB (e.g., $Lp_2 = 35$), the net sound pressure level from these sources is actually 36.2 dB. It is not 65 dB, which would be the erroneous estimated sound pressure level if simple addition were used for the calculation.

Noise sources do not generally emanate at a constant dB level with respect to time. Therefore, the predictive modeling technique also incorporates the variability in the emanating sound pressure level which noise sources provide during their operation. The modeling technique uses the equivalent sound pressure levels, Leq, to include the variability in noise that an operating source will have through time. For a single noise source, the Leq is calculated using the following formula (Kessler, 1978):

$$L_{eq} = 10 \log [UF \times 10^{Lp/10}]$$

where: L_{eq} = the equivalent sound pressure level in dB at a reference distance, UF = Usage Factor (the precentage of time, expressed as a decimel, that the source operates at or near its noisiest mode. Although the equipment may be used for a longer time than indicated by the UF, its sound pressure levels during the other time does not contribute a large part of the total source noise emanations),

Lp = the source maximum sound pressure level in dB at the reference distance, and

log = common base 10 logarithm.

For multiple noise sources, the net L_{eq} is calculated from a formula combining the previous two so that:

$$Leq = 10 \log [UF_1 \times 10^{Lp_1/10} + UF_2 \times 10^{Lp_2/10} + \ldots + UF_n \times 10^{Lp_n/10}]$$

where: L_{eq} = total equivalent sound pressure level in dB from all n sources at a reference distance,

$Lp_1, \ldots Lp_n$ = sound pressure level in dB produced by each source at the reference distance,

$UF_1, \ldots UF_n$ = the Usage Factor for each source, and

log = common base 10 logarithm.

Therefore, the L_{eq} values used in the modeling were derived by application of this formula to the major Project activities. For example, the construction phase L_{eq} for the mine/mill site during average day-night operating conditions established two "worst-case" noise source locations (Pygin, 1982). The first was located immediately west of the access road entrance to the mine/mill site (MM1) and was calculated to have an estimated sound pressure level of 89 dB at 50 feet (see Figure 4.1-21). The second was located adjacent to the timber and steel storage area (MM2) with a calculated estimate of 85 dB for the sound pressure level at 50 feet (see Figure 4.1-21).

Similarly, from the data presented in Table 1.3-11, the total MWDF (pond T1) construction phase L_{eq} was calculated to have an estimated 101 dB sound pressure level at 50 feet (see Figure 4.1-21).

To assess the construction phase (excavation) sound pressure level contribution to each noise sensitive location, the construction activity input to the model was at one central and four perimeter locations to the MWDF (see Figure 4.1-21). The four perimeter locations of pond T1 included areas nearest the noise sensitive receptors. Therefore, the estimated MWDF construction phase sound pressure level will be "worst-case", because MWDF construction activities at each nearest boundary will actually only occur for a short period of time rather than the modeled condition of every day of the year.

Construction of the water discharge pipeline and structure used an L_{eq} of 87.7 dB at 50 feet (Table 1.3-12). This value was obtained from typical public works and industrial construction data (U.S. EPA, 1975). These activities were assumed to occur at the discharge location (W) on Swamp Creek (see Figure 4.1-21).

Construction of the tailings transport pipelines was also estimated to have an L_{eq} of 87.7 dB at 50 feet (Table 1.3-12). Noise emanations for slurry pipeline activities (H) were assumed to occur halfway between the mine/mill site and the MWDF (see Figure 4.1-21).

Construction of the railroad spur (R) was estimated to have an L_{eq} of 95 dB at 50 feet (Table 1.3-12) and was assumed to occur at the northeastern end of the railroad spur (see Figure 4.1-21). Construction activities for the access road and haul road were estimated to have an L_{eq} of 95.9 dB at 50 feet (Table 1.3-12). Construction

TABLE 1.3-11

TYPICAL MINE WASTE DISPOSAL AREA EXCAVATION EQUIPMENT

EQUIPMENT		NUMBER OF UNITS	MAXIMUM SOUND LEVEL LA at 50 feet (dB)/UNIT	USAGE FACTOR
Scraper	CAT 631	10	87	0.13
Bulldozer	CAT D9	2	88.8	0.15
Bulldozer	CAT D8	4	89	0.15
Bulldozer	CAT D6	2	88	0.15
Front-End Loader	CAT 988	2	86	0.30
Front-End Loader	CAT 966	1	89	0.30
Motor Grader	CAT 16G	1	86	0.30
Motor Grader	CAT 14G	4	80	0.30
Excavator	CAT 235	2	83	0.70
Backhoe	J.D. 410	1	82	0.15
Dump Truck	Ford LT-9000	9	92	0.50
Belly Dump Truck and Trailer	Ford LT-9000	5	92	0.50
Compactor	CAT 825	3	80	0.10
Compactor	Raygo 400A	3	80	0.10

Total equivalent sound level (L_{eq}) contribution at
50 feet = 101.0 dB

Table 1.3-12

TYPICAL EQUIPMENT TO BE USED IN CONSTRUCTING THE TAILINGS TRANSPORT AND WATER DISCHARGE PIPELINES, RAILROAD SPUR, AND ACCESS ROAD AND HAUL ROAD

EQUIPMENT TYPE	QUANTITY	SOUND LEVEL dB at 50 feet/unit	USAGE FACTOR
TAILINGS TRANSPORT AND WATER DISCHARGE PIPELINES AREA			
Bulldozer D7	1	88	0.15
Backhoe CAT 235	1	83	0.15
Front-End Loader 988B	1	86	0.15
Dump Truck 8 T	1	92	0.10
Flatbed Truck 8 T	1	83	0.10
Trencher	1	85	0.70
L_{eq} for site = 87.7 dB at 50 feet			
RAILROAD SPUR AREA			
Chainsaw	5	91	0.20
Front-End Loader 988B	1	86	0.15
Front-End Loader 992C	1	89	0.15
Bulldozer D9	1	89	0.15
Bulldozer D6	2	88	0.15
Backhoe (Comb.)	2	83	0.10
Motor Grader 16G	1	86	0.10
Dump Truck 5 CYD	8	92	0.10
Compactor	4	80	0.10
L_{eq} for site = 95 dB at 50 feet			
ACCESS ROAD AND HAUL ROAD AREA			
Chainsaw	5	91	0.20
Front-End Loader 988B	1	86	0.15
Front-End Loader 977L	1	89	0.15
Motor Grader 16G	2	86	0.10
Gradall G1200	1	86	0.10
Bulldozer D9	1	89	0.15
Bulldozer D6	2	88	0.15
Backhoe (Comb.)	2	83	0.10
Dump Truck 5 CYD	12	92	0.10
Compactor	5	80	0.10
Crane	2	85	0.05
L_{eq} for site = 95.9 dB at 50 feet			

for the access road was assumed to occur at four locations (A1, A2, A3, A4) along the access road and halfway between the mine/mill site and the MWDF for the haul road (H) (see Figure 4.1-21).

These data for the estimated noise emanations were used as the base for the inputs to the predictive modeling discussed in Chapter 4. However, the model also accounts for atmospheric loss. Therefore, these L_{eq} A-weighted data are used to incorporate equivalent octave band data by including source data that are expressed as a function of frequency rather than A-weighted data.

Seismic Blast Vibrations (Construction) - Construction phase blasting will occur during shaft sinking and underground development. Blasting is scheduled to begin in month 5 of the construction phase and continue throughout the underground operations.

The shaft construction sequence, as described in subsection 1.3.1.4.2, will utilize a total of approximately 200 pounds of explosives per blast with 24 to 190 pounds of explosives per delay. Little noise will be generated off-site by these activities and seismic vibrations are expected to be undetectable outside the Project site. Additional discussion of seismic impacts is given in Chapter 4.

Solid Wastes - Solid waste material generated by the construction effort should be reduced through the use of bulk deliveries of cement, fuels, and oils. This approach minimizes the quantity of bags, crates, drums and other waste packaging items requiring disposal.

The mine/mill site preparation work of filling, grading, and foundation installation will create a minimum of solid waste; this is estimated at an average of approximately 5 tons per week during the summer months, May through September, of the first 2 years. Waste material will be reduced to approximately 1 ton per week during the winter months of the first 2 years. During Year 3, when most of the building material and equipment will be delivered and installed, waste materials will increase to an estimated 10 tons per week during the summer, and decrease to approximately 3 tons per week in the winter.

Salvageable material, such as wire spools, packing crates, shipping containers, and wood framing, normally will be returned to suppliers. Recycleable paper products will be compressed and banded and disposed at a recycle center. Scrap metal will be stored in bins and sold for salvage. Waste products that cannot be recycled will either be disposed at an approved landfill off-site or in the MRDF developed on-site by Exxon. A more detailed discussion of solid waste generated during the Project life is given in Appendix 1.3A.

Erosion Control - The erosion control measures are based on the yearly construction schedule outlined in subsection 1.3.2. Included in the erosion control program are the various procedures and actions that will be utilized to control erosion. The ground slope and vegetation on the existing terrain generally account for low erosion potential. A comprehensive discussion of erosion control during Project construction is presented in Section D, Reclamation Plan of the Mining Permit Application.

Based on 73-year averages at the Nicolet College weather station, the precipitation in the site area is highest during June.

However, the majority of precipitation from November to March is snow. Thus, the erosion potential is greatest, not during the peak month of precipitation, but during the spring thaw (April-May) when rainfall and snowmelt occur simultaneously as a result of storms.

Erosion could occur in the following four areas: mine/mill site, access road corridor, railroad spur corridor, and the reclaim pond/MWDF. The greatest potential for erosion is estimated for the mine/mill site because of its duration of exposure during construction. Exposure of bare soils during the grading phase in Year 1 will temporarily expose approximately 115 acres of ground in the mine/mill site area. Construction of the access road and railroad spur corridors will disturb a total of approximately 80 acres, but only for a short duration.

Special precautions are planned for the access road and railroad spur corridor construction in wetland areas. Construction methods will include use of temporary retaining berms to prevent disruption of the hydrology, and culverts will be placed to maintain water continuity within the wetlands. For the bridges at the stream crossings, temporary retaining walls 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. Although most construction activities will occur prior to mill operations, those for the MWDF will be continuous and will be staged to correspond with tailings production.

During construction the primary source of contaminated water will be from the developing mine. Other sources of contaminated water will include surface water runoff in the MWDF area and the 5-acre equipment laydown area near the mine main shaft. Contaminated surface water runoff from the equipment laydown area will be impounded in a small pond adjacent to that area.

Mine water flow rates will start at approximately 10 gallons per minute during the first year of development and will not likely exceed 1,000 gallons per minute at any time during the construction period. The water treatment facility will be built in Years 1 and 2 and will be available during the remainder of the construction period. Contaminated mine water and contaminated surface water runoff will be pumped to an influent surge system with a total capacity of 2.75 million gallons and at a constant rate from there into the reclaim water pond. Treated effluent will be discharged to Swamp Creek approximately 1 mile downstream from County Trunk Highway M starting in the third year of construction.

The MWDF will be constructed in four phases over a 23-year period with each phase generally being 4 to 5 years in length. During each phase, 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.

Another potential source of contaminated water is sanitary wastes. Although a permanent sanitary waste treatment facility will be constructed in Year 1, portable units will be used during approximately the first 2 years of construction. Sanitary wastes will be collected and transported off-site to a municipal facility for treatment. Loading factors occurring from the permanent sanitary waste treatment facility are discussed in subsection 1.4.9

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1.4 PROJECT OPERATIONS

Operation of the mine and mill will include mining and processing of the ore. Average capacity for the total operation will be as indicated in Table 1.4-1.

1.4.1 Schedule

The operating schedule for the Project is also shown in Table 1.4-1. 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. Table 1.4.2 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. 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.

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

TABLE 1.4-1

OPERATING SCHEDULE FOR THE MINE/MILL FACILITIES
BASED ON AVERAGE ANNUAL PRODUCTION RATE

FACILITY	Production Rate Tons/Day	Operating Schedule Days per Year	 Shifts per Day	 Hours per Shift
Mine Production	7,800	340*	3	8
Mine Ore Hoisting and Coarse Ore Conveying	7,800	340*	3	8
Concentrator	7,400	360	3	8
Tailings Disposal	–	360	3	8
Water Treatment	–	365	3	8
Ancillary	–	365	3	8

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

TABLE 1.4-2

ESTIMATED STORAGE REQUIREMENTS

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

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.

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.

Evaluations of shutdown/start-up questions during the operating life of the Project consider many of the same parameters as the initial decision to start construction of a new mine. These considerations are similar whether the shutdown period is several months or several years. Some of these factors include:

1) The cost of maintaining facilities during shutdown, including environmental costs;

2) The cost of restarting the facilities;

3) The anticipated future metal prices and operating expenses;

4) The anticipated availability of personnel if the facility is restarted;

5) The remaining ore reserves; and

6) The cost of reclamation.

In general, the potential to restart the operation is more likely early in the property life when future ore reserves are still relatively high. As the remaining tonnage to be mined decreases, the restart of the operation becomes more difficult.

If the Project stopped operations for 2 to 5 years and the understanding was that it would be restarted at the end of the period, then the following might be expected:

1) The mine dewatering pumps would continue to operate;

2) The tailings underdrain pumps would continue to operate;

3) Chemical or vegetative stabilization would occur on the tailings surface; and

4) The water treatment facilities would continue in operation.

The ramification of the above events would be the extension of the mine/mill operation and reclamation time periods.

If the shutdown decision included allowing the mine to flood, then there would be little hope that the mine would be restarted. In this instance the property would be closed and final reclamation work begun. The ramification of these events would be the premature termination of the operations. Environmental impacts would be as projected for the closure period and the reclamation plan would be completed.

1.4.2 Mine Operations

1.4.2.1 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.

The orebody will be divided into stoping blocks (see Figure 1.2-8). Initially, production will come from alternate blocks on one level. At the bottom of the block, drawpoints will be developed to provide access for removing broken ore. Access will also be provided at the top of the block and at its vertical midsection for drilling blastholes.

An initial vertical opening will be provided by raise boring through the entire height of the block (see "stope slot" on Figure 1.2-8). Blastholes will be drilled adjacent to the raise bored opening, and the opening enlarged by blasting the ore, which will drop down into the drawpoints at the bottom level.

This process of blasting ore into a larger opening will continue until all ore within the block has been broken. As the ore is broken, it will be withdrawn through the drawpoints at the bottom of the block. The blastholes will be charged with explosives, typically either ammonium nitrate/fuel oil (ANFO) or water gel, and detonated using non-electric downhole methods initiated by a single remote electric cap.

The blasthole drills will be operated by high pressure compressed air furnished by electrically powered booster compressors. These compressors will receive air from the mine compressed air distribution system, at about 90 pounds per square inch and increase the pressure to about 250 pounds per square inch.

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 load/haul/dump (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.

The LHDs will be equipped with exhaust gas scrubbers. 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.

Because minimal amounts of timber will be used in the mining process and other flammable materials such as oils and tires will be stored in controlled and protected locations, the danger of fire will be low. The ventilation system of the mine provides for all exhaust air to be directed to the surface without substantial reuse by personnel at any point.

1.4.2.2 Ore Transport and Primary Crushing

Broken ore will normally be removed from the stopes by LHD equipment. These LHDs will transport the ore to dump points established at intervals on each of the production levels. The ore or waste rock will be dumped into one of several ore passes, leading down to the main haulage system on a lower level (see Figure 1.2-9). Chutes at the bottom of each of the ore passes will allow the loading of haulage trucks which will transport the coarse ore and waste rock to storage bins ahead of the crusher.

Feeders will control the flow of ore from each of these bins into the top of a jaw crusher, which will reduce the material size to minus 8 inches. Below the crusher, the crushed ore or waste rock will be conveyed to the loading pocket at the shaft. This pocket will measure the proper load for the skips which will then transport the ore or waste rock to the surface. At the surface, the skips will discharge into a bin in the headframe structure. From there, the material will be fed onto a belt conveyor for transport to the surface ore storage facility or to the waste rock handling and backfill crushing system.

Dust suppression and/or collection systems will be used to control dust generated by the handling of the broken ore and rock. At some points, these will be water sprays or foggers. At other points, a system of ducting will collect dust for transport to a collector similar to those used for insertable collector installations modified to include a lower airlock. In still other areas, the flow of fresh air will dilute and remove dust from the exhaust air system of the mine.

1.4.2.3 Ventilation and Mine Air Heating

Fresh air will enter the mine through the main production shaft. Controlled amounts will be drawn from the shaft on each operating level, passed through the various working places, and collected in an exhaust air system. Ultimately, the exhaust air will be routed back to surface through exhaust air shafts located at each end of the orebody. Main fans installed on the surface at the top of the exhaust air shafts will be used to move air through the mine. Fans with a total capacity of approximately 850,000 cubic feet per minute will provide the main motive force for the ventilation system.

A system of secondary booster fans will be installed at appropriate points in the ventilation system to assure proper air quality in all active working places. Additionally, smaller auxiliary fans and air ducts will be used to transport fresh air to mine areas that are not on a completed ventilation circuit. Ventilation doors and regulators will also be used where necessary to control the air streams. The ventilation system will be regularly monitored and adjusted as necessary to maintain adequate levels of ventilation in all parts of the mine.

During early mine development air will be supplied from the surface through ducting to each active heading. In-line fans will be used to establish the required air volume to remove combustion products produced by diesel engines and detonation of explosives. Similar methods of air movement will be used for heading advance after primary ventilation circuits are operational.

Movement of air down the main shaft will be induced by operation of the main mine exhaust fans located on the surface at the east and west exhaust vent shafts. Each level in the mine will receive a predetermined volume of air necessary to conduct work activities on that level. Mine level air splits will be achieved with the aid of "regulators" (used on the levels nearer the surface), air doors, and booster fans (required for those levels farthest from the air flow created by the main mine exhaust fans).

A "regulator" is simply a device which restricts flow. Ventilation air will be directed along the path of least resistance. In an operating mine, a regulator is a blockage (bulkhead) in an airway with an adjustable opening. The opening is adjusted as required to accommodate changes in the required mine air movement.

Air doors are large doors which physically separate sections of the mine while allowing passage of large mining equipment via mechanical opening and closing methods. Generally, air doors are installed in pairs to form an air lock and minimize leakage.

Booster fans are used as motive energy additions to a mine ventilation system. Generally they are found in locations most distant from the main mine exhaust fans. These types of fans are much smaller in size than the main surface units and act in conjunction with them.

The use of these devices serves to control and direct air movements on each mine level. The underground environment is constantly changing with the relocation of primary work areas. Acceptable air quality and air movement conditions will be achieved through constant ventilation network attention and monitoring by mine management.

During the winter months, air entering the downcast shaft will require heating to approximately 40° F. This will be accomplished by direct-fired, natural gas-fueled heaters installed at the intake air portal. The ambient air temperature in the underground mine workings will average approximately 55° F year round.

The planned techniques for ventilation control are in common use throughout the underground mining industry. These techniques have been refined and proven through many years of use.

1.4.2.4 Mine and Backfill Dewatering

Systems for handling water inflow to the mine were described in subsection 1.2.1.2.16, Mine Drainage. The mine water system has been designed to handle 2,000 gallons per minute of ground water inflow which is greater than the expected average of 1,270 gallons per minute predicted by Prickett & Associates (1984). Mine backfill transport water is estimated to be 270 gallons per minute of which 110 gallons per minute will be retained as residual moisture in the placed fill. A minor amount of excess potable water will be a component of mine water pumpage.

Ground water will be collected by an interceptor system of drainage galleries and drill holes in the rock above the active mine workings. This intercepted water will be collected and pumped to the surface in a separate pipe column. Water not collected in the interceptor system and which flows into the mine workings will be collected in ditches and local mine level sumps. Here, solids will be settled, and the water will then be conducted via pipelines and boreholes to the main mine sumps. Backfill water will be collected at backfilled stopes and will flow through pipelines and/or boreholes to the main sumps. The main sump installation will be near the main production shaft on the 470 level. An additional small sump will be constructed at the bottom of the main shaft. A submersible pump will lift water from the shaft bottom sump to the main sump on the 470 level.

In the unlikely event that mine water inflow exceeds the design capacity of 2,000 gallons per minute, there are several contingency options. First, the excess inflow could potentially be controlled by surface source pumping or inflow path grouting as described by Klohn Leonoff (1982) in the mine water control methods study. Secondly, mine pumping systems will be designed for the conservative maximum inflow of 2,000 gallons per minute, including 100 percent installed spare pump and discharge line capacity. Surface surge storage capacity will exist in the reclaim and tailings ponds for temporary handling of excess inflow. The total freeboard volume in the reclaim pond, for example, is 210 acre-feet, or enough for surge of 1,000 gallons per minute of excess mine pumpage for over one and one half months.

1.4.2.5 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, up to two-thirds 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 (subsection 1.4.2.2); however, it will pass through separate vertical waste passes to a storage area above the main crusher (see Figure 1.2-9). 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. Except for several hundred thousand tons of uncrushed development period waste used as MWDF slope protection, all mine waste rock will be used as coarse or crushed mine backfill.

1.4.2.6 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 the possible use of 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 steel-cased through the overburden and fitted with 4 to 6-inch diameter polyethylene distribution pipes. The backfilling operations will 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 will 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. Two-thirds to three-quarters 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.

Cemented backfill will be produced by the addition of Type I Portland cement. Realizing that mill tailings will contain substantial amounts of sulfide mineral, backfill testing programs included evaluation of the use of Type V sulfate-resistant cement. No ultimate strength differences were observed between cemented backfill samples containing Type I or Type V cement, nor were there any indications of long-term strength deterioration for Type I samples.

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. About one-third to one-half of the total fill placed in the mine will contain cement.

1.4.2.7 Water Balance

A water balance for the mine is shown on Figure 1.2-12 which has allowed for up to the design maximum of 2,000 gallons per minute of mine inflow. Backfilling will contribute 270 gallons per minute to the mine of which 110 gallons per minute will be retained as residual moisture in the fill. Excess potable water will contribute a minor amount of water to the system. Approximately 150 gallons per minute of intercepted ground water will be used for mining processes such as drilling and dust suppression. After use, this mine utility water will drain to the main mine water collection sumps. The remaining 850 gallons per minute of intercepted ground water will be pumped from the upper level ground water sump to the surface intercepted water tank. Contaminated mine water at 1,265 gallons per minute will be pumped from the lower level main mine sump to the water treatment plant feed tank. The portion of the treated mine water not used in the mill will be discharged to Swamp Creek. Approximately 50 gallons per minute of water will be hoisted with the ore or waste rock and become part of the mill water balance.

The values above are estimated and are calculated to represent operation of the mine at the design maximum ground water inflow of 2,000 gallons per minute. Pumpage of intercepted ground water and normal mine drainage would be reduced by almost 50 percent at the predicted average ground water inflow rate of 1,270 gallons per minute (Prickett & Associates, 1984).

1.4.3 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.

The annual design and average capacities for the mill are presented in Table 1.4-3; these data were used as the basis for the design of the mill and related facilities. 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

TABLE 1.4-3

ESTIMATED DESIGN CAPACITY AND AVERAGE QUANTITY OF ORE HANDLED AND PROCESSED DURING A FULL PRODUCTION YEAR

		Design Capacities (Tons Per Day)	Average Quantities (Tons Per Day)	Average Quantities (Tons Per Year)*
Massive Ore	(Years 1-16)	8,200	7,400	2,655,000
Stringer Ore	(Years 17-29)	6,400	5,700	2,060,000
Total	(Years 1-29)	--	6,500	2,324,000
Copper Concentrate	(Years 1-16)	210	142.5	51,300
	(Years 17-29)	500	387.3	139,400
Lead Concentrate	(Years 1-16)	106	56.1	20,200
	(Years 17-29)	--	--	--
Zinc Concentrate	(Years 1-16)	1,430	1,058.9	381,200
	(Years 17-29)	100	54.7	19,700
Flotation Tailing	(Years 1-16)	3,280	2,960	1,065,600
	(Years 17-29)	2,600	2,400	864,000

*Yearly values based on 360 operating days per year.

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 90 percent of the time with 10 percent downtime for maintenance and thus the average is about 90 percent of the design rate.

1.4.3.1 Ore Transport and Grinding

A concentrator is a facility in which the crushed ore is ground and separated into concentrates and tailings. Concentrates contain the valuable minerals that were in the ore, and tailings are the materials rejected after the valuable minerals have been removed.

To produce concentrates, the various minerals must be liberated from the host rock and from each other so the valuable minerals can be separated from the waste components. Liberation will be achieved by grinding the ore to a size at which the valuable minerals will be discrete particles which can be separated from each other.

As discussed in subsection 1.4.2.2, 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 (see Table 1.4-2).

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. The SAG mill will be rotated by an electric motor and will be charged with 4 to 6-inch balls.

Fine grinding of the ore will be done in a conventional ball mill. The ball mill will be charged with alloy steel balls ranging in size from about 0.25 to 3 inches. 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.

