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ENVIRONMENTAL IMPACT REPORT

CRANDON PROJECT

Prepared For

Wisconsin Department of Natural Resources

EXXON MINERALS COMPANY

CHAPTER 1

DESCRIPTION OF THE PROPOSED ACTION

CRANDON PROJECT

ENVIRONMENTAL REPORT

DECEMBER 1982

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CHAPTER 1.0

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 operation 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 affect on impact analyses.

Exxon is in the process of filing permit applications necessary for construction of the described facilities. The period required for obtaining all of these permits may be in excess of two years. 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 final Project design and construction. The refinements as they relate to environmental impact evaluation will be brought to the attention of the Wisconsin Department of Natural Resources.

At present, studies indicate that although the potential mineable recovery for the Crandon ore reserve could approach 77 M t (84.9 million short tons) the more probable estimate of mining reserves is 65.8 M t (72.5 million short tons). For design and evaluating environmental impacts, the higher 77 M t (84.9 million short tons) reserve case was utilized. The 65.8 M t (72.5 million short tons) was used to evaluate the socioeconomic impacts.

In Chapter 1, a general description of various Project characteristics, such as location, history and background, need for the Project, 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 in narrative and graphic form. Construction and operational 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. Procedures for removing 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 requests that the DNR initiate the following action on the documents being filed:

1) Review the Environmental Impact Report 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 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 responsible 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 Technical Services 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.

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

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

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

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

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

Northern Lake Service
400 North Lake Avenue
Crandon, WI 54520

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

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

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

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

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

1.1.2 Location of Proposed Action

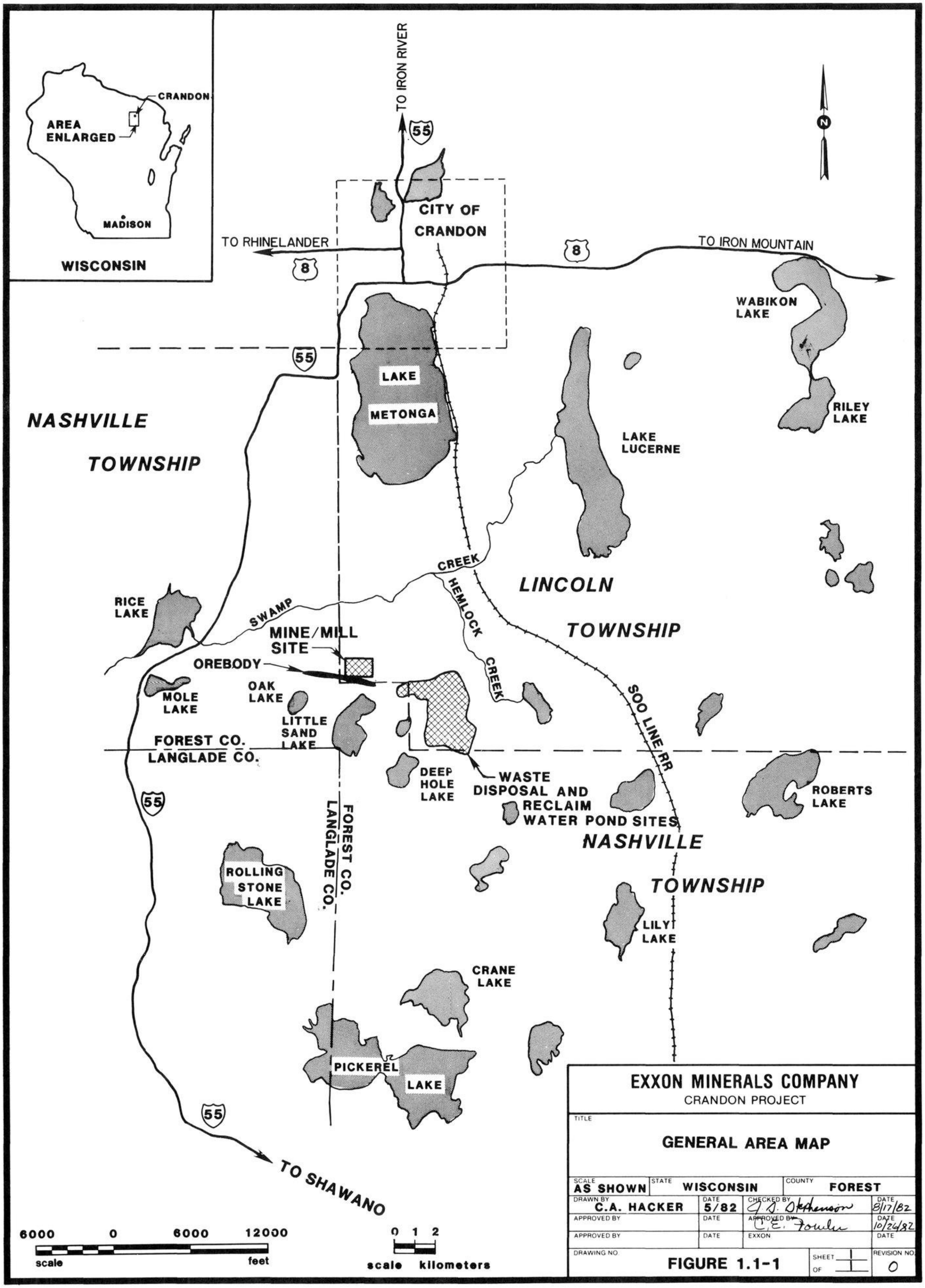
The ore deposit is located in Forest County, in the Northern Highlands region of northeastern Wisconsin (Figure 1.1-1). Crandon, the county seat of Forest County, is located 8 km (5 miles) due north of the proposed Project site. Other communities in the area include Rhinelander, 45 km (28 miles) west, Antigo, 72 km (45 miles) south, and Iron River, Michigan, 71 km (44 miles) north of Crandon, respectively. The Project site is located 3 km (2 miles) east of State Highway 55 on Sand Lake Road.