A schematic for the grinding facility is shown on Figure 1.4-1. The SAG mill will discharge directly to a wet screen where material larger than about 0.50 inch will be separated and recycled by a high angle conveyor to the feed end of the SAG mill. Screen undersize will pass into a sump. A sump pump will then pump the slurry to a cluster of cyclone classifiers. The cyclones will further classify the material and the cyclone overflow (fines) will pass to the flotation circuit. The cyclone underflow will normally flow to a ball mill which is the second stage of grinding. A provision will be made to allow a

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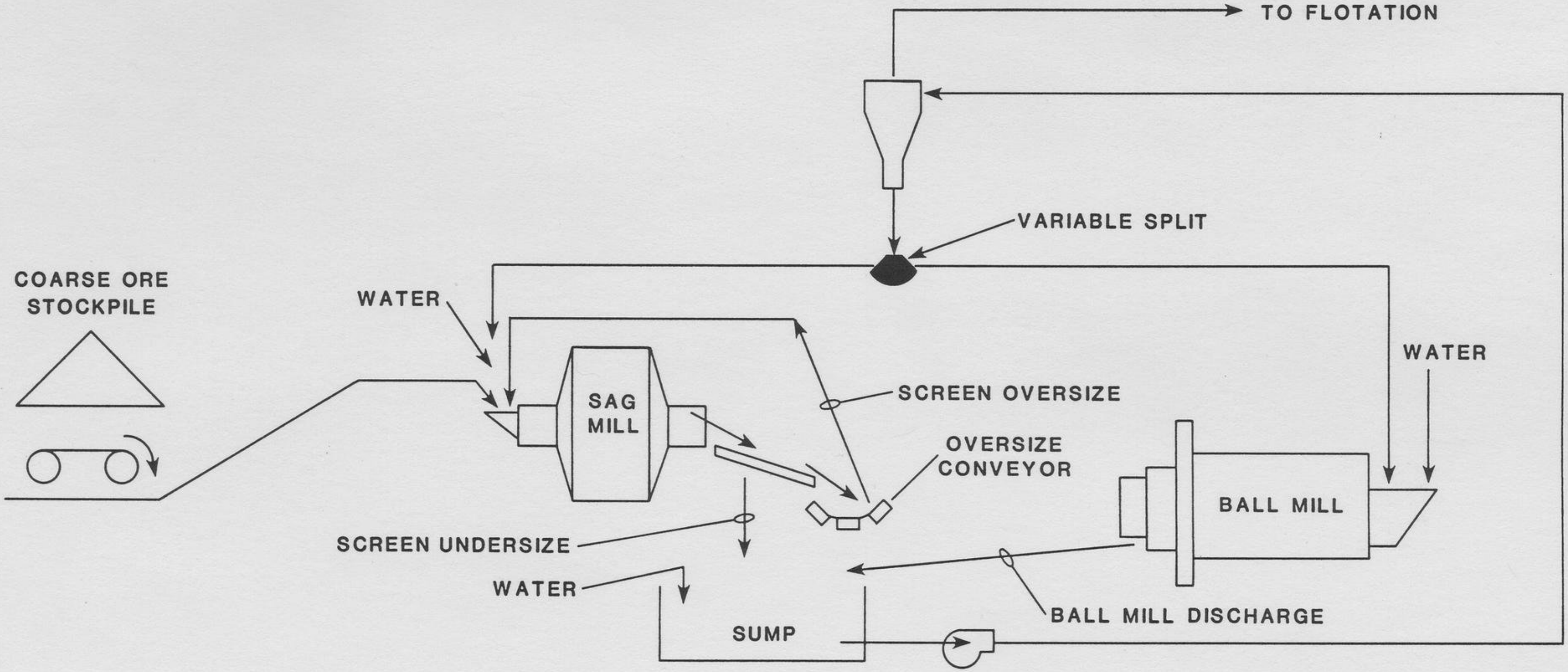


Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY CRANDON PROJECT					
TITLE: MILL FACILITY GRINDING FLOWSHEET					
SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY C. ADAMS	DATE 8/85	CHECKED BY		DATE	
APPROVED BY	DATE	APPROVED BY		DATE	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO FIGURE 1.4-1			SHEET ___ OF ___	REVISION NO	

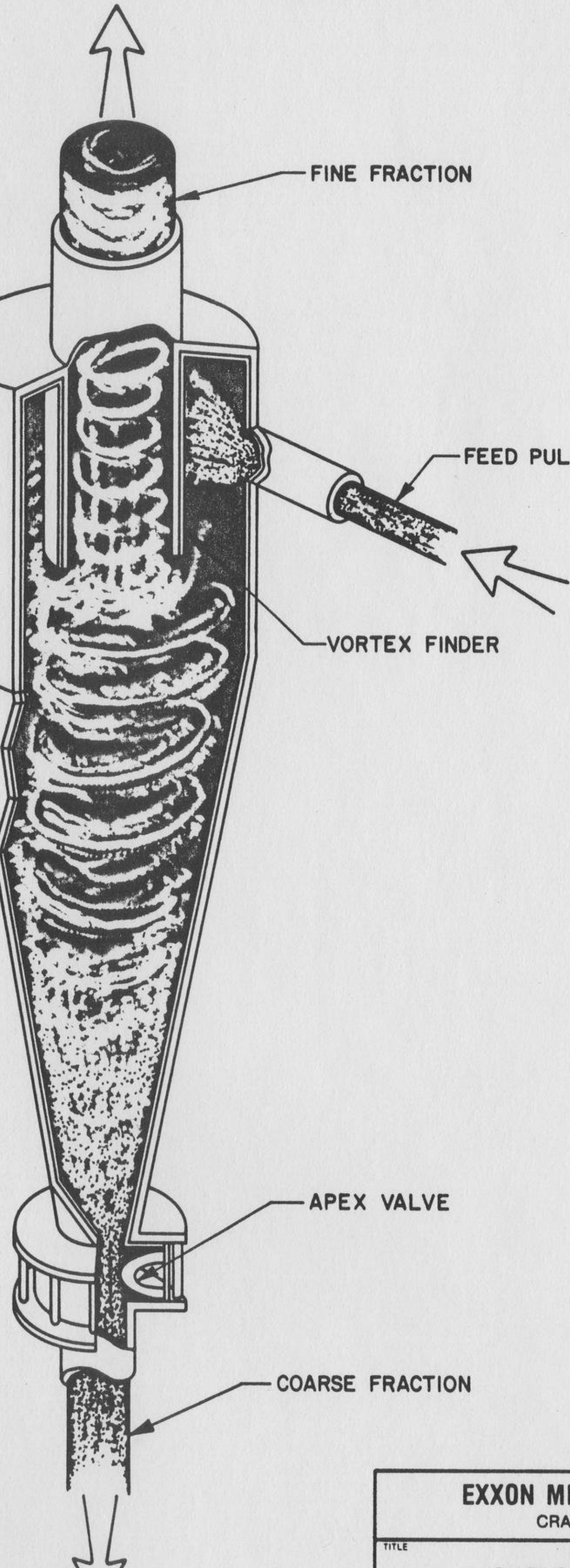
split of the cyclone underflow to return to the SAG mill as a means of balancing the grinding load. The ball mill discharge will flow into the cyclone feed sump and will thus recycle to the cyclone cluster.

A cyclone classifier separates particles based on their size. The ore slurry will be pumped into the cyclone under pressure which causes the mineral slurry to rotate; the coarse particles will pass to the outside of the cyclone and will be collected at the bottom, while the finer particles will tend to collect towards the center and pass through the top of the cyclone. Figure 1.4-2 is a cutaway drawing of a cyclone. The coarse particles from the bottom of the cyclone will be directed to a ball mill for further grinding.

1.4.3.2 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.



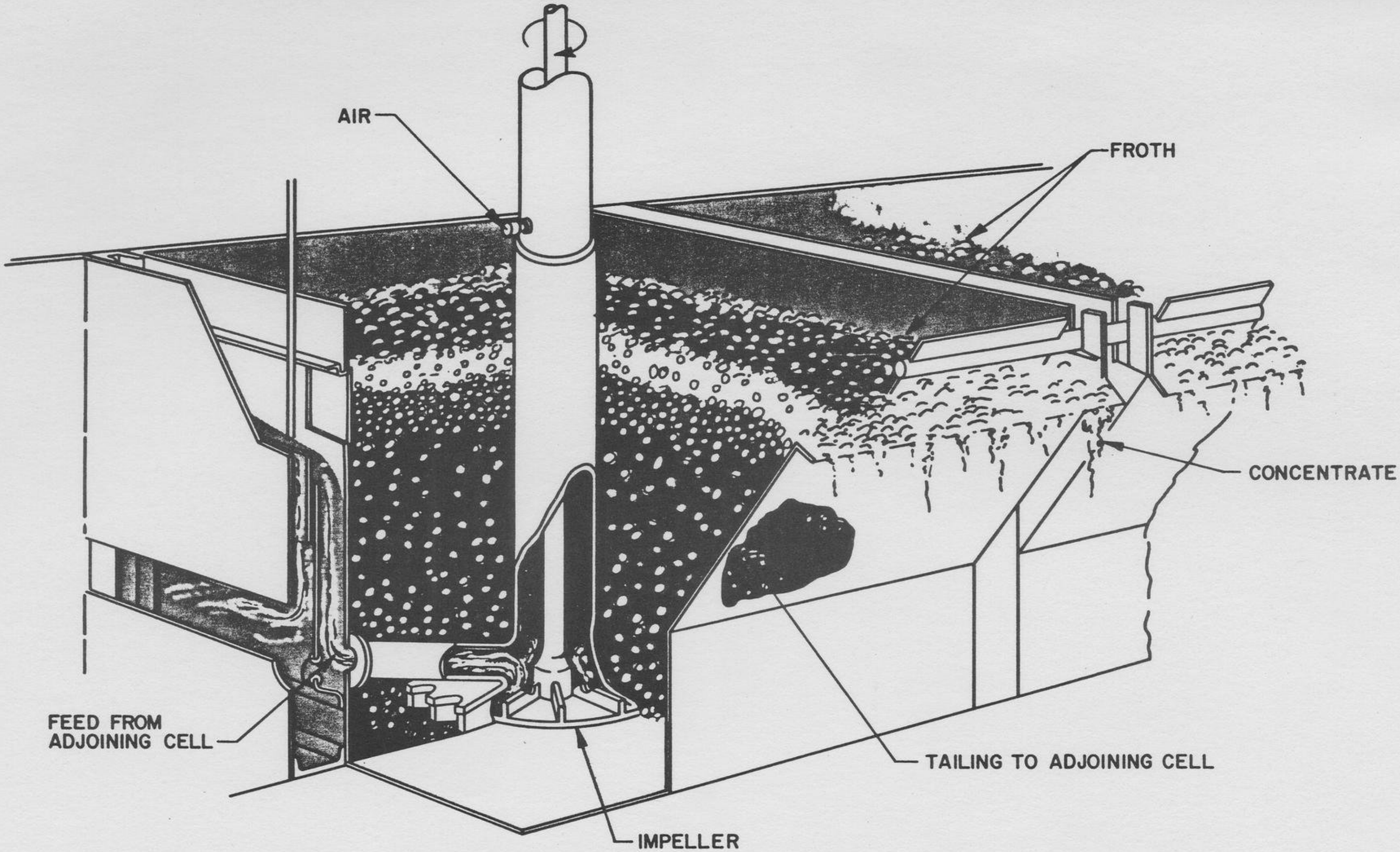
Typical Representation : Refinements
May Be Made During Final Engineering

EXXON MINERALS COMPANY CRANDON PROJECT				
TITLE **CYCLONE CLASSIFIER (TYPICAL)**				
SCALE NONE	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY	DATE 4/84	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 1.4-2**			SHEET ___ OF ___	REVISION NO

Collectors and frothers used in each of the flotation circuits are generally added ahead of the first stages of flotation and as needed in subsequent stages. Collectors are those reagents added to the ore-water slurry that attach to the desired mineral particles thereby imparting a hydrophobic, or air-avid, surface to the mineral particles. These particles then attach to air bubbles and rise to the top of the flotation cell to form a froth. Frothers are added for the purpose of altering the surface tension of the slurry such that stable, mineralized froths can form on the top of the flotation cell and be removed.

The flotation process will be performed in flotation machines similar to that shown on Figure 1.4-3. The ground ore, in a slurry with water, comes from the grinding circuit. Reagents will be added and the slurry passes into the first cell of the flotation machine.

In the flotation machine, air will be introduced into the bottom through an impeller. The very fine air bubbles will be distributed thoroughly through the slurry of ore and water. When an air bubble encounters a mineral particle that has been treated with the proper reagent, that particle adheres to the bubble and will be transported with the froth to the top of the machine. A particle that has not adsorbed the proper reagent will not adhere to an air bubble. This particle then remains in the water and will be carried out with the water and form the tailing. The mineral collecting with the froth will form the concentrate.



Typical Representation: Refinements
May Be Made During Final Engineering

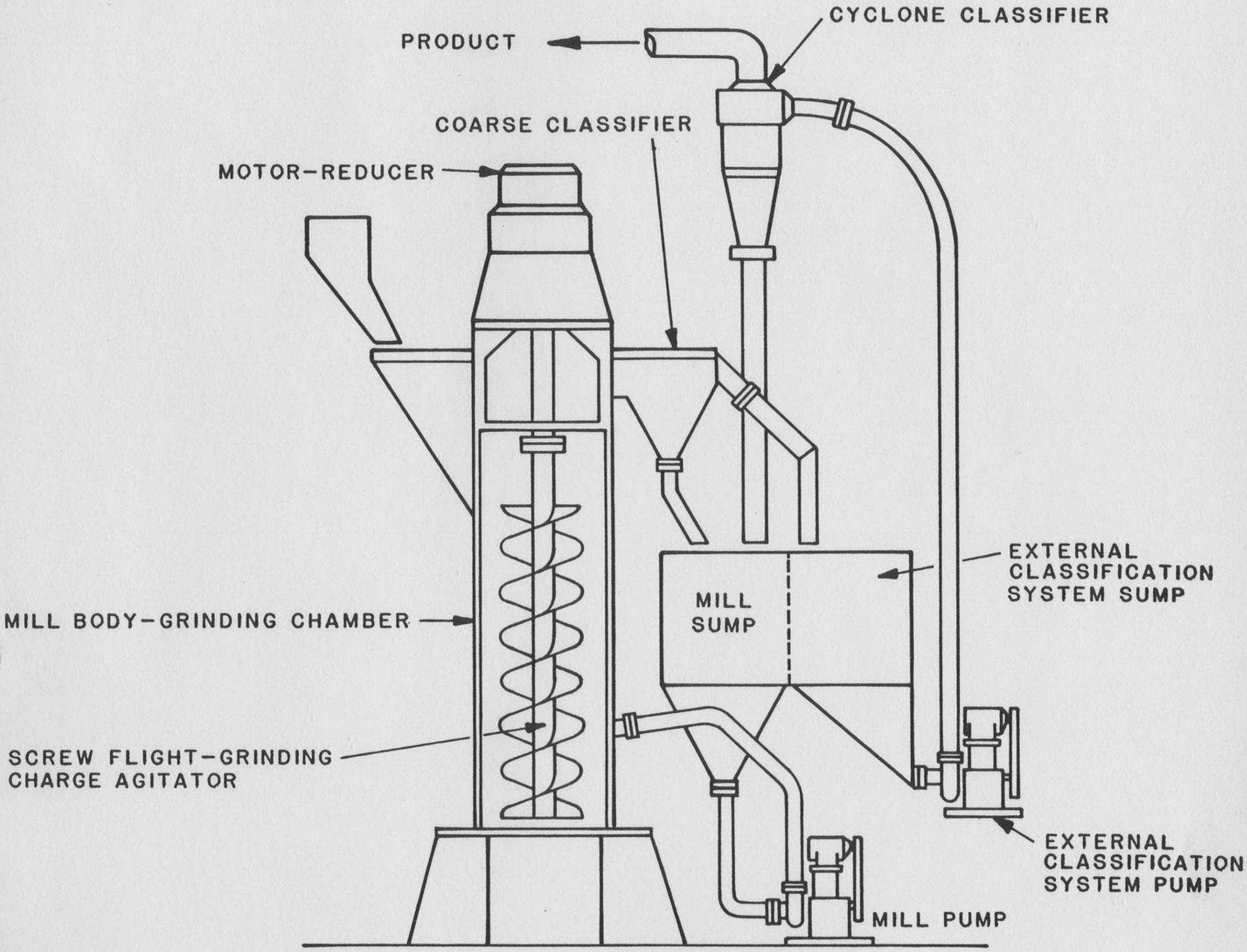
EXXON MINERALS COMPANY CRANDON PROJECT					
TITLE: FLOTATION PROCESS FLOTATION CELL SCHEMATIC (TYPICAL)					
SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY	DATE 4/84	CHECKED BY		DATE	
APPROVED BY	DATE	APPROVED BY C.C. Schroeder		DATE 11/13/85	
APPROVED BY	DATE	EXXON D.E. Moe		DATE 11/13/85	
DRAWING NO. FIGURE 1.4-3			SHEET ____ OF ____	REVISION NO	

Flotation is normally performed in a series of steps so that each step corresponds to an increase in the metal content or grade of the respective metal concentrate. The first step is called rougher flotation. Succeeding steps are called cleaner flotation. The concentrates from the rougher flotation are often reground to further liberate valuable minerals from gangue minerals before being "cleaned." For the Crandon Project, concentrate regrinding will be performed by tower mills.

A tower mill is a wet grinding system which grinds ore using the mechanism of attrition. A typical tower mill system is shown on Figure 1.4-4. A grinding charge of steel balls is placed in the vertical tube-like grinding chamber. A vertical screw mechanism, which acts as an agitator at the top, passes through the chamber and is driven at the top. Material to be ground is fed at the top, center, or bottom of the tower as required. The attrition occurs among the material to be ground, the steel balls, and the screw flight.

As the finely ground material overflows the main body of the tower mill, the largest particles are removed and recycled to the bottom of the grinding chamber. In this sense, the tower mill has its own internal classification mechanism. In addition, an external classification system such as a cyclone is used to further classify the material. The coarse material from finishing hydrocylcone also is recycled to the grinding chamber, whereas the fine fraction is delivered to the cleaner flotation steps.

By use of proper reagents and the appropriate arrangement of the flotation machines, separations will be made between the various sulfide minerals and tailings. This results in the production of concentrates of zinc, copper, and lead, and a tailings waste product.



Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
TYPICAL TOWER MILL WET GRINDING SYSTEM

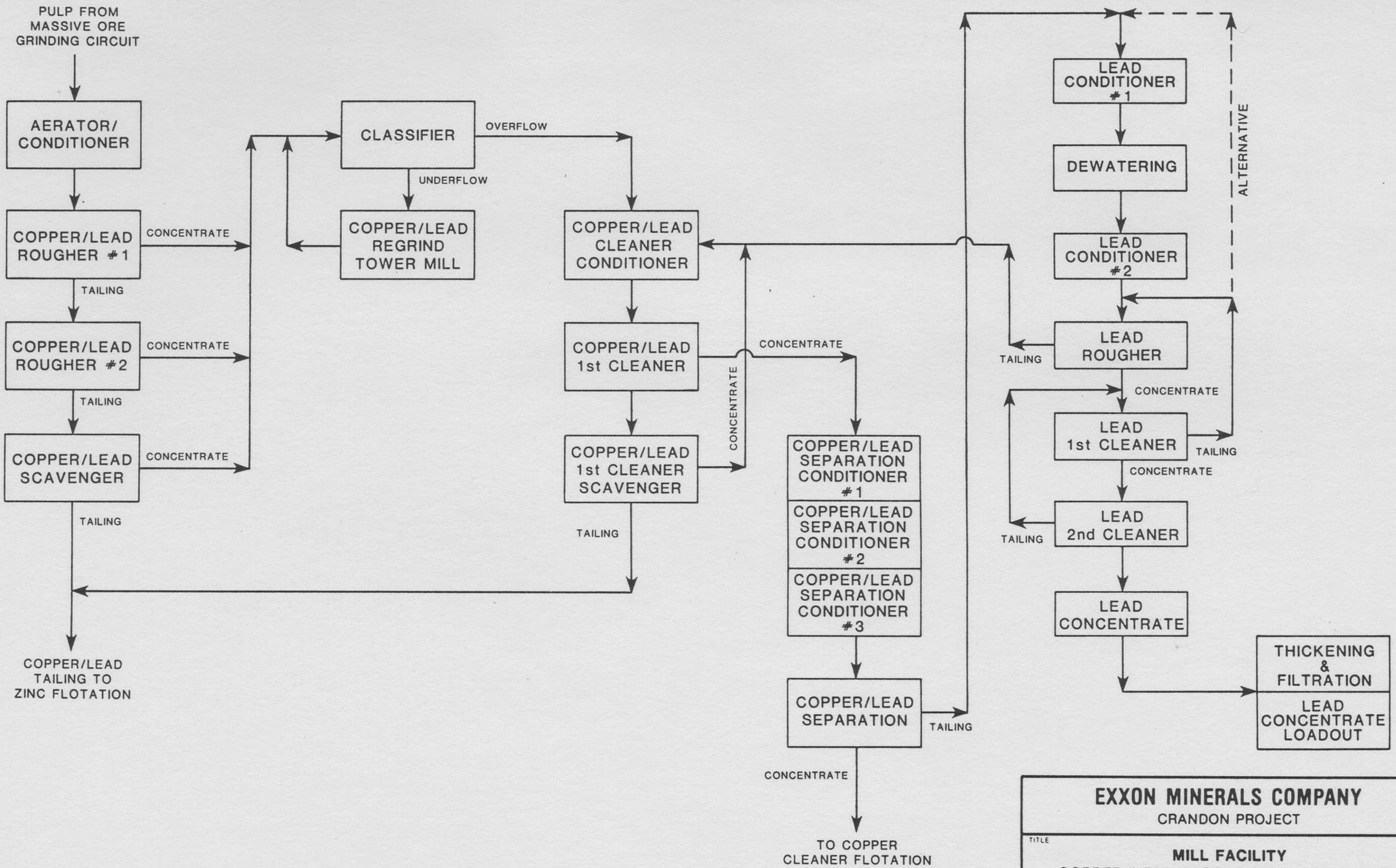
SCALE NONE	STATE WISCONSIN	COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY
APPROVED BY	DATE	APPROVED BY C.C. Schroeder DATE 11/85
APPROVED BY	DATE	EXXON DATE 11/12/85

DRAWING NO. **FIGURE 1.4-4** SHEET OF REVISION NO.

The slurry from the cyclone overflow will pass to an aeration step in which the slurry will be conditioned with reagents and air to prepare it for the flotation of the sulfide minerals. The aerator will consist of large slurry tanks containing agitator mechanisms which serve to dispense air into the slurry. Products from the aerator will be fed to the flotation circuit. For the massive ore, the aerator will precede the bulk copper-lead flotation. When the stringer ore is milled, the same aerator will precede copper rougher flotation.

Copper-Lead and Lead Flotation Circuits (Massive Ore) - A schematic flowsheet for copper-lead and lead flotation is shown on Figure 1.4-5. 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 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.



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 NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY C. ADAMS	DATE 8/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
APPROVED BY	DATE	EXXON	DATE
DRAWING NO FIGURE 1.4-5		SHEET 1 OF 1	REVISION NO

Copper Flotation (Stringer Ore) - A schematic flowsheet for copper flotation is shown on Figure 1.4-6. After grinding, aeration, and conditioning with reagents, the stringer ore will be subjected to flotation for the production of a copper concentrate and a tailing containing recoverable zinc. The copper flotation circuit will be similar to the massive copper-lead circuit containing roughing and scavenger steps.

The copper rougher and scavenger concentrate will be reground and then cleaned in a copper cleaning circuit. This cleaning will result in the production of a final copper concentrate.

Zinc Flotation - A schematic flowsheet for the zinc circuit is shown on Figure 1.4-7. The zinc flotation flowsheet will be the same for massive and stringer ores. The feed to the zinc flotation circuit will consist of the following tailing products:

Massive Ore

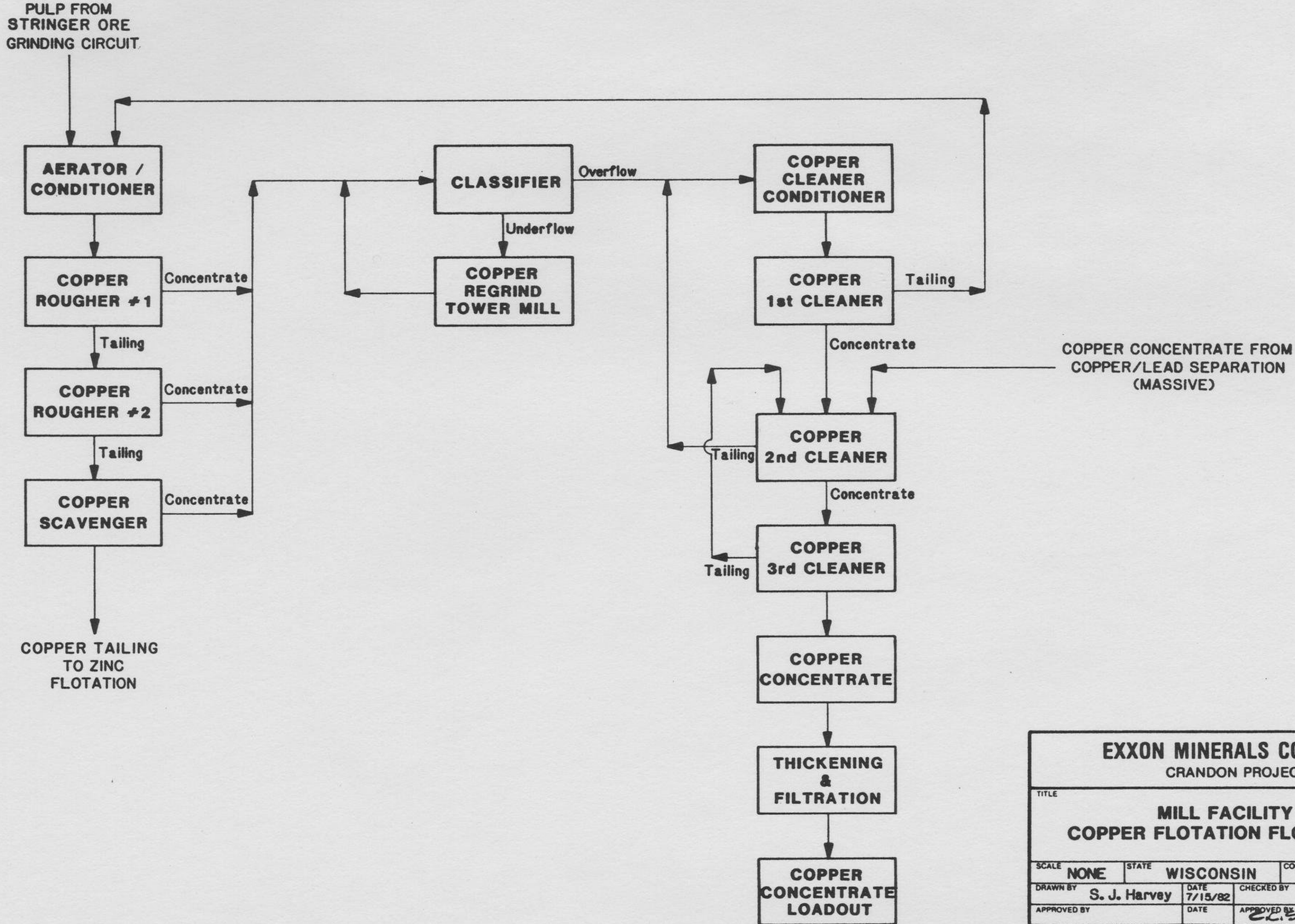
1) Copper-lead scavenger tailing; and
2) Copper-lead cleaner-scavenger tailing.

Stringer Ore

Copper scavenger tailing.

The total zinc flotation circuit feed will be conditioned with reagents and directed to zinc flotation. Zinc rougher and scavenger concentrates will be produced.

The zinc rougher and scavenger concentrate will be reground prior to cleaning. The regrind circuit will consist of a tower mill and cyclones operating in closed circuit. Following regrinding, the

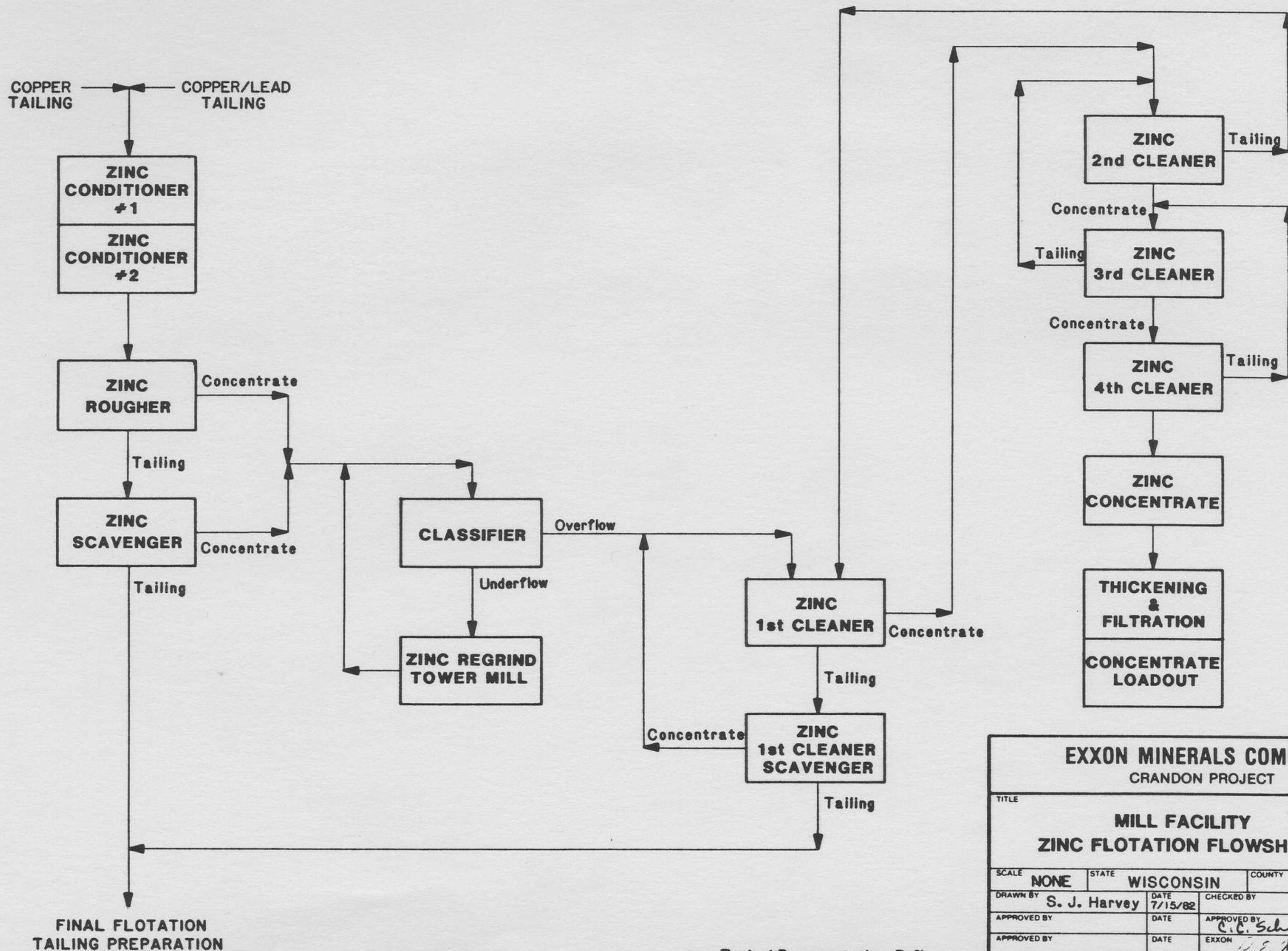


Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
COPPER 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 [signature]		DATE 11/15/85	
APPROVED BY	DATE	EXXON [signature]		DATE 11/1/85	
DRAWING NO FIGURE 1.4-6			SHEET 1 OF 1	REVISION NO 0	



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 [illegible]	DATE [illegible]
DRAWING NO FIGURE 1.4 -7		SHEET 1 OF 1	REVISION NO. 0

concentrate will be cleaned four times to produce a final zinc concentrate. The zinc scavenger tailing will pass to the backfill preparation circuit.

Sampling - Selected process streams will be analyzed using a low level X-ray analyzer which will semi-continuously monitor the appropriate metal levels in the process streams. Data from the analyzer along with mass flow rate data will be used to control the addition of reagents to the flotation process. Reject streams from the analyzer will be returned to the respective process stream with a portion retained for laboratory analysis if desired.

Laboratory analyses will be used for operational control during mill start-up and to calibrate the X-ray analyzer. When the X-ray unit is calibrated, the laboratory analyses will be used for maintaining the calibration of the analyzer and will provide other operating data.

1.4.3.3 Concentrate Handling and Shipping

Each concentrate slurry from the flotation area will be pumped to a thickener where the solids will be allowed to settle. Each thickened concentrate will be further dewatered using filters to produce a filter cake containing 8 to 12 percent by weight moisture.

The filtered concentrate will normally be loaded directly into railcars using 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 copper and zinc concentrate and 10 days production of lead concentrate. These facilities are described in more detail in subsection 1.2.2.9.

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. The number of cars per shipment could vary up to 40.

The railcars used to transport concentrate will normally be open top, rectangular cars called gondola cars. They have a steel bed and sides which will completely contain the concentrate without spillage. After loading, the concentrate will be covered by one of two systems, both of which are in common use for transport of concentrate, coal, and other bulk commodities which could generate dust. The two systems are:

1) A tarpaulin type cover typically made of woven polyolefin fabric and tied down to the car with rope; or

2) A latex-based chemical spray coating and sealant, such as "Aerospace 70" manufactured by American Cynamid.

Since some potential customers have facilities designed to receive open top bottom-dump hopper cars, the Project will accommodate this type car as well. Loading facilities at the Project site can handle either type car. To protect against minor seepage losses during transit the hopper seal will be inspected on car receipt and defective cars will be rejected and returned to the railroad. Hopper seals will be augmented by either an expanding polyurethane foam spray at the seal or by a draft paper on plastic film liner placed on top of the seal prior to loading. These extra steps are not intended to be integral to seepage prevention, but would provide a commonly-used backup to the normal hopper seals.

Noise and air emissions associated with concentrate handling and shipping are discussed in subsection 1.4.9.

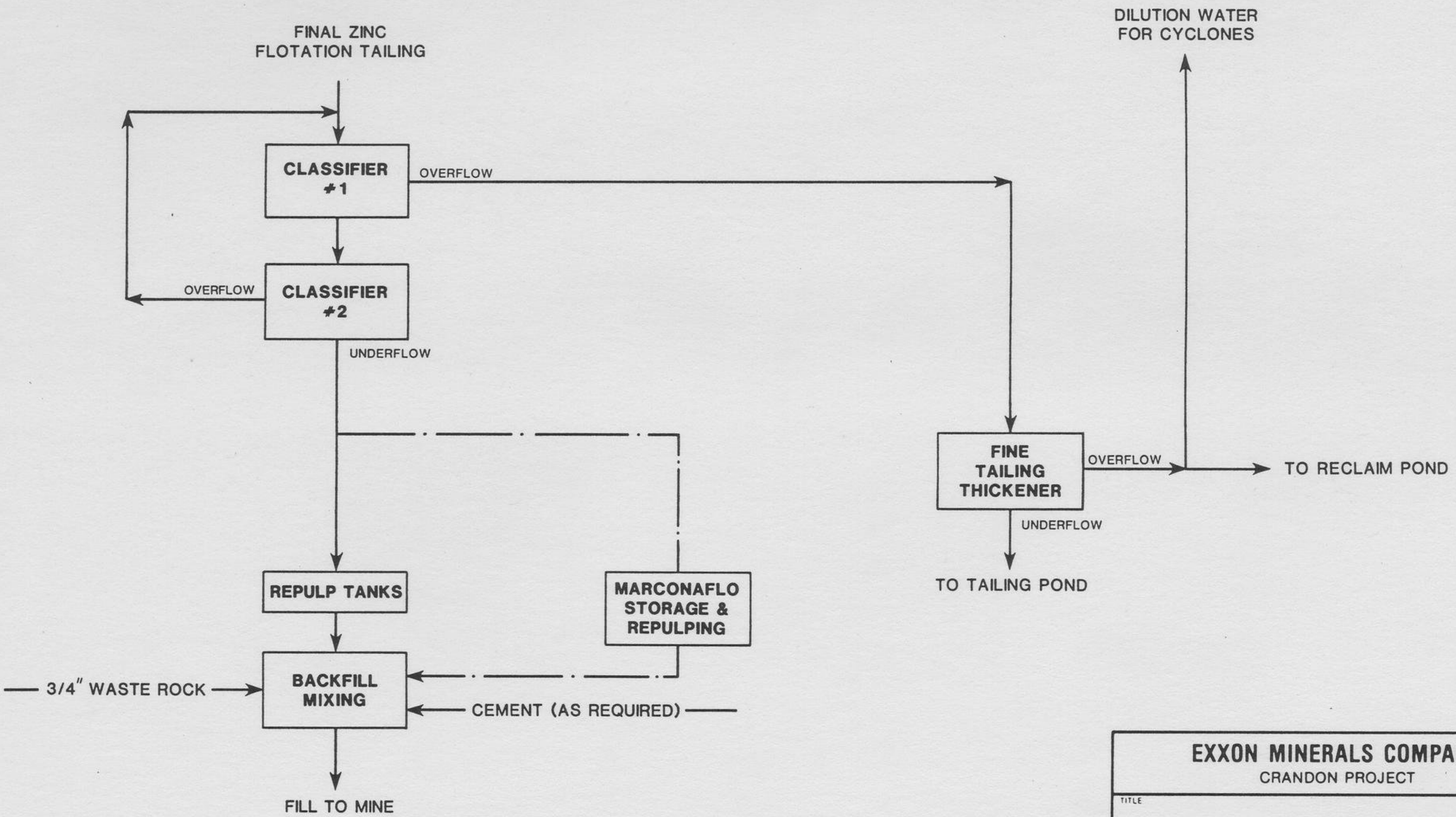
The following information summarizes the physical characteristics of the three concentrates:

	Copper	Lead	Zinc
Specific gravity	4.21	4.14	4.06
Color	brassy	black	brassy
Approximate % moisture	9	9	8
Particle size	90%-25um	90%-25um	90%-25um

1.4.3.4 Surface Backfill System

The underground mining method used for extracting ore, termed sublevel open stoping, uses backfill to stabilize the peripheral in-place rock after the ore is mined. 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 1.4-8.

The surface backfill system will be in two general locations. The backfill cyclone system will be located in the concentrator building (see Figure 1.2-18). The cement storage tanks, waste rock crusher,



Typical Representations: Refinements
May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
BACKFILL FLOWSHEET

SCALE NONE	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY C. ADAMS	DATE 8/85	CHECKED BY		DATE
APPROVED BY	DATE	APPROVED BY		DATE
APPROVED BY	DATE	EXXON		DATE
DRAWING NO FIGURE 1.4-8		SHEET 1 OF 1		REVISION NO

385-2C-220M

Marconaflo storage tanks, batch mixing tank, and the backfill delivery pumps will be located east of the coarse ore stockpile (see Figure 1.2-15).

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 18,000 tons of cycloned tailings sands (approximately 5 days of mill production). These tanks will be located 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 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. A cross section of the Marconaflo tanks is shown on Figure 1.4-9.

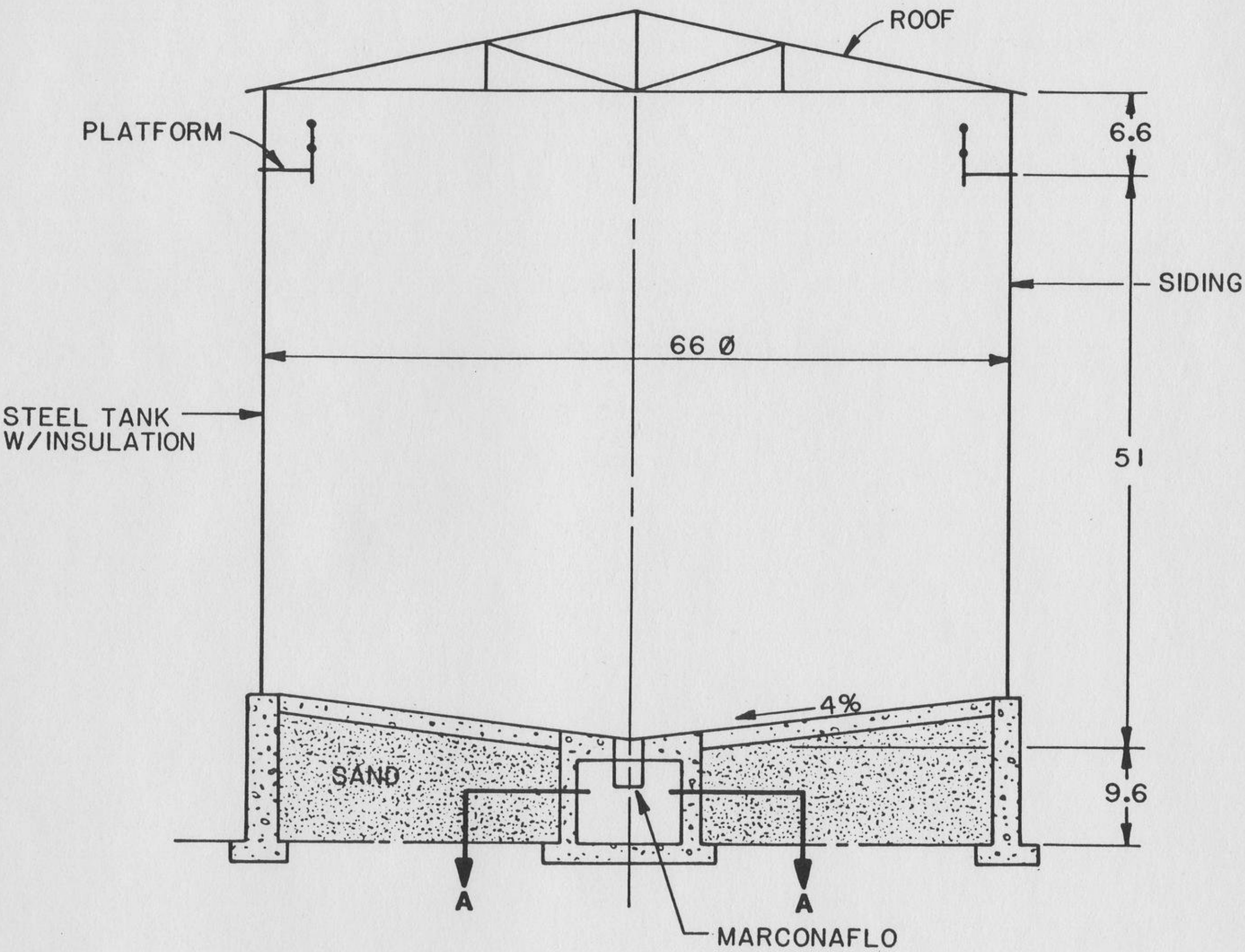
Cement will be added to the system by injection of the cement slurry directly into the mix tank. The variable speed drive of the rotary feeder at the discharge of the cement bin will be controlled by a mass cement/sands ratio (assumed 6 percent by weight).

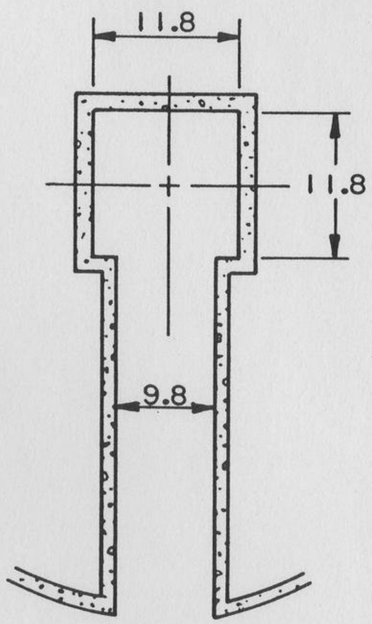
High quality backfill mixture is assured by the two desliming cyclones placed in series and the precise density control and sands/cement ratio control which can be achieved with the system proposed.

1.4.3.5 Fine Tailing Thickening

The fine fraction of the final mill tailing from the backfill cyclones will be pumped to the tailing thickener. The two small overflow streams from the lead feed thickener and the lead concentrate thickener will also be sent to the tailing thickener. Lime will be added as needed to the slurry that is pumped to the thickener to ensure that the solids will settle at the proper rate. A flocculant may be used if necessary to minimize the amount of suspended fine solids in the tailing thickener overflow stream. The tailing thickener is described in subsection 1.2.2.8.

The total feed to the tailing thickener is estimated to contain 3,000 tons per day of solids with a total pulp volume of 6,800 gallons per minute. The solids content in the total feed slurry will be about 7 percent solids by weight. After settling, the thickener underflow will contain about 55 percent solids by weight at a flow rate





SECTION A-A

DIMENSIONS IN FEET

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY CRANDON PROJECT			
TITLE: MILL FACILITY MARCONAFLO BACKFILL STORAGE & REPULPING			
SCALE: NONE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: DR SPRINGBORN	DATE: 8/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY: C.C. Schroeder	DATE: 11/85
APPROVED BY	DATE	EXXON: D.E. Moe	DATE: 11/13/85
DRAWING NO: FIGURE 1.4-9		SHEET ___ OF ___	REVISION NO

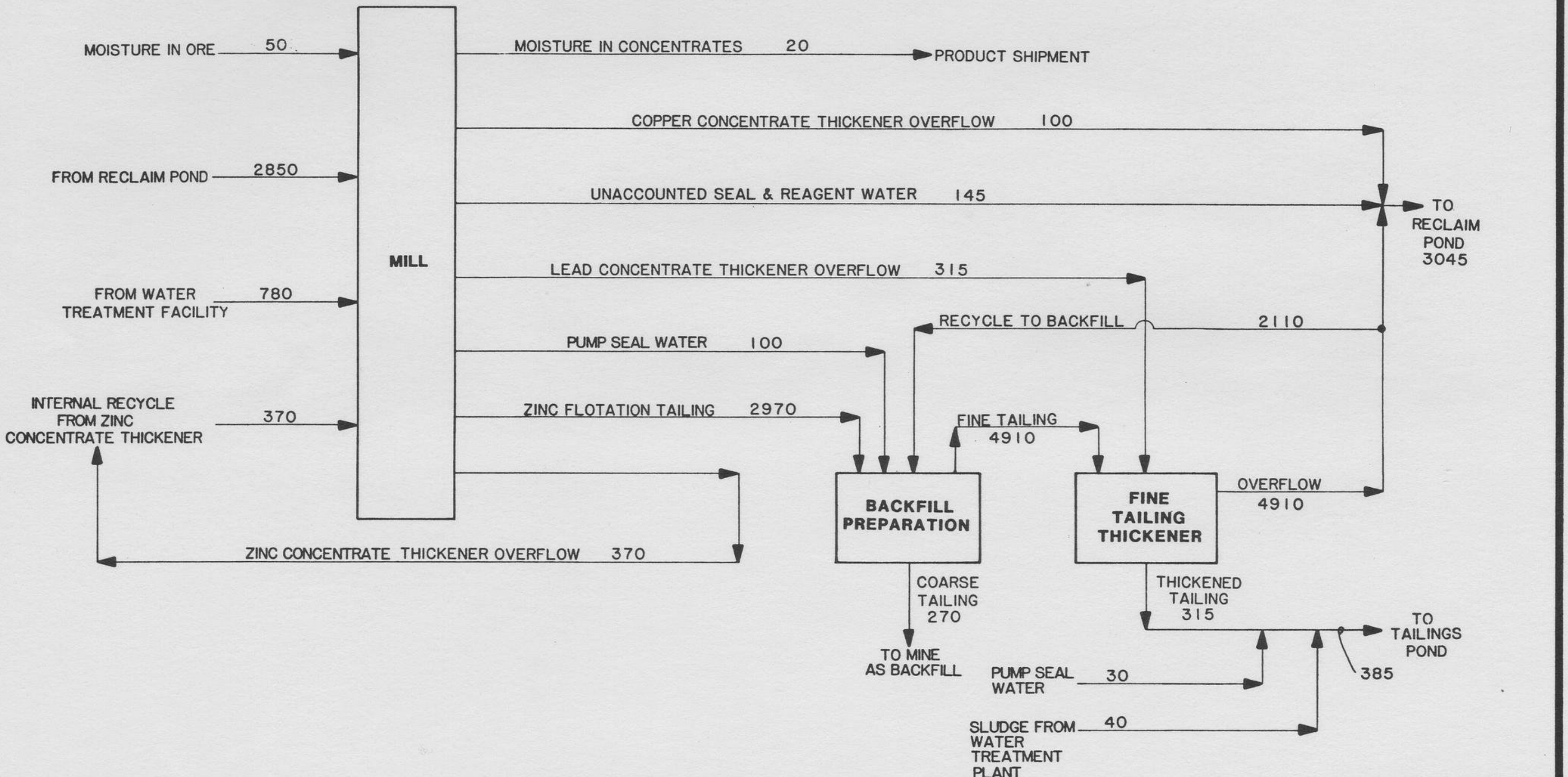
of 540 gallons per minute. The thickener underflow will be collected in a sump and pumped via pipeline to the tailings disposal area.

The thickener overflow at approximately 6,250 gallons per minute will contain some amount of suspended solids, typically 100-1000 ppm. A portion of this water will be recycled to the backfill cyclone classification process as make-up water and the remainder will be recycled to the mill via the reclaim pond.

1.4.3.6 Water Balance

A block flow diagram showing the water balance for the mill and related facilities is presented on Figure 1.4-10. 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. A detailed overall water balance for the mine, mill, tailing and reclaim ponds is presented and discussed in subsection 1.4.6.

The average quantity of water required for the mill process will be 4,050 gallons per minute which includes all process requirements, reagent preparation, and pump seal water in the mill, backfill preparation, and pumps used to transport water and tailings. Approximately 370 gallons per minute will overflow the zinc concentrate thickener and be recycled directly back to the zinc flotation circuit without leaving the mill facility. As indicated on Figure 1.4-10, no continuous need for fresh water as process make-up is required because



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.C. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON	DATE [illegible]
DRAWING NO FIGURE 1.4-10		SHEET ___ OF ___	REVISION NO 1

of the intention to rely on treated and untreated water from the reclaim pond. Approximately 2,850 gallons per minute will be recycled to the mill from the reclaim pond without any treatment and 780 gallons per minute will be recycled from the water treatment plant. A small amount of water will enter the mill from the ore, approximately 50 gallons per minute.