The orebody is an east-west striking deposit located in Section 25, Township 35 North, Range 12 East, Nashville Township, and in Section 30, Township 35 North, Range 13 East, Lincoln Township. Physiographically, the deposit lies 0.4 km (0.25 mile) north of Little Sand Lake and 1.6 km (1 mile) south of Swamp Creek.

Exxon Controlled Land - Exxon currently controls approximately 1,607 ha (3,971 acres) within the Project site (Figure 1.1-2). The Project land is located in Sections 19, 20, 28, 29, 30, 31, 32 and 33, Township 35 North, Range 13 East; Sections 23, 24, 25, 26, 35 and 36, Township 35 North, Range 12 East; and Sections 4 and 5, Township 34 North, Range 13 East. The status of the specific parcels of land within the Project area is shown in Figure 1.1-3.

Exxon currently owns approximately 703 ha (1,737 acres) in the Project area (Figure 1.1-3). The remaining approximately 904 ha (2,234 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	Hectares	Acres
Exxon Owned	703	1,737
Land Purchase Option/Mining Leases	902	2,228
Easement	2	6
Total	1,607	3,971



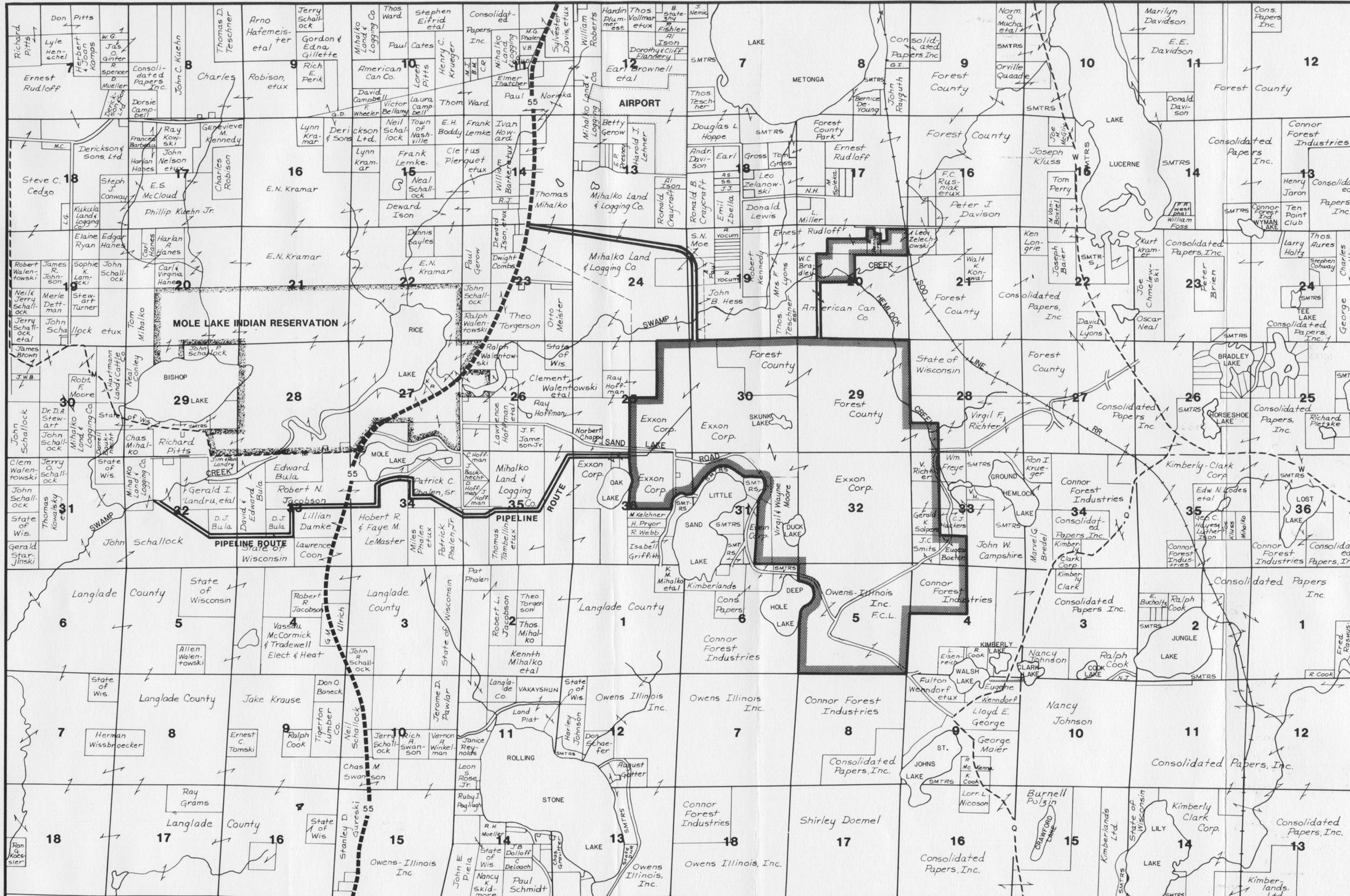
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE

GENERAL AREA MAP

SCALE	STATE	COUNTY
AS SHOWN	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
C.A. HACKER	5/82	[signature]	8/17/82
APPROVED BY	DATE	APPROVED BY	DATE
		C. E. Fowler	10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO.		SHEET OF	REVISION NO.
FIGURE 1.1-1			0