Water overflowing the copper concentrate thickener (100 gallons per minute) will be sent to the reclaim pond. The overflow from the lead concentrate thickener will be pumped to the fine tailing thickener so that any heavy metals in this stream can be precipitated (precipitate then becomes part of the solid tailing product).

The zinc flotation tailing stream will have 2,970 gallons per minute of water and 6,100 tons per day of solids. This stream will be pumped to the backfill preparation circuits where the coarse tailing particles will be separated from the fine tailing particles. An additional 2,110 gallons per minute will be required in the backfill circuits; this water will be recycled from the fine tailing thickener overflow water. The coarse tailings (referred to as sands), along with 270 gallons per minute of water will go to the mine as backfill. The fine tailing from the backfill preparation circuits will be a very dilute suspension of fine solids in water and cannot be used as fill in the mine. The fine material will be pumped to the tailing thickener where it will be thickened to about 55 percent solids by weight. The thickened tailing stream along with the carbonate/hydroxide waste from the water treatment plant will be pumped to the tailings pond. This total flow is estimated to be 385 gallons per minute. The thickener overflow stream will be 4,910 gallons per minute of which 2,110 gallons per minute will be recycled to the backfill preparation area as required dilution water in the cyclone classification circuits. The remainder of the tailing thickener overflow water, 2,800 gallons per minute, will be pumped to the reclaim water pond. It is possible that once operating experience is gained in the mill, some water can be recycled directly from the tailing thickener overflow stream thus reducing the volume pumped to the reclaim pond.

During start-up of the mill, water that will have accumulated in the reclaim pond during construction will be used as a source of water. If another source of water is needed during start-up or intermittently during normal operation, it can be obtained from the mine water (either contaminated or intercepted) or from the 100 gallons per minute potable water well.

The basis for the mill water balance discussed above is the cumulative result of metallurgical process studies, engineering work, and water management studies conducted by Exxon and CH_2M Hill (1982a,b, 1984). The flow quantities shown on Figure 1.4-10 are those used in developing the current designs for the Project. During final engineering, maximum and minimum flow quantities for all streams will be developed so that pumps, sumps, and pipelines can be properly sized. The flows shown on Figure 1.4-10 were assumed to be average flows; during final engineering the average flows in some streams may change slightly but such increases would not be expected to affect predictions of environmental impacts.

1.4.3.7 Reagent Receiving, Storage, and Use

Chemical reagents will be used in the flotation process and in the water treatment processes. The reagent preparation and handling facilities are presented on Figures 1.2-19 and 1.2-20 and are discussed in subsection 1.2.2.5. The reagents, as delivered to the Project site, will either be in solid or liquid form. 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 1.4-4. Figure 1.4-11 shows the reagent addition points in the process. Procedures for preparing the various reagents for use are explained along with the description of reagent facilities in subsection 1.2.2.5.

Fresh or treated process water will be used in the mixing and dilution of reagents. Containment and handling of reagent spills and odor control in the reagent area are discussed in subsection 1.4.3.10.

Reagents received in drums, bags, or small containers, if damaged to the point of not being usable, will be returned to the vendor. For example, if the specially designed Flo-Bin^{tm} for transporting and storing sodium cyanide were damaged to the point of not being usable, arrangements would be made to return the damaged container to the vendor. If some bags or drums are only slightly damaged, the contents of the damaged container will be placed in an appropriate container and saved for use as intended. Any associated spills would be recovered and also saved for use. If a reagent could not be used for some currently unforeseen reason, it would be taken off-site by a hazardous waste handler.

TABLE 1.4-4

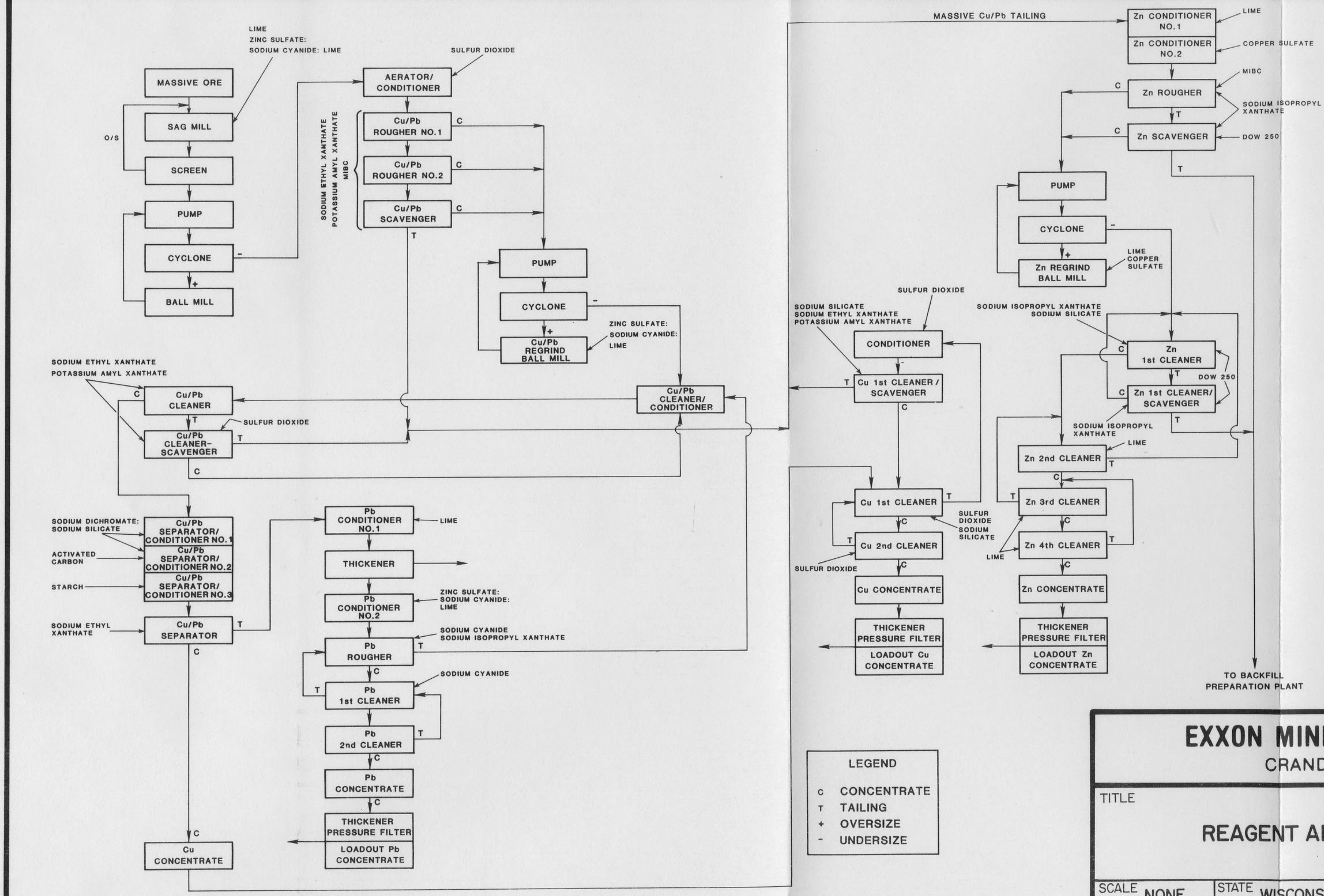
TYPICAL REAGENT USE, CONSUMPTION RATE, AND STORAGE CAPACITIES

REAGENT	PRIMARY USE	PHYSICAL FORM	RECEIVED BY	ESTIMATED MONTHLY CONSUMPTION (TONS)	STORAGE CAPACITY
Sulfur Dioxide (SO_2)	Depressant	Liquid	Truck (Tanker)	50	150,000 lb
Copper Sulfate ($CuSO_4 \cdot 5H_2O$)	Activator	Granular	Railcar	80	300,000 lb
Sodium Cyanide (NaCN)	Depressant	Briquette	Truck	7.2	36,000 lb
Polypropylene Glycol Methyl Ether (Dowfroth 250)	Frother	Liquid	Truck	2.0	50,000 lb
Sodium Sulfide ($Na_2S \cdot 9H_2O$)	Activator & Precipitant	60% Flake	Railcar	2.5	80,000 lb
Xanthates	Collectors	Pellets	Truck	18	63,000 lb
Zinc Sulfate ($ZnSO_4 \cdot 7H_2O$)	Depressant	Granular	Truck	24	54,000 lb
Starch	Depressant	Powder	Truck	11	30,000 lb
Sodium Dichromate ($Na_2Cr_2O_7$)	Depressant	Liquid (69% Solution)	Truck (Tanker)	16	12,000 gal
Sodium Silicate (Na_2SiO_3)	Dispersant	Liquid	Tank Car	46	15,000 gal (175,500 lb)

TABLE 1.4-4 (continued)

REAGENT	PRIMARY USE	PHYSICAL FORM	RECEIVED BY	ESTIMATED MONTHLY CONSUMPTION (TONS)	STORAGE CAPACITY
Activated Carbon	Absorbent	Powder	Railcar	25	75,000 lb
Methyl Isobutyl Carbinol (MIBC)	Frother	Liquid	Tank Car	8	40.5 tons (125,000 gal)
Lime (CaO)	pH Modifier	Pebble	Rail	441	617 tons
Flocculant (Type not chosen yet)	Flocculant	Liquid or Powder	Truck	--	45,000 lb
Caustic Soda (NaOH)	Used in Preparation of Sodium Cyanide	Pellet	Truck	0.12	600 lb
Soda Ash (Na_2CO_3)	1) Water Treatment 2) pH Modifier	Granular	Railcar	265	309 tons
Sulfuric Acid	Water Treatment	Liquid	Truck (Tanker)	39	74.5 tons
Ferric Sulfate $Fe_2(SO_4)_3$	Water Treatment	Granular	Truck	7.5	80,000 lb

Note: This is a typical representation of the reagents for use in the flotation process and in the water treatment processes. The actual reagent use, consumption rate, and storage capacities could change depending upon final operating conditions.



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 1.4-11		SHEET 1 OF 1	REVISION NUMBER 2

Non-returnable reagent containers, such as bags, will be disposed in a licensed solid waste facility. Fiber drums are returnable and reusable.

1.4.3.8 Ventilation

Buildings will have permanently installed heating and ventilation equipment. Portable heaters will be provided as necessary during cold weather when repairs are being made in areas not normally heated.

1.4.3.9 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.

1.4.3.10 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 respective 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 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 occur only when the reagents are being 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.

1.4.4 Mine Waste Disposal Operations

1.4.4.1 Waste Rock Disposal

Waste rock will be produced during the development and operation of the Project as described in subsection 1.2.3.2. 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.

During the early high rock production years, rock hauling will extend over one shift; however, throughout most of the Project life waste rock hauling will be necessary only a few hours per day.

Some of the waste rock will be hauled to the MWDF area where it will be used as rip-rap in slope protection for the reclaim pond and tailing ponds.

During operations, approximately 200,000 tons of waste rock will be generated from the underground on an annual basis. Of this amount, approximately 50 percent will be hoisted to the surface. The material hoisted to the surface will be crushed in the backfill system and reintroduced into the mine with the coarse tailing to fill mined out stopes.

1.4.4.2 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 operations discussed in this subsection cover only that part of the transport systems between the tailing thickener and water tanks in the mine/mill site and the interface point at the northwest corner of pond T1 in the MWDF area.

The routing of the tailing and water lines and the waste rock haul road, which share the same corridor, is shown on Figure 1.2-27. Operation of the thickener and the transport systems within the waste disposal area is described in subsections 1.4.3.5 and 1.4.4.3, respectively.

The transport systems will be designed with the objective of obtaining reliable and trouble-free performance throughout the operating life. The systems will be designed for continuous operation at the flows, velocities, and pressures shown in Table 1.4-5.

All pumps will be located at either 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.

Spare plastic pipe will be stored on-site so that it is available for repairs when required. Repairs to HDPE pipelines are expected to be needed infrequently and the pipeline life in slurry service is expected to be longer than would be anticipated for pipelines

TABLE 1.4-5

TAILING SLURRY/RECLAIM WATER TRANSPORT SYSTEMS DATA

	FLOW* (gpm)	VELOCITY (fps)	PRESSURE* (psi)
Tailing Slurry (Thickener Underflow) and Water Treatment Sludge	545	5.4	95
Thickener Overflow Water to Reclaim Pond	2800	5.6	25
Reclaimed Water to Mine/Mill	2850	6.2	95

*Rounded to nearest 5.

constructed of alternative materials. For water service, the life of HDPE pipe is expected to be longer than would be expected for carbon steel pipe.

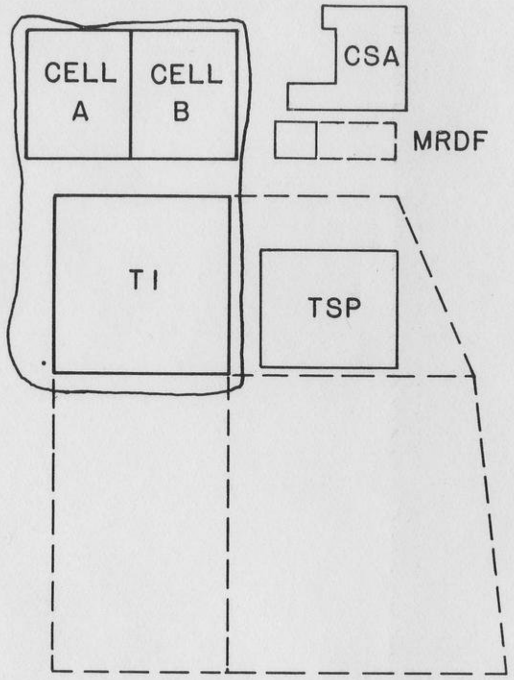
1.4.4.3 Mine Waste Disposal Ponds

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 as shown on Figure 1.4-12. 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.

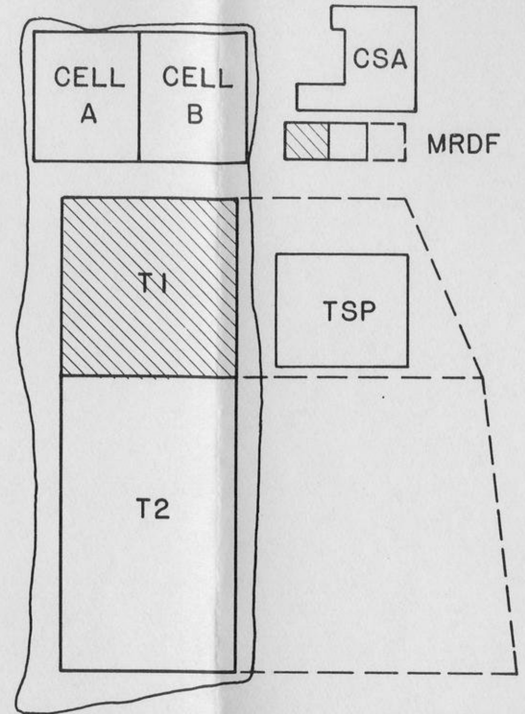
Tailing Discharge - At full production approximately 3,000 tons per day of tailing will be produced and disposed at the MWDF. Tailing will be transported to the MWDF in a water based slurry at approximately 55 percent solids by weight. Slurry flow will be at an approximate rate of 555 gallons per minute. The tailing slurry will be deposited from one side of an operating pond (Figure 1.2-25). 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

PHASE 1 - YEARS 1-4



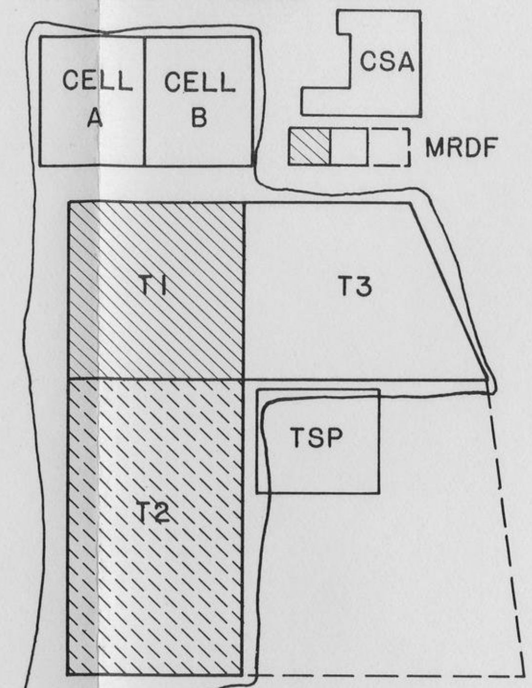
CONSTRUCTION OF TAILING POND T1, WATER RECLAIM POND, MRDF CELL 1 & CSA

PHASE 2 - YEARS 5-11



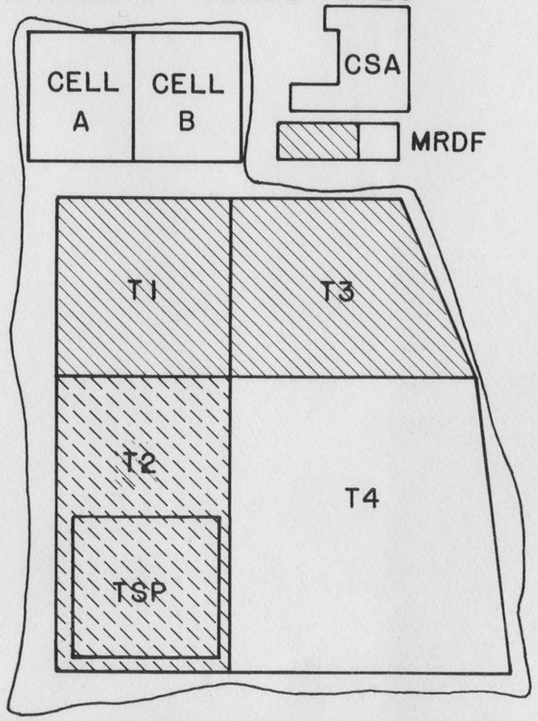
CONSTRUCTION OF TAILING POND T2 & MRDF CELL 2
RECLAMATION OF TAILING POND T1 & MRDF CELL 1

PHASE 3 - YEARS 12-16



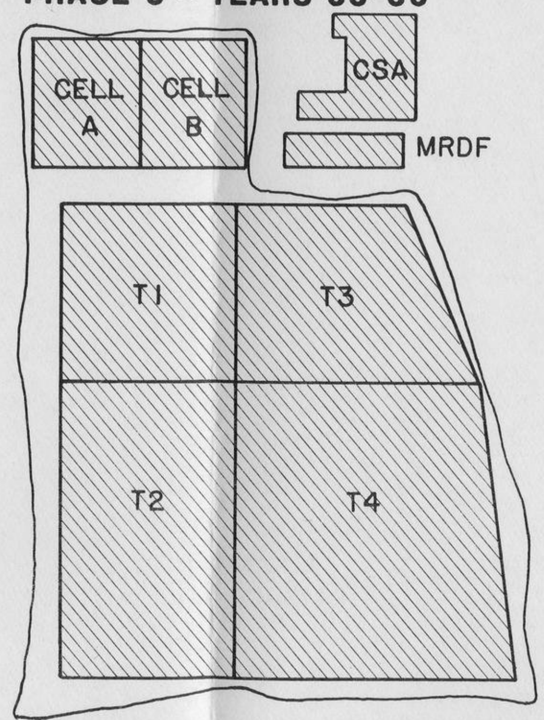
CONSTRUCTION OF TAILING POND T3
PARTIAL RECLAMATION OF TAILING POND T2

PHASE 4 - YEARS 19-23



CONSTRUCTION OF TAILING POND T4 & MRDF CELL 3
RECLAMATION OF TAILING POND T3 & MRDF CELL 2

PHASE 5 - YEARS 33-36



RECLAMATION OF TAILING POND T2 & T4, WATER RECLAIM POND, MRDF CELL 3 & CSA

LEGEND:
CSA – CONSTRUCTION SUPPORT AREA
TSP – TILL STOCKPILE
MRDF – MINE REFUSE DISPOSAL FACILITY

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL AREA FACILITIES CONSTRUCTION & RECLAMATION PHASES

SCALE NONE	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.E. Moe	DATE 11/19/85
DRAWING NO **FIGURE 1.4-12**		SHEET ____ OF ____	REVISION NO

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.

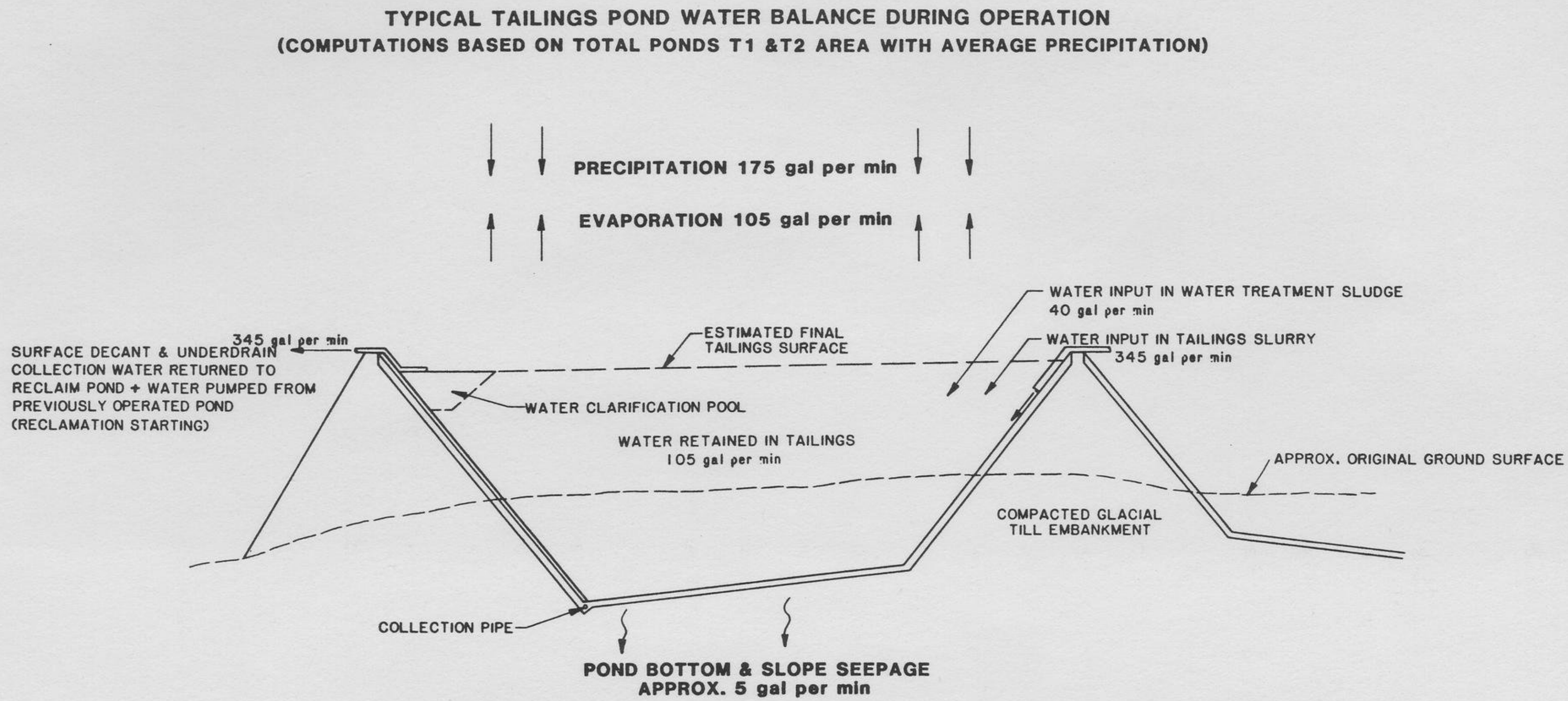
The development of the pond water pool is dependent on the permeability of the exposed filter area on the embankment slope and the rate of decant pumping. The estimated pond water depth of 20 feet is consistent with the permeabilities anticipated and the decant water pumping rates planned.

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. Figure 1.4-13 shows the approximate balanced water flows for a typical pond during a normal year.

The decant water system and the seepage control system are illustrated on Figures 1.2-27 and 1.2-28. 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. The complete network of piping at the MWDF area is shown on Figure 1.2-25. 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. These pumps will be electric, in the 25-50 horsepower range and will produce minimal noise.

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.

A ground water monitoring program for the MWDF is presented in the Mining Permit Application.



NOTE:

PRECIPITATION – 30.77 in/YEAR

EVAPORATION – 22.36 in/YEAR
OVER 80% OF POND AREA

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY CRANDON PROJECT					
TITLE: WASTE DISPOSAL FACILITY TYPICAL TAILINGS POND WATER BALANCE					
SCALE: NONE	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: [illegible]		DATE: [illegible]	
DRAWING NO: FIGURE 1.4-13			SHEET ___ OF ___		REVISION NO

1.4.5 Water Treatment

1.4.5.1 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 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 freeboard capacity in the pond will allow for storage of water from the following events:

1) 100-year, 24-hour storm and wave runup;

2) Probable maximum precipitation (PMP) for 6 hours including volume of water that would be collected on the tailing pond; and

3) Mine water, assuming 1,385 gallons per minute of water are pumped from the mine, could be pumped to the reclaim pond for about 26 days and use up only 75 percent of the total freeboard.

All of these events can be accommodated singularly but not simultaneously.

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/1
Decant and Underdrain Water from Tailing Pond	Trace to 100 mg/1

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. The settled sludge will occupy 16 percent of the total normal operating volume and will occupy a depth of 2.8 feet if divided evenly between the two cells.

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

If the settled solids had to be removed from the reclaim pond, suitable methods are available that would not damage the pond liner nor interrupt operation of the pond. A small floating suction dredge with depth control on the suction head could be used. In practice, a small depth of settled solids (1.0 foot) would not be removed in order to maintain an additional layer over the liner. If the estimated 140,000 cubic yards of settled solids were distributed evenly over the final tailing surface of pond T4, the depth of sludge would be approximately 1.2 feet. Since there are no crucial timing constraints on reclamation of pond T4, there will be ample time for proper management of the sludge through drying or blending with tailing 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.

Retention of water in the reclaim pond will promote the oxidation of thiosulfate and other polythionate compounds to sulfate. During warm weather, this process will occur rapidly but will slow down in the winter months. The concentrations of these compounds will generally be reduced by about 90 percent in summer and 10 percent in winter. Lime will be added to the water where it flows from cell B to cell A to neutralize the acid formed as a result of thiosulfate oxidation.

The cells in the reclaim pond are intended to promote oxidation processes and were designed for a normal operating depth of 21 feet or less. Therefore, it is unlikely that the deeper portions of the ponds will become anaerobic. However, in the unlikely event that an anaerobic condition does exist and hydrogen sulfide is generated at depth, it would not reach the surface of the pond because it would be oxidized to thiosulfate by other polythionates. The unlikely presence of trace concentrations of hydrogen sulfide in water from the reclaim pond would not be detrimental to either the water treatment plant or the milling process.

Most of the cyanide added in the mill process will exist in the form of an insoluble complex of ferric ferrocyanide precipitate on pyrite in the tailing ponds and in backfilled stopes. The total cyanide concentration of water entering the reclaim pond is estimated to be about 0.10 mg/l and the final reclaim pond effluent is expected to contain 0.02 mg/l. Most of this cyanide will exist as complex ions rather than the toxic, free cyanide ion form. Factors causing natural degradation of cyanide include photodecomposition by sunlight, acidification, oxidation by oxygen in the air, and biological action. Cyanide will be converted to hydrocyanic acid which will evaporate. When more complete oxidation occurs, carbon dioxide, and ammonia (NH_3) will be formed. These processes will continue in the winter especially in open areas of the pond.

Organic compounds will be present in the water from the collectors and frothers used in the flotation process. These concentrations are expected to range from less than 1 mg/l to between 10 and 20 mg/l depending on the compound in question. Natural processes of evaporation and oxidation will reduce the concentrations of these compounds by 90 percent or more; these processes will continue throughout the year. This estimate is based on data from other operations.

Reclaim pond treatment efficiency will be reduced during winter conditions. This will primarily be reflected in a decrease in the pond's ability to allow oxidation of thiosulfate and other polythionates to sulfate. However, this also is accounted for in the design of the mill water treatment system and will not reduce the plant's capability to sufficiently treat the process water. Water will be pumped from the reclaim pond to the mill facilities via a pipeline system as described in subsection 1.4.4.2. The water will be transported to the reclaim water tank for distribution to the plant water tank and the water treatment plant.

1.4.5.2 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;

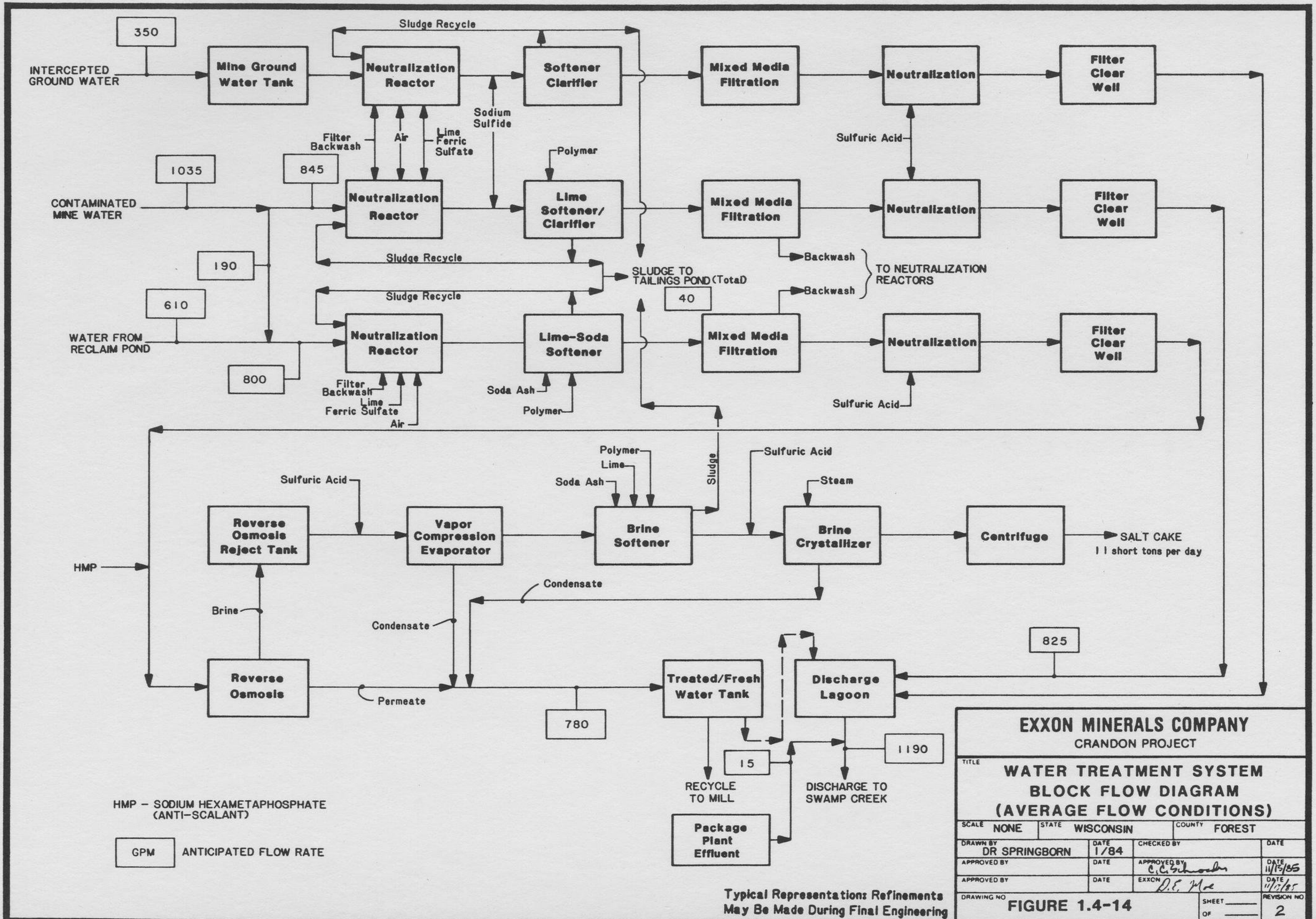
2) Provide removal of scale-forming compounds to permit recycle water use in the mill;

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 1.4-14. The equipment needed for lime precipitation, sulfide precipitation and filtration is the same as is needed for either lime



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 11/13/85
APPROVED BY / DATE	EXXON D.E. Moe	DATE 11/13/85
DRAWING NO FIGURE 1.4-14	SHEET ___ OF ___	REVISION NO 2

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 precipitation and filtration. Therefore, the water plant will have the flexibility to handle even a scenario in which no ground water interruption is undertaken in the mine.

The unit processes and corresponding functions in the lime precipitation, sulfide precipitation and filtration for treating contaminated mine water and intercepted ground water respectively are described in subsection 1.2.4.11. As previously explained, the equipment needed for the two circuits is the same, the difference is only in the amount of lime needed to effect treatment. The unit processes and corresponding functions for the recycle water treatment system are also described in subsection 1.2.4.11.

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)
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

Contaminated mine water will be pumped to a holding tank and then to the treatment plant. The proportion of this water that is treated for discharge or recycle will be controlled using flow control valves. Water from the reclaim pond will be pumped to the reclaim water tank from which about 82 percent of the flow will be directed to the mill water tank and the remainder will be sent to the water treatment system for recycle.

In the event of a short-term shutdown of the contaminated mine 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 overflow from the contaminated mine water tank to flow 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.

Ground water collected in the interceptor system is expected to be pumped from the mine at an average of 350 gallons per minute and sent to the mine ground water tank. Water from this tank will normally be treated, as needed, by lime neutralization, sulfide precipitation and filtration and will be monitored for flow, conductivity, turbidity, and pH before being sent to the excess discharge lagoon. A composite sampler will also be installed to collect flow-proportional samples to be used for chemical analyses. Provision will be made to allow this water to be used in the mill (untreated) if it is required, thus reducing the dependency on another well to provide process make-up water.

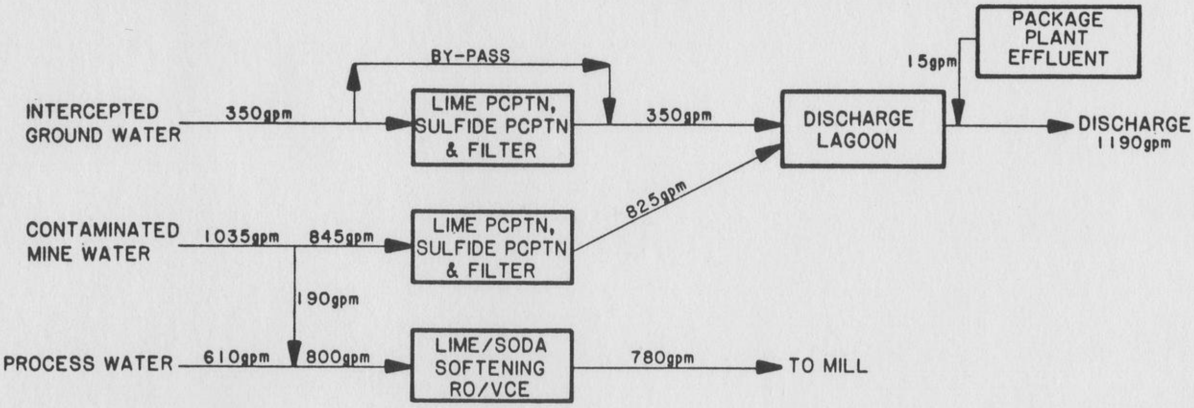
Treated mine water and treated ground water will be sent to the discharge lagoons to be located immediately east of the tailing thickener. The lagoon system is sized for a total water retention time of 48 hours under average flows. Discharge from the lagoons will be pumped via pipeline to the discharge point at Swamp Creek.

The normal mode of operation is shown on Figure 1.4-15 as the "Base Case." Also shown on Figure 1.4-15 are two operating alternatives.

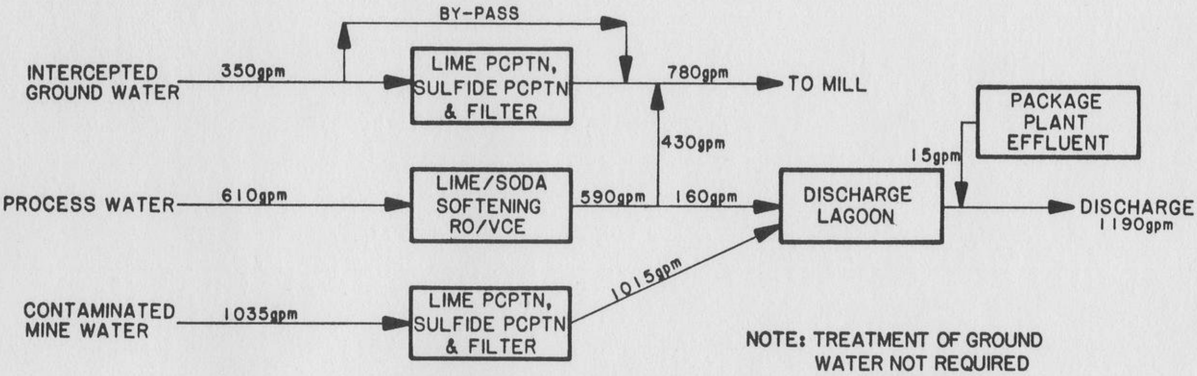
Alternative A depicts a mode of operation whereby process water treated by lime/soda softening, reverse osmosis and vapor compression evaporation is discharged with treated contaminated mine water. This mode of operation demonstrates the flexibility that will be designed into the system.

Alternative B shows a mode of operation whereby the mill make-up water is a mixture of intercepted ground water and treated reclaim water. This mode of operation also demonstrates 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 it was assumed that the mill would continue to operate

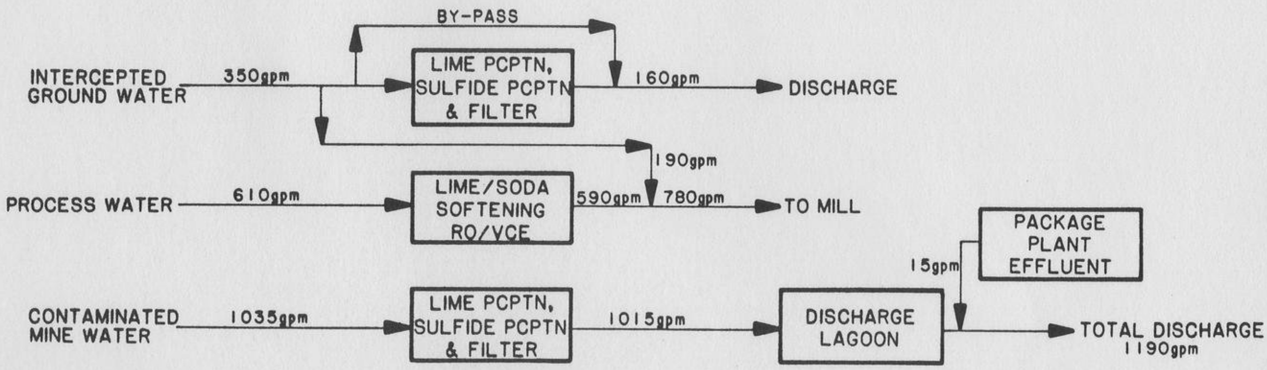


BASE CASE



NOTE: TREATMENT OF GROUND WATER NOT REQUIRED WHEN USED IN MILL.

OPERATING ALTERNATIVE A



OPERATING ALTERNATIVE B

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY

CRANDON PROJECT

TITLE

WATER MANAGEMENT & TREATMENT OPERATING ALTERNATIVES (AVERAGE FLOW CONDITIONS)

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY DR SPRINGBORN	DATE 8/85	CHECKED BY		DATE	
APPROVED BY	DATE	APPROVED BY C.C. Schroeder		DATE 11/13/85	
APPROVED BY	DATE	EXXON [illegible]		DATE 11/13/85	
DRAWING NO FIGURE 1.4-15		SHEET ___ OF ___		REVISION NO	

at its normal capacity. The calculation of the amount of time water can be pumped to the reclaim pond is as follows:

		Gallons Per Minute
Contaminated Water from Mine		1,035
Intercepted Ground Water		350
	Total	1,385
Available Freeboard Volume in Reclaim Pond (75% of Total)		51,500,000 gallons

$$\frac{51{,}500{,}000 \text{ gallons}}{1{,}385 \text{ gallons/minute}} = 37{,}200 \text{ minutes or } 26 \text{ days}$$

(Reclaim Pond Retention Time)

The following chemicals will be used in the water treatment processes:

	Intercepted Ground Water (lb/d)	Contaminated Mine Water (lb/d)	Process Water (lb/d)
Lime (90% CaO)	210	660	320
Soda Ash (as 98% Na_2CO_3)	Ø	Ø	12,100
Sulfuric Acid (as 93% H_2SO_4)	400	1,240	1,310
Ferric Sulfate*	80	200	200
Flocculant	20	50	50
Sodium Hexa-metaphosphate	Ø	Ø	100
Sodium Sulfide	5	10	Ø
Cleaning Solutions**		980 gallons/month	

*Will only be used if needed.

**Cleaning solutions for the reverse osmosis will also be used and are discussed in subsection 1.4.5.4.

Lime will be used to raise the pH of the influent water in all the treatment processes and to precipitate dissolved metals as metal-hydroxide precipitates. Sodium sulfide will be used as an additional precipitating agent for metals in the treatment of contaminated mine water and intercepted ground water. Soda ash (sodium carbonate) will be used in the treatment of process water to precipitate dissolved calcium as calcium carbonate. Sulfuric acid will be used to lower the pH of the lime-treated mine water and ground water prior to discharge and to control the pH of water going to the reverse osmosis, vapor compression evaporation, and crystallization unit operations in the treatment of process water. An allowance has been made for the use of ferric sulfate as a coagulant in the reactor/clarifers. This is a commonly used coagulant in many water treatment plants; however, the requirement for use of ferric sulfate for the Project will not be known until the plant is in operation. A flocculant will be used to ensure that the precipitates in the reactor clarifiers will settle faster and ensure a clear overflow from the vessels. Sodium hexametaphosphate will be used as a scale inhibitor in the reverse osmosis process. Allowance has also been made to add activated carbon to the reactor/clarifiers if any organic material must be removed at that point.

1.4.5.3 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.

As stated previously, treated mine water will be sent to the excess discharge lagoons and then pumped via pipeline to the discharge point adjacent to Swamp Creek downstream from County Trunk Highway M.

Treatment systems will be provided with continuous 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 for the facilities. The concentrations of contaminants in the water to be discharged will meet the effluent limitations to be determined by the DNR.

The quality of recycled or discharged water will not fluctuate greatly. The unit processes selected for the proposed treatment system are designed to provide uniform and consistently high removal of contaminants.

1.4.5.4 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 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 one cell of the reclaim pond. The water treatment facility will be operated to ensure that it will perform as designed, but it is expected that water will not have to be routinely treated for discharge. The sludge, which will be produced from either water treatment plant shake-down testing or treatment of water for discharge, will be permanently 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). It will be produced at an estimated rate in the range of 0 to 11 tons per day. This material could potentially be marketed for use in Kraft pulp and paper mills. Subsection 1.2.3.5 contains a description of the estimated consumption of salt cake by Kraft pulp mills in Wisconsin and in the states of Minnesota and Michigan and the Canadian provinces of Manitoba and Ontario.

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	Concentration In Solution
1	Citric Acid	0.17 lb/gal
	Liquid Nonionic Detergent	0.0045 qt/gal
	Ammonium Hydroxide	Adjust to pH 4.0
2	Sodium Tripolyphosphate	0.17 lb/gal
	Sodium - EDTA	0.07 lb/gal
	Liquid Nonionic Detergent	0.0043 qt/gal
	Sulfuric Acid	Adjust to pH 7.5
3	Liquid Nonionic Detergent	0.0043 qt/gal
	Sodium Perborate	0.0415 lb/gal
	Sulfuric Acid	Adjust to pH 8.0

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.

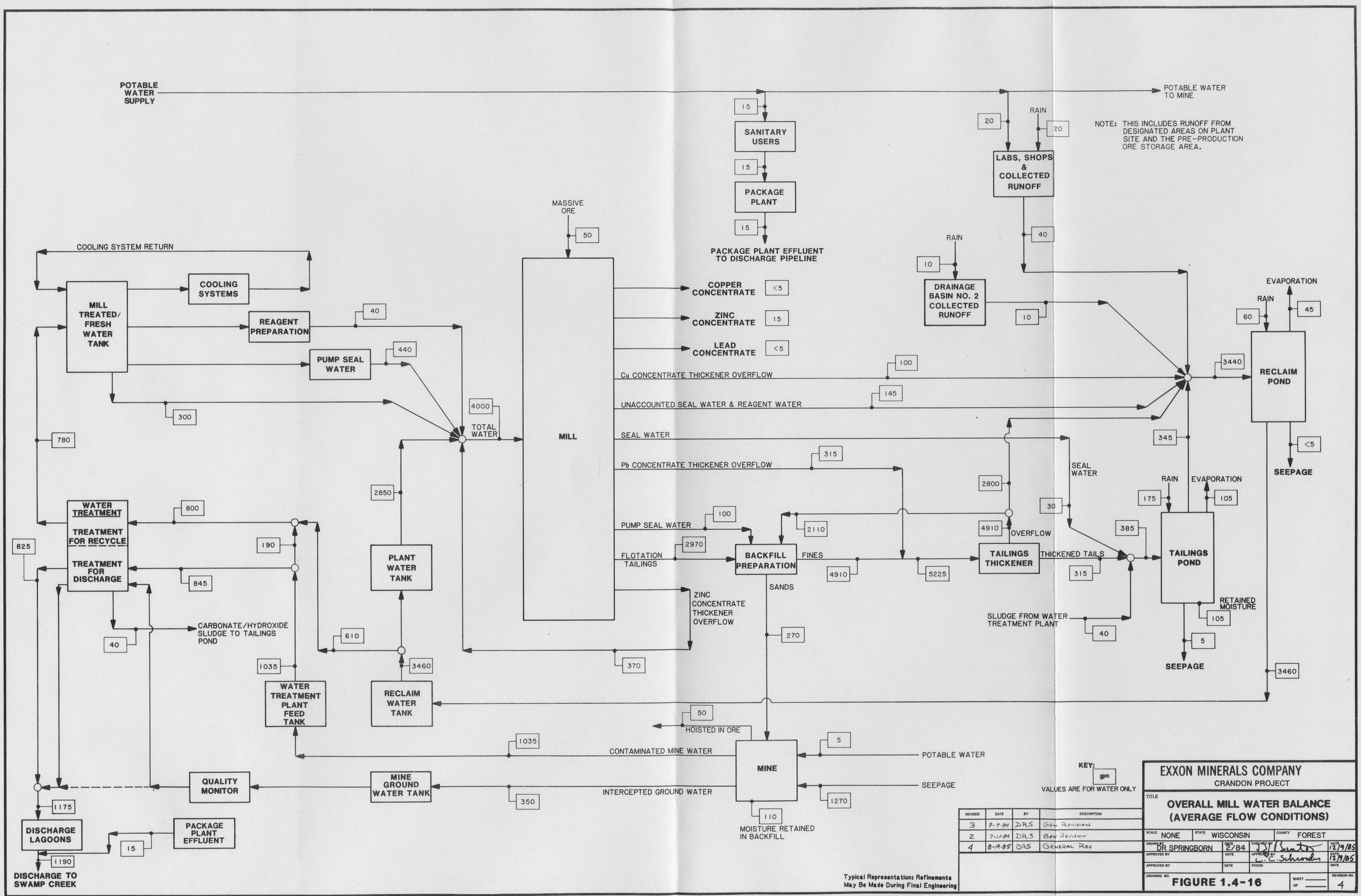
1.4.6 Overall Water Balance

A water balance for mill operations is shown on Figure 1.4-16. 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 average 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 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 package 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