LEGEND

PROJECT SITE

EASEMENT

EXXON MINERALS COMPANY

CRANDON PROJECT

TITLE

LAND OWNERSHIP PROJECT SITE

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

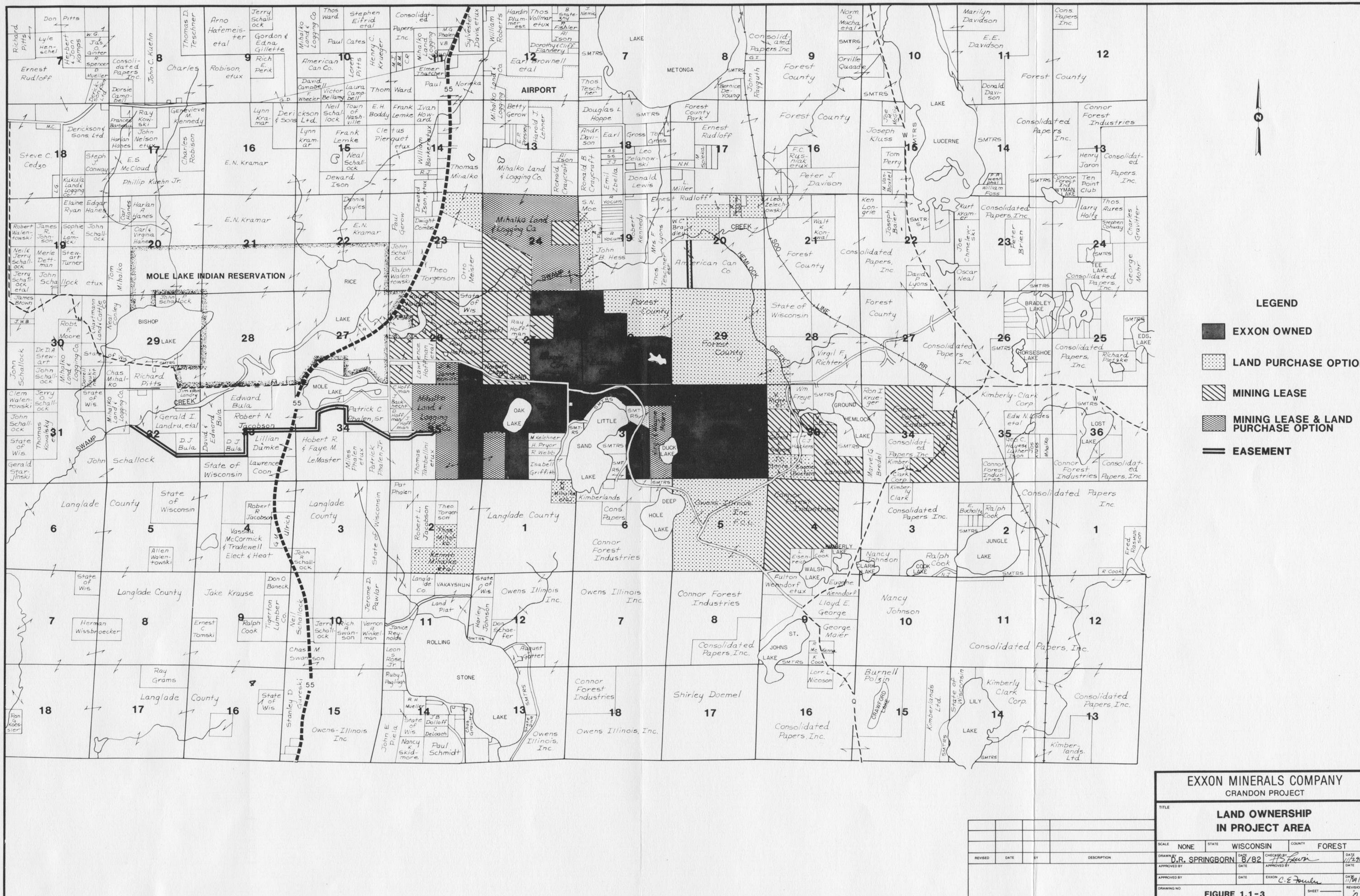
REVISED	DATE	BY	DESCRIPTION

DRAWN BY D.R. SPRINGBORN DATE 8/82 CHECKED BY [signature] DATE 11/29/82

APPROVED BY DATE

APPROVED BY DATE EXXON C.E. Fowler DATE 11/29/82

DRAWING NO **FIGURE 1.1-2** SHEET OF REVISION NO 0


LEGEND
EXXON OWNED
LAND PURCHASE OPTION
MINING LEASE
MINING LEASE & LAND PURCHASE OPTION
EASEMENT
MOLE LAKE INDIAN RESERVATION
AIRPORT
METONGA
LUCERNE
BISHOP LAKE
RICE LAKE
MOLE LAKE
OAK LAKE
LITTLE SAND LAKE
DUCK LAKE
DEEP HOLE LAKE
ROLLING STONE LAKE
LILY LAKE
JUNGLE LAKE
LOST LAKE
BRADLEY LAKE
HORSESHOE LAKE
GROUND HEMLOCK LAKE
WALSH LAKE
CLARK LAKE
COOK LAKE
JOHNS LAKE
CRAWFORD LAKE
SWAMP CREEK
HEMLOCK CREEK
SOO LINE RR
EXXON MINERALS COMPANY
CRANDON PROJECT
LAND OWNERSHIP
IN PROJECT AREA
SCALE NONE
STATE WISCONSIN
COUNTY FOREST
DRAWN BY D.R. SPRINGBORN
DATE 8/82
REVISED
DATE
BY
DESCRIPTION
APPROVED BY
EXXON
DRAWING NO.
FIGURE 1.1-3
SHEET
OF
REVISION NO. 0

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 1982 and the results will be used as the basis for the permits and EIR.