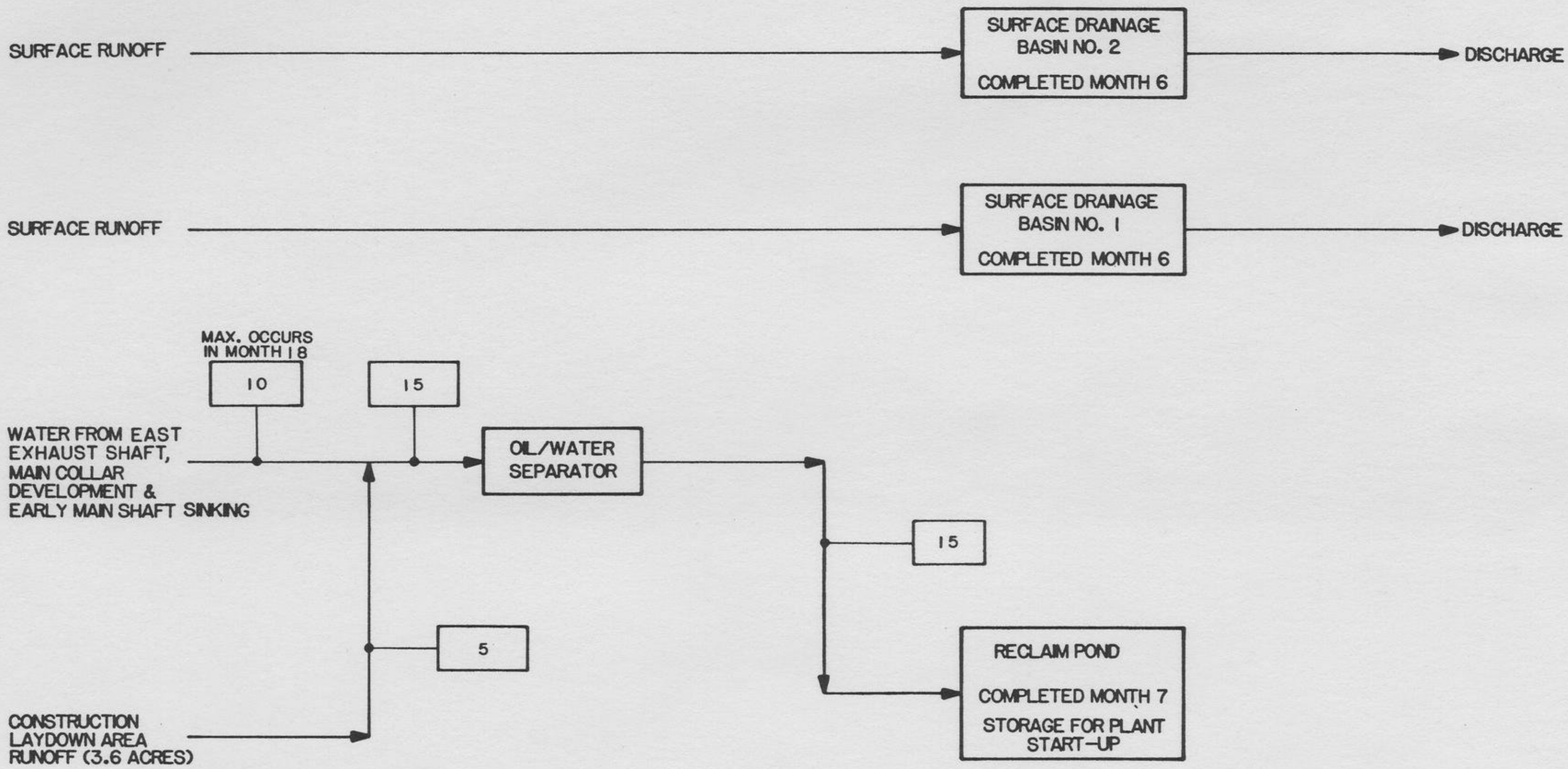
POTABLE WATER SUPPLY
POTABLE WATER TO MINE
NOTE: THIS INCLUDES RUNOFF FROM DESIGNATED AREAS ON PLANT SITE AND THE PRE-PRODUCTION ORE STORAGE AREA.
15
SANITARY USERS
15
PACKAGE PLANT
15
PACKAGE PLANT EFFLUENT TO DISCHARGE PIPELINE
20
RAIN
20
LABS, SHOPS & COLLECTED RUNOFF
40
RAIN
10
DRAINAGE BASIN NO. 2 COLLECTED RUNOFF
10
EVAPORATION
RAIN
60
45
RECLAIM POND
3440
345
<5
SEEPAGE
MASSIVE ORE
50
MILL
COOLING SYSTEM RETURN
MILL TREATED/ FRESH WATER TANK
COOLING SYSTEMS
REAGENT PREPARATION
40
PUMP SEAL WATER
440
300
4000
TOTAL WATER
780
COPPER CONCENTRATE
<5
ZINC CONCENTRATE
15
LEAD CONCENTRATE
<5
Cu CONCENTRATE THICKENER OVERFLOW
100
UNACCOUNTED SEAL WATER & REAGENT WATER
145
SEAL WATER
Pb CONCENTRATE THICKENER OVERFLOW
315
2800
SEAL WATER
30
PUMP SEAL WATER
100
2110
4910
OVERFLOW
FLOTATION TAILINGS
2970
BACKFILL PREPARATION
FINES
4910
5225
TAILINGS THICKENER
THICKENED TAILS
315
385
RAIN
175
EVAPORATION
105
TAILINGS POND
RETAINED MOISTURE
105
5
SEEPAGE
SLUDGE FROM WATER TREATMENT PLANT
40
ZINC CONCENTRATE THICKENER OVERFLOW
SANDS
270
370
3460
2850
PLANT WATER TANK
610
3460
RECLAIM WATER TANK
WATER TREATMENT
TREATMENT FOR RECYCLE
TREATMENT FOR DISCHARGE
800
190
845
825
CARBONATE/HYDROXIDE SLUDGE TO TAILINGS POND
40
1035
WATER TREATMENT PLANT FEED TANK
50
HOISTED IN ORE
1035
CONTAMINATED MINE WATER
MINE
5
POTABLE WATER
SEEPAGE
1270
INTERCEPTED GROUND WATER
350
MINE GROUND WATER TANK
QUALITY MONITOR
110
MOISTURE RETAINED IN BACKFILL
1175
DISCHARGE LAGOONS
PACKAGE PLANT EFFLUENT
15
1190
DISCHARGE TO SWAMP CREEK
KEY: gpm
VALUES ARE FOR WATER ONLY
Typical Representation: Refinements May Be Made During Final Engineering
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
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE OVERALL MILL WATER BALANCE (AVERAGE FLOW CONDITIONS)
SCALE NONE
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
2/84
DATE 12/9/85
DATE 12/9/85
DRAWING NO.
REVISION NO. 4
DESIGN PRODUCTS CO.

FIGURE 1.4-16

These assumptions include 1,200 gallons per minute as the maximum flow rate of intercepted ground water. Contaminated mine water includes 1,200 gallons per minute and also 165 gallons per minute of backfill drainage (and some excess potable water). These flow rates are based on a mine inflow of 2,000 gallons per minute with an additional 20 percent contingency. An allowance was made to keep treating some water from the reclaim pond with the assumption that it would all be discharged (i.e., the mill is not operating and recycle is not needed). Under this unlikely set of assumed circumstances, the maximum discharge volume is estimated to be 3,000 gallons per minute.

Water balances for construction, start-up, and Project closure cannot be accurately shown because they represent periods when conditions will change continuously. Figures 1.4-17 and 1.4-18 show conceptually how water will be handled during two distinct phases in construction.

Figure 1.4-17 shows how water will be handled during the first 18 months of construction. Surface drainage basins No. 1 and 2 will both 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 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 3.6-acre area designated "Construction Laydown Area." There is potential for oil



LEGEND:

GPM

NOTE: AVERAGE FLOWS ROUNDED TO THE NEAREST 5 GPM

Typical Representation : Refinements May Be Made During Final Engineering

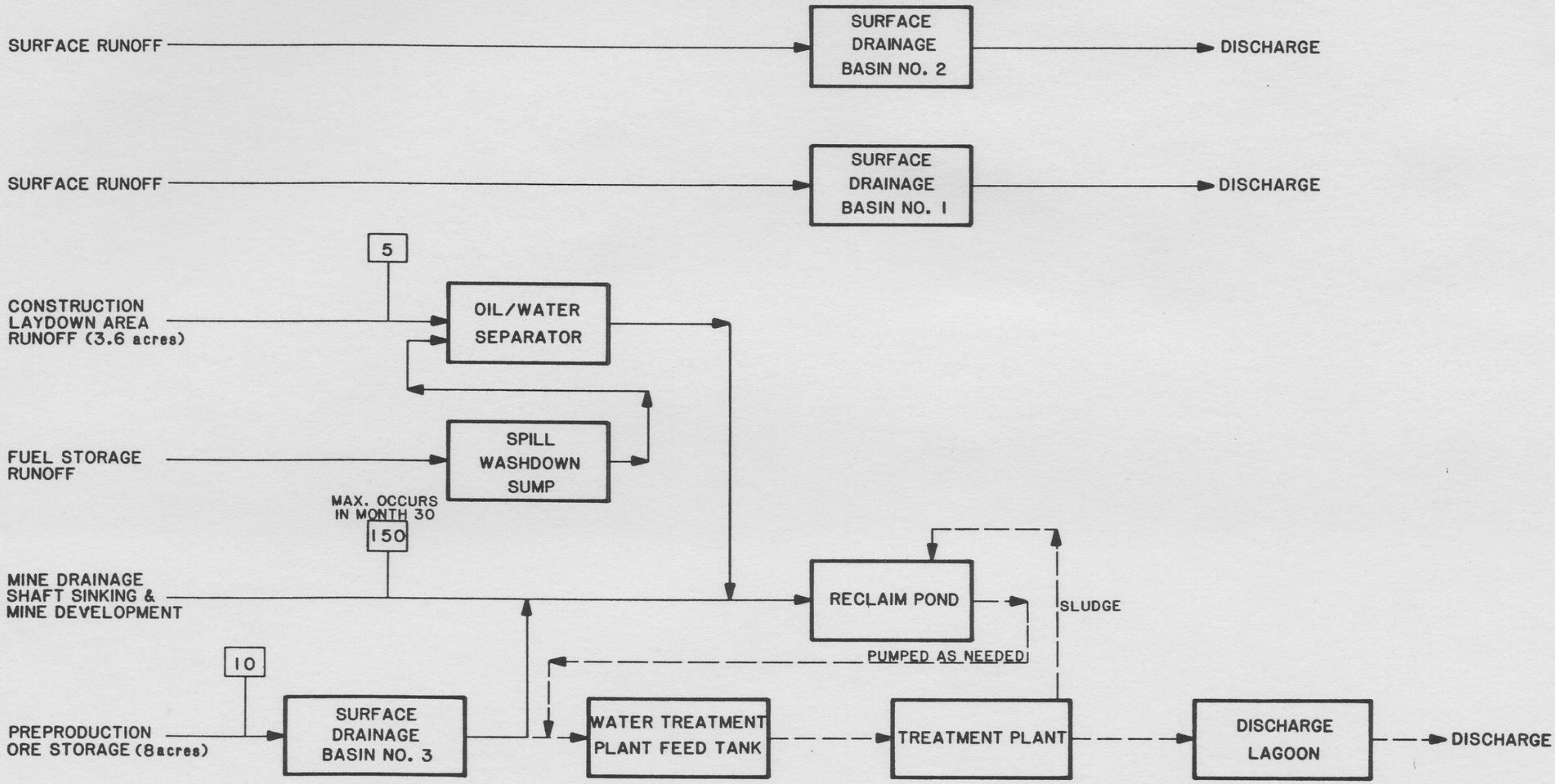
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **WATER MANAGEMENT CONSTRUCTION MONTHS 1 - 18**

SCALE NONE	STATE WISCONSIN	COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 3/84	CHECKED BY
APPROVED BY	DATE	APPROVED BY C.C. Schroeder
APPROVED BY	DATE	EXXON

DRAWING NO **FIGURE 1.4-17**

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 CONSTRUCTION MONTHS 19 - 30

SCALE NONE	STATE WISCONSIN	COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 9/85	CHECKED BY / DATE
APPROVED BY / DATE	APPROVED BY C.C. Schroeder	DATE 11/13/85
APPROVED BY / DATE	EXXON D.F. [illegible]	DATE 11/1?/85
DRAWING NO FIGURE 1.4-18	SHEET ___ OF ___	REVISION NO.

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. Cell A of the reclaim pond will be completed during month 4. Water from the oil/water separator will be diverted to this pond upon its completion.

Figure 1.4-18 shows how water will be handled during construction 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 in subsection 1.4.5.4, it is expected that all of the mine drainage from month 18 to 30 can be stored in one cell of 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.

The mill is currently expected to start processing ore during month 30 after the start of construction. During the development of the water management system for the Project, consideration was given to determining if water management practices and water treatment requirements during mill start-up would be significantly different than for operation of the Project at normal capacity. The results of this work and other subsequent Project engineering studies indicated that water management practices and water treatment requirements, particularly for water discharge, will be nearly the same during mill start-up and mature operations.

However, 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 becomes 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 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.

1.4.7 Operations Traffic

Estimates for operations traffic associated with the Project were based on employee vehicle volume, delivery truck traffic to the site, surface vehicles involved in routine daily activities necessary for the operation of the Project, and railroad deliveries of bulk raw materials to the site and routine pickup of outbound concentrates.

Personal vehicles represent the largest volume of operations traffic. Assuming an occupancy rate of 1.6 persons per vehicle, using projected manpower requirements in subsection 1.4.10, an average attendance of 90 percent, allowing approximately 10 percent contingency for visitors, salesmen, and other miscellaneous traffic, and rounding to the nearest 10, the number of vehicles associated with each shift will be:

Shift	Vehicles	Delivery Trucks
Day	160	5
Afternoon	80	1
Night	80	-
TOTAL	320	6

Based on projected personnel residence locations from the socioeconomic studies, the total vehicle travel will be approximately 22,000 miles per day.

Project traffic from southern points of origin will comprise about 30 percent of the total average daily traffic. The number of delivery trucks from the south will increase truck traffic on State Highway 55 south of the intersection with the access road by approximately 11 percent during Project operations. Traffic from northern points of origin will average about 70 percent of the total average daily traffic during the life of the operation. Truck traffic on State Highway 55 north of the intersection with the access road for delivery services will increase by approximately 4 percent during operations. The trucks to and from the site will consist of panel trucks for small supplies, semi-flatbeds and closed trailers for large supplies, dump trucks for various wastes, and tank trucks for fuel hauling and concrete mixers. Truck traffic anticipated during operations is presented in Table 1.4-6.

In addition to those vehicles providing employee and visitor transportation and delivery of supplies, the following vehicles will be utilized in the daily operation of surface facilities, including the waste disposal areas:

No.	Item	Primary Function
1	Grader	Road Maintenance
1	Water Truck (1500 gal.)	Road Maintenance/Dust Control
1	Front End Loader (5 yard)	Maintenance
2	Front End Loaders (1.5 yard)	Maintenance and Material Handling
1	Dozer (D-7)	Construction and Maintenance
1	Backhoe (Rubber-tired)	Maintenance
3	End Dump Trucks (35 ton)	Waste Rock Haulage
1	Crane (60 ton)	Material Handling
1	Crane (10 ton hydraulic)	Material Handling
1	Semi Tractor/Lo-boy Trailer	Equipment Handling
4	Fork Lifts	Material Handling
2	Trucks (5 ton)	Supply and Maintenance
2	Trucks (3 ton)	Supply and Maintenance
20	Trucks (1/2 and 3/4 ton pickups)	Personnel and Supply Movement
1	Fire Truck	Emergency Use Only
1	Ambulance/Rescue Vehicle	Emergency Use Only
1	Tractor/Mower	Grounds Maintenance

Note: This list is intended to demonstrate the type and quantity of equipment required to perform the process and activities described herein. The actual type and quantity of equipment used will vary to some extent, depending upon need and availability.

TABLE 1.4-6

OPERATIONS TRUCK TRAFFIC

	Item	Nominal Trucks per day	Actual Frequency	Truck
1)	Mill balls @ 1.9 lb short ton ore = 14,000 lb/day	0.40 trucks/day	1 truck/2 days	Semi/Flatbed Trailer
2)	Liners @ 65,000 lb/month	0.07 trucks/day	2 trucks/month	Semi/Flatbed Trailer
3)	Explosives @ 5,000 lb/day	0.15 trucks/day	1 truck/week	Semi/Closed Trailer
4)	Fuel oil 1,050,000 gal/year	0.75 trucks/day	1 truck/day	Tanker
5)	Gasoline 33,000 gal/year	0.02 trucks/day	1 truck/2 months	Tanker
6)	Sodium sulfate (remove from site) @ 11 tons/day (Maximum)	0.32 trucks/day	1 truck/3 days	Dump
7)	All process reagents and water treatment supplies that will be delivered by truck	0.45 trucks/day	1 truck/2 days	Tankers Flatbed/ Closed Trailer
8)	Operating supplies, drill steel, rock bolts, tires, timber, etc.	0.40 trucks/day	1 truck/2 days	Flatbed Closed/ Trailer
9)	Scrap metal, rubber (remove from site)	0.02 trucks/day	1 truck/2 months	Dump
10)	Waste oil, hydraulic fluid (remove from site)	0.02 trucks/day	1 truck/2 months	Flatbed
11)	Replacement equipment and machinery parts	0.40 trucks/day	1 truck/2 days	Flatbed
12)	Sanitary sludge (remove from site)	0.03 trucks/day	1 truck/2 months	Tanker
13)	Office supplies	0.40 trucks/day	1 truck/2 days	Panel
14)	Food, drink, vendor supply	0.75 trucks/day	1 truck/day	Panel
15)	Concrete	0.75 trucks/day	1 truck/day	Mixer
	Average	4.93 trucks/day		

The frequency of use and the hours of operation for each of the above equipment items will depend on the operations schedule, delivery schedule for raw materials and movement of materials and supplies. Some vehicles such as waste rock haulage trucks will be operated daily, whereas others will be used occasionally.

Rail traffic into the mine/mill site will be controlled by a single diesel yard locomotive. Bulk raw materials will be transported to the site on a single-track spurline connecting with the Soo Line northeast of the mine/mill site. Delivery of the bulk raw materials and pickup of empty railcars will be at the rate of approximately 8 cars per week. Approximately 16 to 18 railcars per day of concentrates will be moved from the mine/mill site to the sidings each day of the week.

1.4.8 Ancillary Facilities

1.4.8.1 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.

1.4.8.2 Treatment of Sanitary Wastes

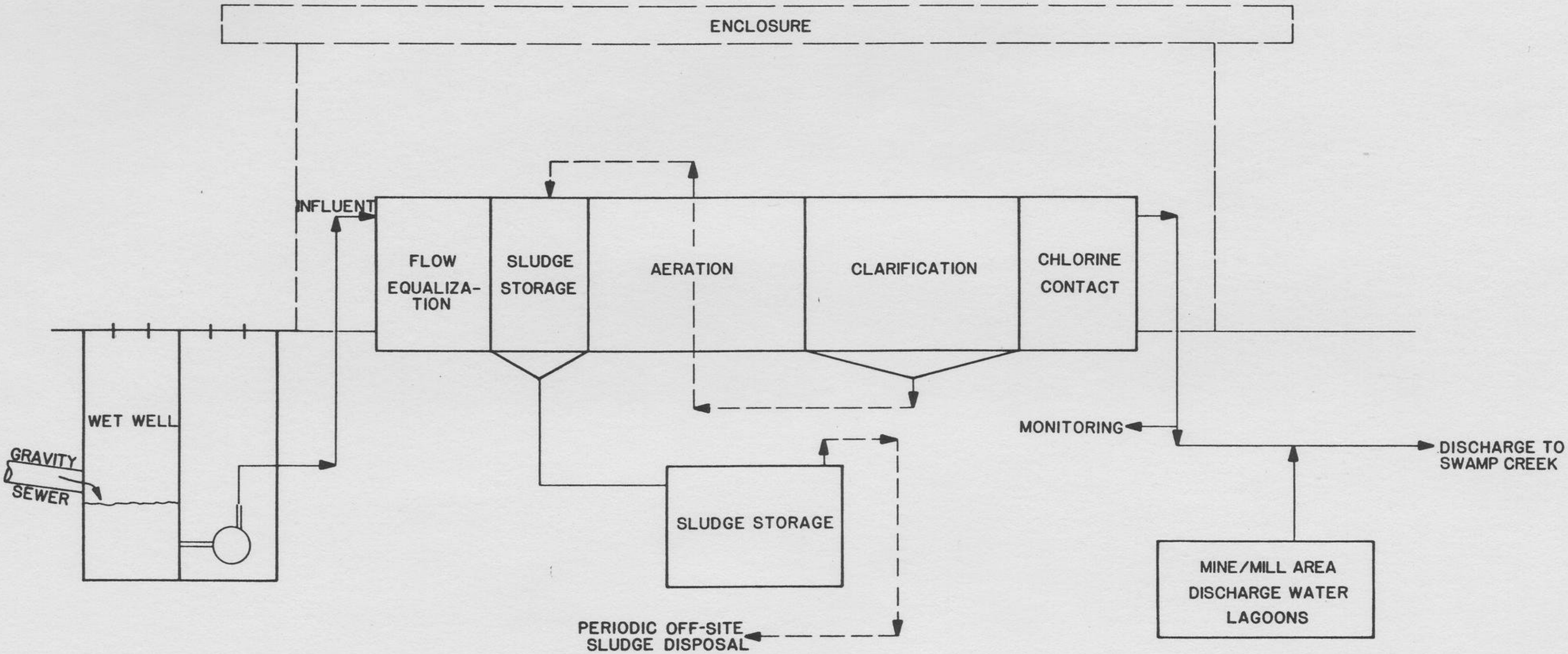
Waste Water Quantity - The average daily flow rate of sanitary waste water will be approximately 16 gallons per minute or a total daily estimated flow of 23,500 gallons. This estimate is based on 650 people with a waste generation rate of 35 gallons per day per person and a 750 gallon per day base flow allowance (DILHR Code). Assuming all worker showers (18 shower heads in the services building) in use at the same time and adding the average sanitary flow rate of 16 gallons per minute, the peak hourly sanitary waste water flow rate will be approximately 110 gallons per minute.

The sanitary waste treatment system will be designed to accommodate sanitary wastes from surface activities as well as wastes from the dry or chemical toilets used in the mine. The mine sanitation units will be serviced as demanded by local use frequency. Containerized waste will be transported to the surface in the mine cage for disposal in the plant septic system. The formaldehyde and perfume used in the chemical toilet control solutions will be in dilute concentrations compatible with the activated sludge treatment system.

Waste Water Quality - Per capita BOD and TSS contributions obtained from the literature are listed in Table 1.4-7. 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.

Treatment Plant - A general process diagram for the treatment plant system is presented on Figure 1.4-19. 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.



Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY

CRANDON PROJECT

TITLE

SANITARY WASTE TREATMENT PLANT SYSTEM

SCALE NONE	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 9/85	CHECKED BY		DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder		DATE 11/13/85
APPROVED BY	DATE	EXXON D E Moe		DATE
DRAWING NO FIGURE 1.4-19		SHEET ___ OF ___		REVISION NO

TABLE 1.4-7

SANITARY WASTEWATER QUALITY

TYPE OF SOURCE	BOD (lb/person/day)	TSS (lb/person/day)
Domestic[a]	0.09 - 0.15	0.09 - 0.15
Construction Camp - With Food Service[b]	0.15	--
Factories - With No Food Service[b]	0.07	--

[a]Barnes, D., and F. Wilson, 1976, The design and operation of small sewage works: Halsted Press.

[b]Parker, H. W., 1972, Wastewater systems engineering: Prentice-Hall, Inc.

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.

1.4.8.3 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 or production related equipment. Typically, this material will be collected in a specific location 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 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 mine refuse disposal facility (MRDF).

Refuse from Project facilities will be collected daily 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. Additional detail on the non-tailings mine waste is given in Appendix 1.3A.

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.

1.4.8.4 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. The estimated energy and fuel requirements are shown in Table 1.4-8.

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 Wisconsin Public Service Corporation (WPSC) from the power network serving the general area of the mine/mill. The source of this power will be located approximately 18 miles northwest of the mine/mill site, and a 115 kV transmission line will be constructed by WPSC from this source to the mine/mill site.

Lists of typical equipment for the mine and mill are presented in subsections 1.2.1.2.5 and 1.2.2, respectively. A summary of the average electrical power demand is shown below:

Operation		Average Demand kw
Mine		6,390
Mill		10,890
Water Treatment		1,900
Services Building		1,600
Miscellaneous Loads		350
	TOTAL	21,130

With an allowance for approximately 10 percent contingency, the projected average demand has been set at 23,250 kw.

TABLE 1.4-8

FUEL AND ENERGY REQUIREMENTS DURING OPERATION[a]

	ESTIMATED DAILY PEAK	ESTIMATED YEARLY AVERAGE
Diesel Fuel	3,950 gallons	1,343,000 gallons
Gasoline	125 gallons	33,000 gallons
Natural Gas - Winter	1,980,000 cubic feet	165,236,000 cubic feet
- Summer	256,000 cubic feet	
Electrical Power	26,700 kw[b]	176,000,000 kwh[b]

[a]The fuel and energy requirements for the Crandon Project as shown in this table are estimates. The actual quantities shown may change with actual type of equipment utilized, variances in operating schedules, and other factors.

[b]These values include a 10 percent contingency allowance.

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. The source of natural gas will be from a pipeline running generally east-west about 8 miles north of the mine/mill site. A gas pipeline extension will be constructed by the utility company from this source to the mine/mill site.

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 (see Figure 1.2-38).

1.4.9 Pollution Control, Emissions and Effluents

Potential air emissions, noise levels, and soil erosion will be controlled during the operation phase of the Project by using properly sized air pollution control equipment, process equipment selected with effective noise control characteristics, and retention basins for drainage/erosion control. Insertable collectors to control emissions from the surface mine/mill operations are specified where the captured material is fine and can be returned directly to the process. There are no dusts and sludges which will be nonrecyclable from the air pollution control equipment. All concentrates will be recovered for shipment and other dusts and sludges will be recycled to the process streams.

Air Emissions - The type of air emissions which will be the highest from Project operations will be total suspended particles (TSP) of various sizes. The operation phase estimated controlled total TSP emissions are below 245 tons per year (see Table 1.3-10). The highest estimated TSP emissions are expected to occur during operations when a new tailing pond is being developed. These TSP emissions are estimated to be highest in Year 20 of operations (see Table 1.3-10). The estimated TSP emission rates for Year 20 of operations were used in the air quality modeling analyses. These results are presented in detail in the Air Permit Application and are summarized in Chapter 4 of the EIR.

The underground facilities will produce emissions resulting from air heating, blasting, ore/rock handling, ore/rock crushing, and diesel equipment operation. Estimated air emissions produced from these processes are presented in detail in the Air Permit Application.

Ore handling and crushing, mine production activities, vehicle travel, and fuel transfer and storage constitute the air emission sources from surface facility operations. All potential air emission sources will have reliable and effective controls. A complete listing of operation activities, component emissions, control methods, and emission rates are also presented in the Air Permit Application.

To contain dust, conveyors used to transport ore and waste rock will operate inside covered galleries, and the ore will be stored until it is processed in the concentrator building. Material transfer points will be enclosed and exhausted through appropriately sized insertable collectors. This type of collector will not discharge to the outside environment and emissions will be virtually eliminated. Also, energy requirements for facility heating will be reduced because heated air within the buildings will not be exhausted outside.

Insertable collectors will be used to control dust emissions in the coarse ore handling and storage building, the waste rock crushing and processing facility (i.e., for use as backfill), transfer tower, storage bins, and lime facility in the concentrator. Dust collected by the insertable collectors will be returned directly to the process stream.

Flotation is a wet process and will not generate dust emissions. To minimize potential dust emissions from zinc, copper, and lead concentrate handling, water will be added in sufficient quantities to maintain the concentrate in a moist condition which will virtually eliminate emissions from concentrate loadout activities.

Transfer and storage of fuels will occur primarily at the 30,000-gallon bulk diesel storage facility and at the fueling station. A vapor balance system will be used during storage tank loading to minimize hydrocarbon emissions. This will consist of a product line and ventilation line connected between tank car or tank truck and the storage tanks. The ventilation lines will exhaust the hydrocarbon vapors from the tank vents to the tank car or tank truck.

Fugitive dust (i.e., TSP) emissions will be produced by operation of support equipment on facility roads (paved and unpaved). Emissions from unpaved roads will be controlled by watering and chemical stabilization. Also, emissions will occur from combustion of gasoline and diesel fuel. Emissions from these equipment sources will be maintained at low levels by proper maintenance.

Air emission control techniques that will be used during development of the initial tailing pond will be used in the construction of subsequent ponds during operation. All roadways and excavation sites will receive chemical stabilization as necessary to control dust emissions. To suppress blowing dust from vehicles hauling soil and construction material over long distances, such vehicles will be covered if required. Speed controls will reduce TSP emissions from the roads having haulage vehicle traffic. Minimizing drop distances will reduce TSP emissions during loading and dumping. Once land surface grades have been established on exposed soil, temporary vegetation will be planted for prompt soil stabilization and dust control; permanent vegetation will also be planted as appropriate.

To eliminate dust emissions associated with the concrete batch plant, the cement silo and cement weigh hopper will be supplied with insertable collectors. Pre-washed aggregate will be used by the plant, thus minimizing dust emissions. The aggregate loading and discharge points will be vented through ventilation hoods into a baghouse. Water will be added at the transit mix truck loading point to further minimize dust emissions. Similar controls will be used on the liner batch plant and soil processing plant at the MWDF.

Noise Emissions - Operation phase activity will be conducted 24 hours a day, 7 days per week. The evening and night periods are expected to produce less noise than the daytime because of reduced surface activity. However, for modeling purposes, all noise sources were assumed to occur continuously for 365 days per year.

Mine/mill surface facilities operation phase activities were estimated to produce noise emanations with associated A-weighted sound pressure levels as presented in Table 1.4-9. The equivalent sound pressure level (L_{eq}) for the mine/mill site was calculated to be 88.3 dB at 50 feet. The mine/mill site operations phase noise was assumed to occur centrally (MM3) from the area because of the general location of the permanent (i.e., stationary) sources (see Figure 4.2-6). Two other noise sources locations, the east and west exhaust raise fan stations (E1 and E2), were also included as finite noise sources (see Figure 4.2-6). Five simultaneously operating fans have been modeled: two at the west exhaust raise (WER) and three at the east exhaust raise (EER) (Table 1.4-9). Under actual operating conditions, only three fans will be noise sources at the east exhaust raise during the first 5 years of the operation phase, and two fans at the EER and WER thereafter. The

TABLE 1.4-9

TYPICAL MINE/MILL SITE OPERATION PHASE NOISE SOURCES

EQUIPMENT	SOUND LEVEL (dB)* at (50 feet)
Train/Concentrator	88
Transformer	72
Crusher	65
Batch Plant	67
Air Heater A	68
Air Heater B	68
Compressor	63
TOTAL Mine/Mill L_{eq} = 88.3 dB at 50 feet	
East Exhaust Raise Fans (3 units)	89
West Exhaust Raise Fans (2 units)	87

*A-weighted sound levels.

equivalent sound pressure level (L_{eq}) for a single fan was calculated to be 84 dB at 50 feet.

The MWDF (pond T2 construction) operation phase noise sources were assumed to be located at four perimeter areas (T3, T6, T7, T8) at the boundary and one central location (T4) (see Figure 4.2-6). As shown in Table 1.4-10, the equivalent sound pressure level for the MWDF (pond T2 construction) operation phase activity is 100 dB at 50 feet. Since no major noise emanations are associated with tailings disposal at pond T1, only the noise sources from construction activity of the other tailing ponds were included during the operation phase modeling for this area.

The access road operation phase noise levels were estimated from the number and types of vehicles that are expected to be traveling the road (subsection 1.4.7) during the morning, afternoon, and nighttime shift changes. An L_{eq} of 52.4 dB at 50 feet (Federal Highway Administration, 1978) was calculated and assumed to occur along the access road at varying receptor locations (1 through 10) nearest to each noise sensitive receptor location (see Figure 4.2-6).

Railroad spur operation phase noise level estimates were obtained from mine/mill noise level contours (Pygin, 1982). The locomotive and railcars were assumed to be located at the northeastern end of the spur (R) and were estimated to produce an L_{eq} of 86 dB at 50 feet.

Haul road operation phase noise was assumed to be emitted from three heavy trucks, in transit, midway (H) between the mine/mill site and the MWDF (see Figure 4.2-6). The combined noise emanating from these sources was estimated to produce an L_{eq} of 90 dB at 50 feet.

TABLE 1.4-10

TYPICAL MINE WASTE DISPOSAL FACILITY AREA (POND T2 CONSTRUCTION)
EXCAVATION EQUIPMENT - OPERATION PHASE

EQUIPMENT		NUMBER OF UNITS	MAXIMUM SOUND LEVEL LA at 50 feet (dB)/UNIT	USAGE FACTOR
Scraper	CAT 631	5	87	0.13
Bulldozer	CAT D9	3	88.8	0.15
Bulldozer	CAT D8	4	89	0.15
Bulldozer	CAT D6	3	88	0.15
Front-End Loader	CAT 988	2	86	0.30
Front-End Loader	CAT 966	1	89	0.30
Motor Grader	CAT 16G	1	86	0.30
Motor Grader	CAT 14G	4	80	0.30
Excavator	CAT 235	1	83	0.70
Backhoe	J.D. 410	1	82	0.15
Dump Truck	Ford LT-9000	6	92	0.50
Belly Dump Truck and Trailer	Ford LT-9000	5	92	0.50
Compactor	CAT 825	6	80	0.10
Compactor	Raygo 400A	3	80	0.10

Total equivalent sound level (L_{eq}) contribution at 50 feet = 100 dB

No operating noise was estimated from the slurry and water discharge pipelines because each is buried.

The estimates of operation phase noise emanations used in this assessment are considered "worst-case." For example, at the mine/mill site, it was assumed that all listed noise sources would be in continuous operation, even though some may operate intermittently. At the MWDF, the sources were assumed to be at the boundary nearest a receptor, when in actuality they will only operate there for a small fraction of the time. Railroad spur operations were assumed to occur for 5 hours per day. However, for actual plant operations, there will be, on the average, less than 25 railcars per day (including concentrate shipment and supplies received) traveling the length of the spur in less than 1 hour.

These data for the estimated noise emanations were used as the base for the inputs to the predictive modeling discussed in Chapter 4. However, the model also accounts for atmospheric loss. Therefore, these L_{eq} A-weighted data are used to incorporate equivalent octave band data by including source data that are expressed as a function of frequency rather than A-weighted data.

Seismic Blast Vibrations (Operations) - As described in subsection 1.2.1.2.4, the mining method to be utilized for the Crandon orebody will be predominantly blast hole open stoping with delayed backfill. In the upper portions of the mine, the method will be modified to an adaptation of cut-and-fill mining. This mining sequence will utilize the largest blasts deep in the mine with lower quantities of explosives per blast used as mining progresses toward the crown pillar.

Preliminary design indicates that explosive charge weights per delay could range from 1,100 to 22,000 pounds depending on the type of stope and location within the mine. The overriding design criterion will be to limit the charge weight per delay such that the ground vibration (peak particle velocity, PPV) produced by the blast in the mine/mill site area will be less than 2 inches per second. This criterion will ensure that any seismic blast vibration in an 0.5-mile radius will be in the barely detectable to detectable (0.1 to 0.2 inches per second) range. Further discussion of potential impacts from seismic blast vibrations is given in Chapter 4.

Erosion Control (Operational Drainage) - The measures employed to control erosion which will be incorporated during construction of the mine/mill are presented in Section D, Reclamation Plan of the Mining Permit Application. This plan establishes the construction phase erosion control methods and, during the latter construction period, covers permanent controls which will be effective during the entire operational phase.

Control measures for surface water runoff during mine/mill operations will include retention barriers to contain mine/mill site stormwater (see subsection 1.2.4.14). These barriers, established during the construction phase, will be formed by the roads, railroad, and special runoff retention structures which direct surface water drainage to basins located at the perimeter of the mine/mill site (see Figures 1.2-49 through 1.2-51). The drainage basins allow settling of suspended materials and slow discharge from both percolation and outfall piping.

Surface water runoff from the plant area with potential for contamination will be captured and passed through an interceptor for removal of oil and solids. Collected runoff will be sent to the reclaim pond via the tailing thickener overflow sump. Collected waste oil will be sent to a reprocessing facility or will be disposed at an approved off-site facility.

Surface water runoff from the preproduction ore storage area along with contaminated mine water will be pumped to the water treatment plant feed tank. This tank will have a capacity of 1,000,000 gallons. Some water from the reclaim water tank will also be fed to the water treatment plant for treatment for reuse. These tanks are located just east of the water treatment plant along with other water tanks. These systems will consist of tanks and treatment plant feed pumps. The flow rate to the treatment plant will be controlled by automatic valves between the feed pump and treatment plant.

Intercepted mine water will be pumped to the intercepted water mine tank. This tank will have a capacity of 250,000 gallons. This water will be treated and discharged from the site, but provisions are made to use this water as make-up if needed.

Data presented in the MWDF Feasibility Report, Table 3.4 show that waste rocks are not classified as hazardous waste according to U.S. EPA extraction procedure tests. Any runoff from the storage pile will be collected in a sump and transferred to the reclaim pond.

Water Treatment - Operation of the water treatment system for the Project is described in subsection 1.4.5. The system is designed to treat all water pumped from the mine, including contaminated mine water and intercepted ground water and sufficient water from the reclaim pond to control gypsum scaling in the mill water circuit. It is anticipated that an average of 1,995 gallons per minute will require treatment. Chemical reagents and consumption rates to be used in the water treatment system are discussed in subsection 1.4.5.2. Treated mine water will be used as make-up water for the mill to the maximum extent possible, and excess treated mine water will be discharged.

The water treatment system will contain the following unit processes which will be operated in the proper combination on the varying influent streams to generate an effluent that is compatible with state and federal standards: surge and equalization, lime and sulfide precipitation, lime-soda softening, pH adjustment, mixed media filtration, reverse osmosis, vapor compression evaporation, and evaporative crystallization.

Excess treated water (i.e., the volume of water that cannot be returned to the process) will be discharged. The anticipated average discharge will be 1,190 gallons per minute. The excess water will be pumped and transported via pipeline to Swamp Creek for discharge downstream from County Trunk Highway M. (For a plan view and cross-section of the discharge structure see Figures 1.2-40 and 1.2-41.) The quality of the water to be discharged will meet the effluent limitations for that discharge location as developed by the DNR. Treated water for discharge will be monitored for pH, turbidity, and specific conductance. Composite samples of treated water will be analyzed in accordance with the terms of the WPDES permit for the facilities.

Waste products from the water treatment plant will consist of one product primarily containing calcium carbonate and another product containing sodium sulfate. The carbonate-bearing waste will be disposed with the tailings. The sodium sulfate product, if the product meets specifications, may be marketed to Kraft paper mills. Alternatively, the material may be placed in an isolated lined area in tailing pond T1.

Water Discharge Sources - There will be four sources of water discharge: (1) effluent from the water treatment plant, (2) any seepage from the reclaim and tailing ponds, (3) effluent from the sanitary waste water treatment plant, and (4) discharge from the mine/mill site drainage basins. The environmental loading factors to surface and ground water that would occur during the operation phase of the Project and the proposed control technology are presented below.

Water Treatment System - A block flow diagram of the proposed water treatment system is presented on Figure 1.4-14.

Mine Waste Disposal Facility - A description of the MWDF, including location, waste volume, and seepage control system, is presented in subsection 1.2.3. The tailings transport system and design characteristics of the tailing ponds are described in this subsection. Subsection 1.4.4 contains a discussion of operations of the waste slurry transport system and the waste disposal ponds. Additional information on the MWDF, including design criteria and waste characterization, is presented in the MWDF Feasibility Report.

Reclaim and Tailing Ponds - Some discharge or seepage will occur from the four tailing ponds. It is estimated that the maximum rate of seepage from the tailing ponds will range from approximately 2 to 5 gallons per minute per pond during operation of the MWDF. After reclamation, following shutdown of the underdrain pumps in the last pond, seepage is estimated to peak at a maximum value of less than 8 gallons per minute under T4 and then decline to an eventual steady state seepage rate ranging from approximately 0.2 to 0.4 gallons per minute per pond. With this seepage history and its predicted "worst-case" quality, the MWDF discharge will meet the ground water quality requirements of NR 182.

Sanitary Waste Treatment System - The average flow of sanitary waste water was estimated to be 23,500 gallons per day. Estimates of BOD and TSS contributions were calculated based on maximum loadings of 0.10 pound/person/day and 0.11 pound/person/day, respectively (subsection 1.4.8.2). The sanitary sewage system will consist of a small factory manufactured treatment plant utilizing an activated sludge process with extended aeration. Operation of the system is discussed in subsection 1.4.8.2.

1.4.10 Operations Personnel

The Project will employ an estimated total of 620 people at full production. About 15 percent of the work force will be classified as "unskilled." This category includes jobs such as laborers and janitors. Seventy percent of the work force will be in the skilled category which includes personnel trained as mechanics, equipment operators, mill operators, miners, technicians and clerks. About 5 percent of the employees will comprise the non-managerial professional work force. These employees will hold jobs such as accountants and engineers. The supervisory and managerial will constitute about 10 percent of the total jobs. This category includes jobs such as project manager and production, mechanical, and maintenance supervisors. Where feasible and to the maximum extent practicable, employees will be drawn from the local labor force.

A summary of the employment categories for operations along with a projected annual hiring schedule is presented in Table 1.4-11. It is difficult at this time to accurately predict the number of operation phase workers which will be hired locally (local hires are defined as residents of the local study area included in the socioeconomic report). The actual number will depend on many factors, some of which are listed below.

1) Local unemployment rates at the time of hiring.

2) The availability of people with required skills in the local labor force.

3) The willingness of local workers to accept employment at the Project. Mining will be a new industry to the area and it is difficult to estimate how the local labor force will accept underground employment.

4) The availability of locally trained technical school graduates.

TABLE 1.4-11

EXXON EMPLOYMENT CATEGORIES

PROJECT PHASES
(BASED ON NUMBER OF EMPLOYEES AT YEAR-END)

EMPLOYMENT CATEGORY	BASE YEAR 1984	CONSTRUCTION ADDITIONAL PERSONNEL DURING BASE YEAR Year 1	Year 2	Year 3	OPERATION TOTAL
Administration	13	32	14	18	77
Mine Technical	--	8	15	3	26
Mine Operations	--	1	80	186	267
Mine Maintenance	--	1	26	59	86
Mill Technical	--	1	1	20	22
Mill Operations	--	1	1	55	57
Mill Maintenance	--	1	1	26	28
Central Maintenance	--	1	1	55	57
Project Management Team	--	28	14	(42)	0
Total Additional	--	74	153	380	
TOTAL (Cumulative)	13	87	240	620	620*

*This number maintained throughout Project life (into Year 32).

Note: This listing is intended to demonstrate the type and number of people necessary to operate the facilities described. The actual number and type of employees will vary to some extent, depending on skill availability and Project timing.

Based on the job requirements estimated for the Project, it is possible to make some general judgements on the local hiring picture. Table 1.4-12 gives a summary of the estimated educational requirements and projected hiring schedule for the Project work force, and Table 1.4-13 presents a summary of the estimated educational requirements of the Project work force and the number of employees that might be hired locally.

The permanent (operations and maintenance) work forces of large mining projects and similar resource developments generally are comprised largely of craftsmen, technicians, equipment operators, and mechanics. Because wages paid by mines are generally higher than those of most other rural area jobs demanding similar skills, many of the local workers with appropriate skills typically are interested in obtaining employment at a new mine (Leholm et al., 1975; Murdock and Leistritz, 1979). Thus, even in areas with relatively sparse population and small local labor pools, mining firms have often been able to achieve high rates of local recruitment. For example, a survey of workers at seven coal mines and seven power plants in the Northern Great Plains indicated that local workers made up 62 percent of the overall work force (Wieland et al., 1977; Wieland et al., 1979). Substantial variations in the rates of local hiring were found among these projects, with higher rates of local hiring usually occurring where the local (area) labor pool was larger in relation to the project's labor requirements. The local hire rate was less than 60 percent at only two of the seven mines surveyed.

TABLE 1.4-12

PROJECTED HIRING SCHEDULE BASED ON EDUCATION LEVEL FOR THE CRANDON PROJECT

YEAR	EMPLOYEE EDUCATIONAL REQUIREMENTS			
	COLLEGE	VOTECH	HIGH SCHOOL	TOTAL NEW HIRES
Year-End 1984	7	3	3	13
	Additional Personnel Required Over 1984 Year-End			
Year 1	28	8	10	46*
Year 2	6	28	105	139*
Year 3	6	87	329	422*
TOTALS	47	126	447	620

*Does not include Project Management Team.

Note: This listing is intended to demonstrate the type and number of people necessary to operate the facilities described. The actual number and type of employees will vary to some extent, depending on skill availability and Project timing.

TABLE 1.4-13

ESTIMATED NUMBER OF EMPLOYEES
TO BE HIRED LOCALLY FOR THE CRANDON PROJECT

EDUCATIONAL REQUIREMENTS*	TOTAL	LOCAL HIRES Percent	LOCAL HIRES No.
College	47	20	9
Vocational/Technical	126	40	50
High School	447	70	313
TOTAL	620	60	372

*These represent actual degrees or equivalent combinations of education and experience.

Note: This listing is intended to demonstrate the type and number of people necessary to operate the facilities described. The actual number and type of employees will vary to some extent, depending on skill availability and Project timing.

More recent surveys of operations work forces indicate rates of local hiring similar to those previously cited. For example, a survey of workers at two coal mines near Sheridan, Wyoming indicated that about 60 percent of the work forces had been recruited locally (Hooper and Branch, 1983). Similar results were reported from a survey at the Jim Bridger power plant in southwestern Wyoming (Browne, Bortz, and Coddington, 1981).

Considering the Crandon Project specifically, several factors would suggest that a relatively high rate of local recruitment can be expected. These include: the large local labor force (relative to project labor requirements), the substantial percentage of local workers possessing skills consistent with Project employment requirements, the general slack condition of the local labor market (as evidenced by a persistent trend of moderate to substantial unemployment), and the fact that no other major projects are anticipated to be developed in the area during the period when the major hiring for Crandon will occur. Thus, the 60 percent rate of local hiring assumed in the impact assessment could prove to be conservative.

As stated above, these percentages are estimates and must not be treated as commitments on the part of Exxon. They represent the number of local hires which could be achieved given current plans for the Project.

It is Exxon's policy to hire qualified candidates without regard to age, race, creed, color, sex, handicap, national origin, or ancestry. With respect to employment at the Crandon Project, Exxon is committed to hiring local people preferentially to the extent allowed by applicable laws and by the necessary skill requirements. Furthermore, Exxon will request construction contractors to give preference to hiring local people, including Native Americans, among equally qualified candidates, to the extent allowed by law. This policy has been communicated to the local communities during various meetings, as well as through written correspondence between Exxon management and local community leaders and their representatives.

Exxon has no contracts or agreements at other Exxon operations which could impact employment opportunities at the Crandon Project.

1.4.11 References Cited

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1.5 FACILITIES CLOSURE

The useful economic life of the Project is estimated to be approximately 29 years at anticipated production rates and known ore reserves. At the end of this period, if additional ore reserves do not extend the mine life further, operations will be discontinued and the mine/mill facilities will continue in use insofar as alternative uses can be found. If the facilities cannot be used, they will be dismantled and the site will be restored to its original state as far as is practicable. The process of removal of the facilities and reclamation of the area is expected to take approximately 4 years after production is discontinued.

1.5.1 Facilities Removal

The machinery from all areas of the plant will be removed first, and the structures and buildings then dismantled in an orderly sequence. All salvageable items will be hauled off the site and sold or recycled as appropriate.

Above grade structural concrete and masonry structures will be broken and used as fill to aid in site contouring.

Reclamation plans in the mine/mill area include the removal of all concrete and masonry to approximately 1.5 feet below final proposed grades. Deeper concrete and masonry would be left in place; however, large expanses of concrete (such as floor slabs or pits) would be broken up before covering to permit normal infiltration of precipitation. Following solid waste disposal requirements, a one-time disposal permit would be applied for to utilize the disposal of concrete and masonry as reclamation fill in the mine/mill area. A minimum 1.5 feet soil cover would also be provided in these fill areas.

Because of their necessary function, the water storage and fire protection systems will be maintained until very late in the reclamation phase. The roads and railroads will be the last items to be removed as they are required for movement of material and personnel. Main access and necessary in-plant roads will remain until the tailing water treatment process is complete.

The water treatment plant, electrical substation, main access road, water recirculation lines and in-plant access road will be fenced and equipped with locking gates for personnel and equipment access. These facilities will be retained in place for cleanup of the water in tailing ponds and dams prior to final reclamation, at which time they will be removed. Concrete broken up at this time will be removed from the site, as the surrounding plant area will be revegetated.

The potable water supply well(s) at the surface facilities site will be plugged and abandoned, in accordance with applicable state regulations, upon cessation of mining activities.

Backfill placed in stopes as a part of the normal mining operations will prevent surface subsidence. Throughout the mine, drifts, raises, and shafts will not require filling, since their dimensions are sufficiently small that they will not experience stress concentrations of a magnitude sufficient to cause rock failure large enough to propagate surface subsidence.

Rock mechanics studies will be performed late in the mine life to specifically confirm the stability of mine workings upon abandonment. An evaluation of underground mining activities that could affect surface land subsidence was undertaken by Mitchell et al. (1982). It was concluded that the proposed mining practices would have a negligible effect on surface topography. Nevertheless, prior to termination of mining, particular attention will be directed to the area of preventing surface subsidence.

The original ground surface above the proposed Crandon mine will be maintained by a permanent bridge or "crown pillar" of bedrock left undisturbed above the mine workings. Mining methods and practices contributing to the stability of the protective crown pillar are described in Section 1.2. 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 specialists, prepared a summary report, entitled "Evaluation of Surface Effects" in April 1982 (Mitchell et al., 1982). Their analysis integrated all the related test work and included a description and quantification of 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 dimensions, 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 summary conclusion of all subsidence evaluations is that the combined effects of any bedrock/soil movements will result in less than a 6-inch maximum change in surface elevations directly over the ore deposit. Gradational deflections of this magnitude distributed through glacial overburden of varying thickness will have a negligible effect on surface topography or land use.

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 chemical 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 ground water interceptor system drill holes, which penetrate the crown pillar or into the glacial 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 mesasures will limit the post-mining circulation of overburden aquifer ground water to the undisturbed crown pillar area 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 typically 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 (Dames and Moore, Golder Associates, D'Appolonia, Prickett) 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 aquifer 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 three shafts leading to surface (main production and hoisting shaft, east exhaust vent shaft, and west exhaust vent shaft). 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 hoists and conveyances which will be dismantled in conjunction with demolition of the main shaft concrete tower headframe.

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 the 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.

Final abandonment procedures for each of the three concrete lined shaft collars extending through the overburden to bedrock will include:

1) Placement of a reinforced concrete ground water isolation plug, connected to the shaft lining, at the bedrock subcrop elevation.

2) Removal of all shaft steel, service pipelines, and utilities above the ground water isolation plugs, with the possible exception of a single steel casing pipe left to penetrate the plug for possible insertion of post-reclamation ground water monitoring piezometers and/or access for bedrock ground water sampling.

3) Overburden backfilling of the shafts above the ground water isolation plugs to within 10 feet of the final reclaimed surface grade.

4) Demolition of the near surface concrete shaft lining and collars, subsequently combined with the final grade fill prior to site revegetation.

5) Placement of identification and security structures for any reclaimed shaft sites containing provisions for ground water monitoring.

Mine backfill consisting of development waste rock and prepared mill tailings will be universally placed in ore extraction areas (stopes) to maintain perpetual mine area rock mass and overburden stability. Access drifts and shafts developed exterior to the orebody, which represent less than 10 percent of the total mine excavation volume, will not be filled prior to mine closure, except as described for those openings extending to surface.

During the operational life of the mine and mill, an attempt will be made to maximize the amount of material returned underground to be used as fill. At the completion of the milling operation, the current plan is to complete the final reclamation work for the tailing ponds. Consideration of several factors has led to this choice as opposed to trying to return any additional tailings back underground.

First, not all of the tailings could be returned underground. Through the mining and milling process, the density of a cubic yard of rock decreases from 2.8 tons per cubic yard to an approximate average tailings density of 1.5 tons per cubic yard. This is approximately double the volume of space required for disposal of the tailings compared to the mined ore tonnage.

Second, the amount of tailings that could be readily accessed would be limited to those contained in the last active pond. The other ponds would have been reclaimed in previous years.

Third, to move the tailings from the disposal ponds to the mine would require repulping of the tailings. This would be done by mechanical agitation and/or by the use of water jets. Both of these methods have the potential to disrupt the liner system.

Finally, there is an additional cost to remove and transport the tailings from the disposal ponds to the mine.

For these reasons tailings will be left in the final pond and not used for backfill upon completion of mine and mill operations.

1.5.2 Mine/Mill Facilities Reclamation

Reclamation of the mine/mill site will be an evolving process beginning during the construction phase. Native landscape plantings will be established during the construction period as major Project surface facilities are completed. Proposed landscaping plans during this period are described in subsection 1.3.4. Implementation of the final reclamation plan for the mine/mill site will follow the schedule for facilities removal (subsection 1.5.1).

After all mine/mill surface facilities have been removed following Project closure, site revegetation will be undertaken to control erosion in disturbed and regraded areas. During the period of final site reclamation, many of the landscape plantings established during the construction and early operation phases will have reached maturity and will serve as seed colonies capable of invading adjacent cleared areas. Seed colonies located on the perimeter and in the interior of the mine/mill site will promote the natural invasion of indigenous species.

The two components of the mine/mill reclamation program listed below will aid in the restoration of the natural landscape:

1) Regrading the site to meet facilities removal requirements following mine cessation. Facilities debris retained on-site as backfill for sub-grade levels of surface facility structures will be covered with fill acquired on-site. Site regrading will also focus on salvaging topsoil, maintaining existing drainage patterns and the continued use of existing retention basins for erosion control during the reclamation process.

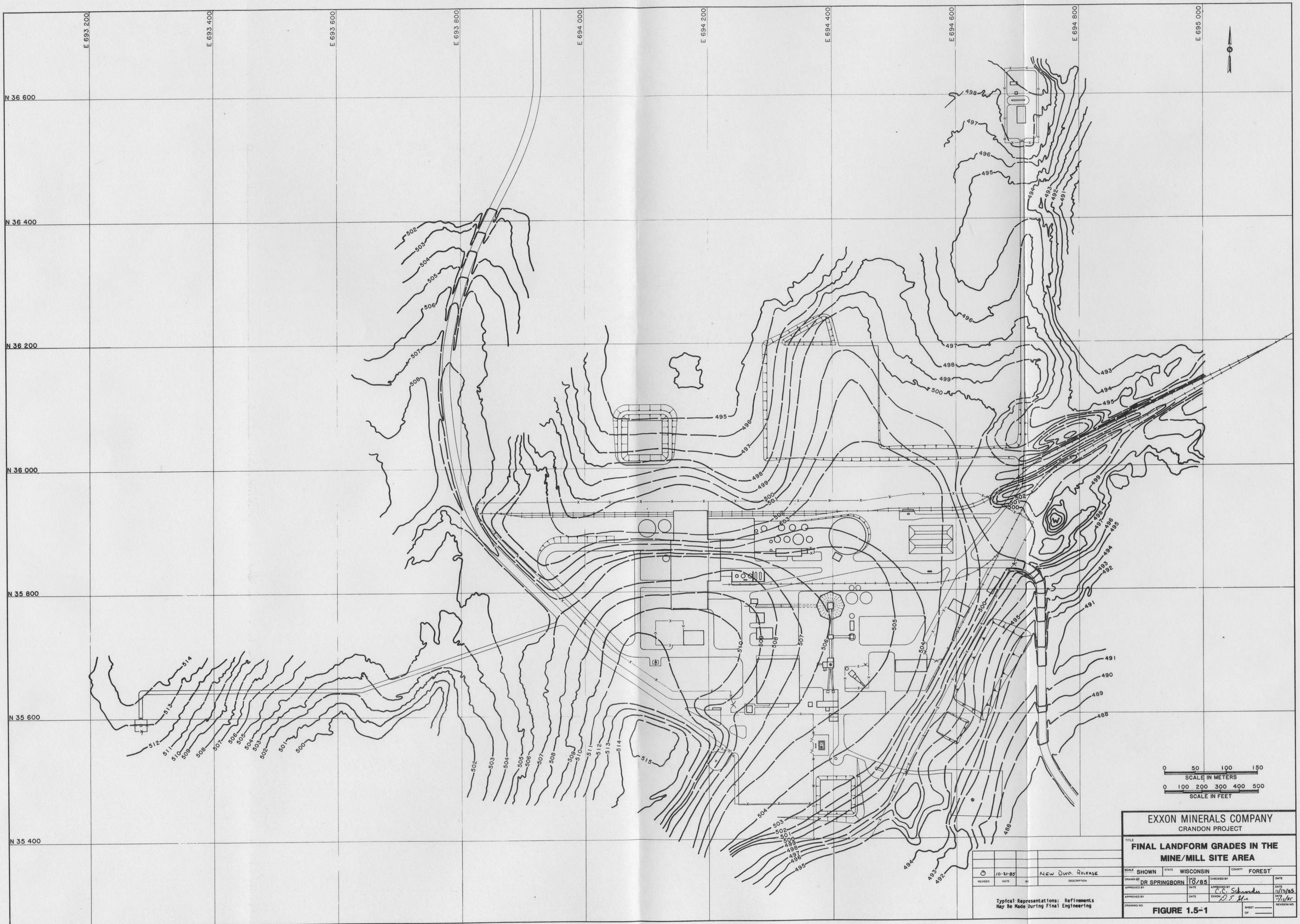
2) A mixture of non-competing vegetative ground cover and indigenous herbaceous forbs and grasses will be established on disturbed areas of the site which will allow for the continued invasion of native herbaceous and woody plant species. The surrounding undisturbed plant communities and established landscape plantings within the mine/mill site will be the sources of the invading plants.

Within the mine/mill site area, approximately 80 acres will be regraded to meet backfill and earthen cover requirements. During regrading, existing vegetation will be preserved and existing drainage features and retention basins will be maintained to the extent possible. Building foundations and other Project features not removed following facilities closure will be covered with a minimum of 1.5 feet of soil. Existing vegetation adjacent to or within areas to be graded will be protected with fencing well beyond the perimeter of the plants to minimize soil compaction and subsequent damage to trees. Merchantable timber which must be removed will be salvaged and brush will be chipped and stockpiled with topsoil for use in revegetation of the site.

Final landform grades within the mine/mill site are shown on Figure 1.5-1. These grades will allow surface runoff to flow into the drainage basins before release.

Upon completion of the facilities removal and regrading phases, disturbed areas will be seeded to establish an assemblage of plant species effective in rapid stabilization of slopes and prevention of erosion. Indigenous species will be included in the seed mixture. Native plant species from established seed colonies within the site and from undisturbed communities on the site perimeter will be allowed to invade these seeded areas. This will permit establishment of plant species that are representative of the surrounding area.

Long-term maintenance of the reclaimed area will include filling and reseeding of eroded areas to ensure establishment of a stable vegetative cover over the entire site. Periodic inspection of plant invasion also will be performed in conjunction with management of other lands within the Project area.


E 693 200
E 693 400
E 693 600
E 693 800
E 694 000
E 694 200
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N 36 600
N 36 400
N 36 200
N 36 000
N 35 800
N 35 600
N 35 400
0 50 100 150
SCALE IN METERS
0 100 200 300 400 500
SCALE IN FEET
0 10-31-85 New Dwg. Release
REVISED DATE BY DESCRIPTION
Typical Representations: Refinements
May Be Made During Final Engineering
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
FINAL LANDFORM GRADES IN THE
MINE/MILL SITE AREA
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.E. Moe
DATE 11/13/85
DRAWING NO.
FIGURE 1.5-1
SHEET
OF
REVISION NO.

A more comprehensive discussion of reclamation of the mine/mill site is presented in Section D, Reclamation Plan of the Mining Permit Application.

1.5.3 Mine Waste Disposal Facility and Water Reclaim Pond Reclamation

The reclamation plan for the MWDF and water reclaim pond will be designed for compatibility with the biological and physical characteristics of the disposal area and the adjacent undisturbed environment. The main elements of the reclamation plan will include landform design of the topcover, surface water hydrology, soil management, and revegetation. Reclamation of the area will be sequenced to coincide with the schedule for development, use, and closure of each of the four tailing ponds and the water reclaim pond (Figure 1.4-12). A more detailed discussion of the plan and schedule for reclaiming these facilities is presented in Section D, Reclamation Plan of the Mining Permit Application.

1.5.3.1 Tailing Ponds Precipitation Infiltration Control Measures

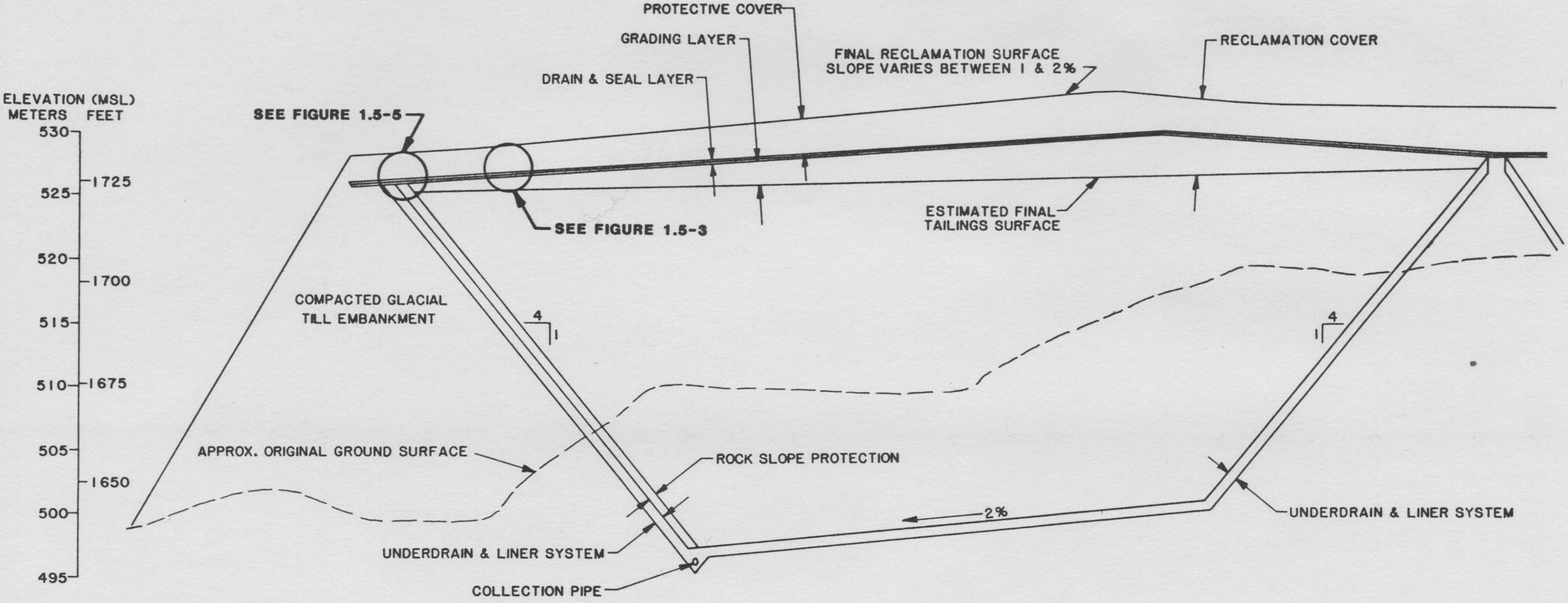
At the end of operation the surface of a tailing pond will be covered with a cap composed of five layers. The bottom (or first) layer, composed of glacial till and possibly some waste rock, will be used to grade the final pond surface to approximately a 2 percent slope, the second layer will be composed of a bentonite modified soil admixture seal to prevent surface water from percolating through the tailings. The seal will be an overall 8-inch minimum thickness consisting of two separate 4-inch thick lifts of liner placed in a manner similar to a roadway pavement. The upper lift will be placed so that seams between construction passes are offset; the third layer immediately above the bentonite modified soil seal will be a 40 mil thick polyethylene membrane. Fourth, an 8-inch coarse gravel overdrain layer will be placed above the composite seal to promote drainage of the final layer and remove any seepage inducing head from the seal. The final layer will be formed by spreading a layer of glacial till 5 feet thick to provide a protective cover for the seal and drain layer and to provide a medium for plant growth.

A typical tailing pond cross-section showing the relationship between the final initial pond configuration, the final tailings surface at completion of pond operation and the final reclamation cover is shown on Figure 1.5-2. Additional detail of the typical reclamation cap elements is shown on Figure 1.5-3.

1.5.3.2 Preparation of Final Reclamation Surfaces

The waste disposal system is designed so that reclamation will be done in stages. After each tailing pond is filled and removed from service, the ponded water will be pumped to the reclaim pond, or in the case of the last tailing pond, to the wastewater treatment facility for treatment prior to discharge.

Construction of the reclamation cover system will involve placing a working mat of till soil and/or waste rock over the tailings surface. The till and/or waste rock will be used to develop approximate 2 percent grades over the tailing pond area surface below the bottom of the seal. After the pond has been graded, a bentonite modified soil

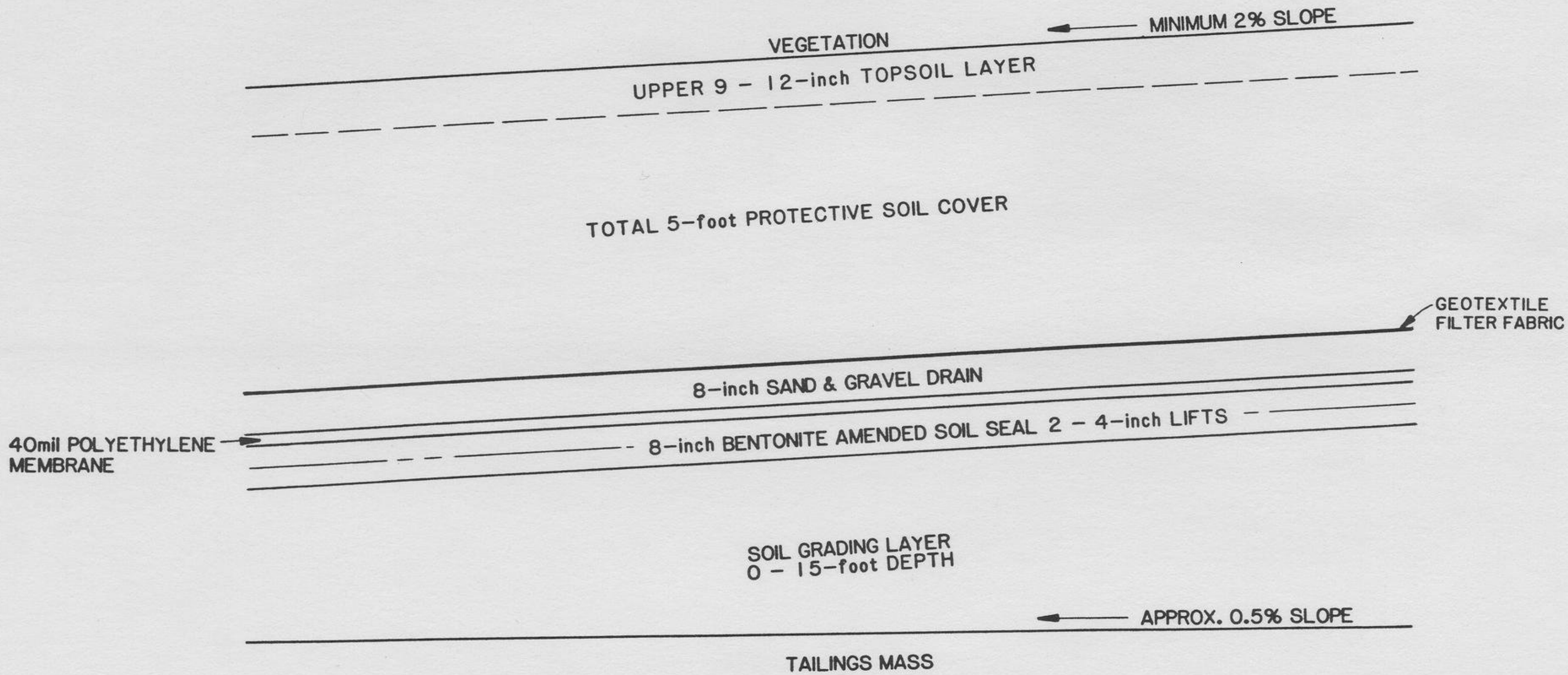


Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY TYPICAL RECLAMATION CAP

SCALE NONE	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY		DATE
APPROVED BY	DATE	APPROVED BY C.G. Schroeder		DATE 11/13/85
APPROVED BY	DATE	EXXON [illegible]		DATE [illegible]
DRAWING NO FIGURE 1.5-2		SHEET ___ OF ___		REVISION NO



Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY RECLAMATION SEAL DETAIL

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 7/84	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. [illegible]	DATE [illegible]
DRAWING NO FIGURE 1.5-3		SHEET ____ OF ____	REVISION NO

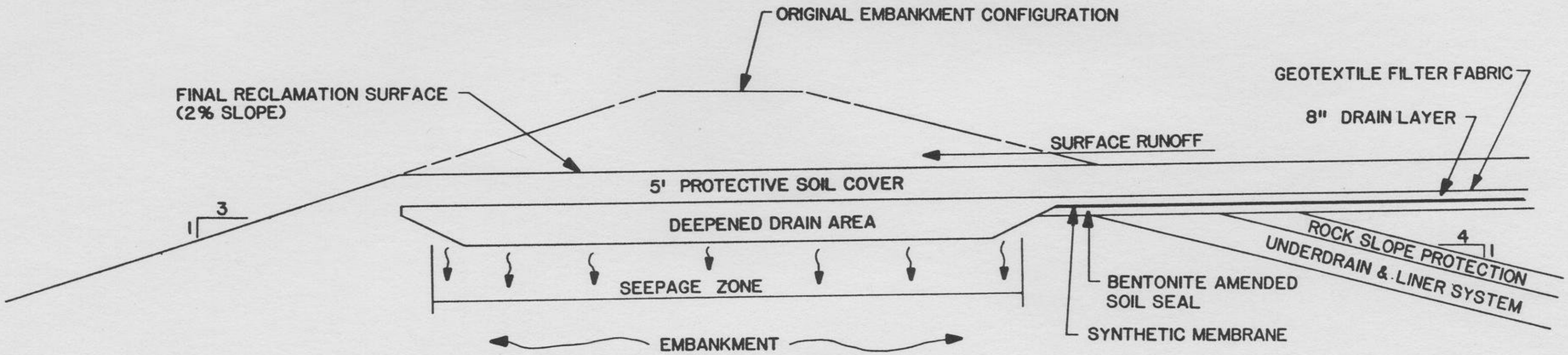
seal, a synthetic membrane, an overdrain, and a soil cover will be placed over this subgrade. Final MWDF landform surface grades are shown on Figure 1.5-4.

1.5.3.3 Mine Waste Disposal Facility Overall Reclamation Cap Performance

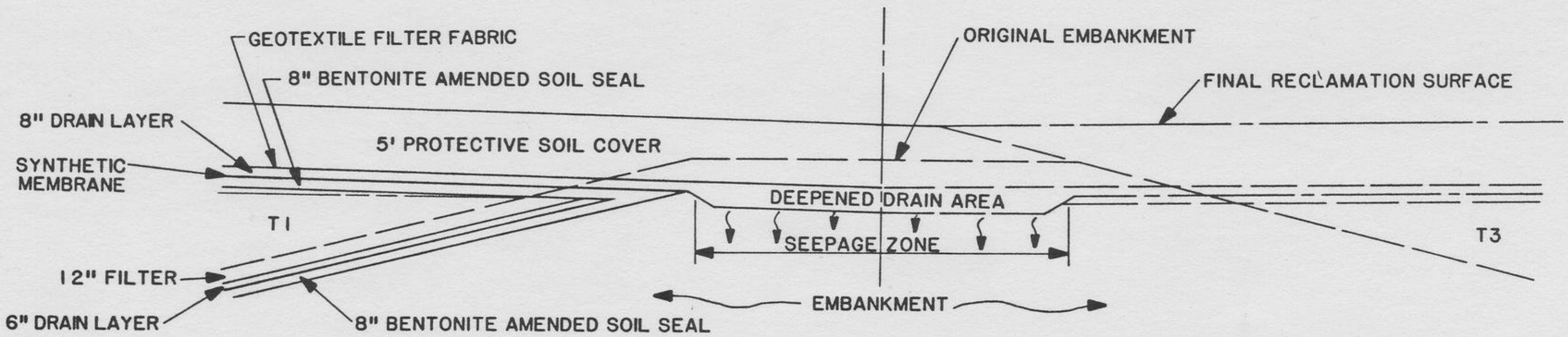
The drain layer and composite seal will work effectively to reduce final seepages through the seal to a minimal amount. The final seepages through the composite seal and hence on through the tailings mass and pond bottom have been used in evaluating overall MWDF seepage characteristics and performance through the use of ground water models as described in Chapter 4.

The drain layer channels nearly all final protective cap infiltration to the perimeter of each individual pond of the MWDF where it infiltrates as recharge through the depth of the embankmemt. Figure 1.5-5 presents the configuration of the drain layer as it terminates in both the exterior and interior embankments of the MWDF. This system approaches, as nearly as possible, the restoration of initial site infiltration patterns in the final reclamation of the MWDF area. Runoff, which currently occurs throughout the area occupied by the MWDF, still will occur although probably to a lesser degree since final reclamation grades will be fairly low. After reclamation of the MWDF, infiltration will continue to occur; however, its pattern will be changed since the cap drain system redirects infiltration to the individual pond perimeters where it will infiltrate into the embankments. Beyond the MWDF embankments there should be relatively

PERIMETER ACCESS ROAD
TOE OF SLOPE
RECLAIM
POND
MWDF
MRDF
CONSTRUCTION SUPPORT AREA
TOE OF SLOPE
TOE OF SLOPE
533
532.5
532
531
530
529
528
527
526
518
516
513
510
505
504
503
LEGEND
AREAS POTENTIALLY REQUIRING SPECIAL EROSION CONTROL
DIRECTION OF SURFACE WATER RUN-OFF
NOTES:
1) SEE DETAIL B, FOR TYPICAL RECLAMATION COVER PLAN SHEET 28.
2) SEE PLAN SHEET 28 FOR CROSS-SECTION THROUGH ENTIRE FACILITY.
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
PROFESSIONAL ENGINEER
REVISED
DATE
BY
DESCRIPTION
Typical Representation: Refinements may be made during final design.
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
RECLAIMED SURFACE OF THE MWDF, MRDF & RECLAIM POND
SCALE
AS SHOWN
STATE
WISCONSIN
COUNTY
FOREST
DRAWN BY
J.J.T.
DATE
APPROVED BY
DATE
APPROVED BY
DATE
FIGURE 1.5-4
SHEET 17
0
DESIGN PRODUCTS CO.



MWDF PERIMETER EMBANKMENT



MWDF INTERIOR EMBANKMENT

Typical Representations: Refinements
May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY
TYPICAL RECLAMATION CAP
EMBANKMENT DRAIN DETAIL

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY DR SPRINGBORN	DATE 9/85	CHECKED BY		DATE	
APPROVED BY	DATE	APPROVED BY C. C. Schwede		DATE 11/13/85	
APPROVED BY	DATE	EXXON D F [illegible]		DATE 11/1/85	
DRAWING NO **FIGURE 1.5-5**			SHEET ___ OF ___	REVISION NO	

little change in surface water infiltration quantities or flow patterns. Additional information on the MWDF reclamation cap design and water balance analysis is presented in Ayres Associates (1984, 1985).

1.5.3.4 Removal of Reclaim Pond

On completion of milling, water in the reclaim pond will be treated for discharge and the pond basin reclaimed. The reclaim pond liner, rock slope protection materials and water treatment sludge contained therein will be placed in tailing pond T4 before it is reclaimed. The reclaim pond area will be regraded with the glacial till soils that formed the reclaim pond embankments. The final reclaimed surface of the reclaim pond is depicted on Figure 1.5-4.

1.5.4 Mine Refuse Disposal Facility Reclamation

Reclamation of the MRDF will be sequenced in accordance with the schedule for construction, use, and closure of each cell (Table 1.3-1). The soil cover/grading layer will be placed continuously as the cell is filled with refuse. The reclamation cap seal and protective cover will be installed when each cell is filled and will consist of the same components as proposed for the MWDF (Figure 1.5-3). Construction procedures for installing the reclamation cover system will be similar to those described in subsection 1.5.3.2 for the MWDF. Final MRDF landform surface grades are shown on Figure 1.5-4.

Further information on the plan for reclaiming the MRDF is presented in Section D, Reclamation Plan of the Mining Permit Application.

1.5.5 References Cited

Ayres Associates, 1984, Mine waste disposal facility, reclamation cap design and water balance analysis: Eau Claire, Wisconsin. (September).

_____, 1985, Mine waste disposal facility, revised reclamation cap design and water balance analysis: Eau Claire, Wisconsin. (November).

Mitchell, R. J., Olsen, R. and Smith, J. D., 1982, Evaluation of surface effects, Crandon Project, Exxon Minerals Company, U.S.A. Unpublished report prepared by John D. Smith Engineering Associates Limited for Exxon Minerals Company - Crandon Project, Rhinelander, Wisconsin.