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

During 1982, final work was initiated on the Environmental Impact Report 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 - 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 department, 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 hearings, 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 Departmental 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 Environmental Impact Statement (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.

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 and the Northwoods.

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

Exxon's Crandon Project consists of a mining and ore benefication operation expected to produce a number of base and precious metals in the form of intermediate products known as concentrates. These products will serve both U.S. requirements and that of the western world through exports. Production of metal concentrates from U.S. mines, whether for domestic consumption or export, will have a positive impact on the U.S. balance of payments and trade position with industrialized overseas nations. The output also will help reduce the nation's dependence on foreign metals.

Each of Crandon's products will compete in international trade and will face strong cost competition from a variety of foreign and domestic producing properties. This factor mandates that the Crandon operation, while complying with all applicable laws and regulations, be cost effective so it can compete with the most efficient of the world's metal mines. It is particularly important that the Crandon mine be competitive with new operations which come into being and produce copper and zinc in the same time period as that contemplated for the Crandon Project.

Crandon's output, which is in the form of concentrates, will require further processing away from the mine/mill site before it can be readily marketed as metals to industrial users. This processing is called smelting and refining. Major smelting and refining centers exist within the United States, Canada, Europe, and Japan. The specific destination of Crandon's zinc, copper, and lead concentrates will vary with the individual metal and also with the world industry balances between mine production and smelting and refining capacity at any given point in time. The amount of concentrates smelted and refined in the U.S. will, accordingly, vary with time as capacity at U.S. facilities and the need changes for concentrates by specific smelters. There are no plans for Exxon to build or purchase smelting and refining fa[illegible]o process these concentrates at this time. Its plans are to rely upon the current sufficiency of western world smelting and refining capacity.

The Project will generate, over its life, a significant increment of Federal tax revenues through Federal corporate income taxes. In that wages for the types of jobs offered by the Crandon Project are in excess of the national average, more Federal tax revenues per job will be generated than is typical for the population as a whole. Additional revenues will be generated by Federal taxes paid as a result of indirect employment associated with the Project and firms furnishing equipment and services.

1.1.3.1.2 State and Local Benefits

The significant economic and social benefits to the local and state communities are discussed in Chapter 4 of this report, and in related socioeconomic documents prepared as a part of Exxon's socioeconomic studies for the Crandon Project. The Crandon Project would considerably reduce the out migration of younger workers which has been a prevalent condition during the last several decades. Additionally, important trade and tax benefits flow through to local and state governments. The burdens of growth will be moderate upon local units of government.

The Project will generate significant potential revenue for the Wisconsin construction and mining equipment industry which is centered in the Milwaukee-Racine area, as well as provide a base for the development of local and regional service industries.

It is Exxon's current assessment, based on its estimates of construction cost, understanding and forecast of the demand for the specific metals to be produced, and our assessment of its cost competitiveness with present and future operations, that the Crandon Project represents a prudent and economically attractive venture. More detailed engineering is required over the next several years to increase Exxon's confidence in Project construction costs. Similarly, additional competitiveness and marketing studies are planned by Exxon prior to a final decision to construct the mine.

Prudence in reserving the decision relative to actual funding of the Project is heavily influenced by the length of time required by the permitting process. The current assessment, however, is that the Project will be economically beneficial to local and state communities, as well as to Exxon. Wisconsin property taxes, sales taxes, minerals net proceeds taxes, and state corporate income taxes all will be substantially and positively impacted.

1.1.3.1.3 Uses and Outlook for Recovered Metals

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, lead, and gold. No other elements found in the ore are economic to recover.

The following subsections discuss the benefits of recovery of each of the metals mentioned above. The primary source of the information was "Minerals Facts and Problems," Bureau of Mines (1980).

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 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 primary zinc production in 1978 was 5.9 M t (6.5 million short tons).

U.S. mine production was 303,000 t (334,000 short tons), some 5.1 percent of the total. The Crandon Project is expected to produce about 175,000 t (193,000 short tons) 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 about a 3 percent expansion of production.

United States mine production of zinc covers only about 25 percent of total U.S. demand. 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 these imports, and thereby reduce U.S. dependence for this important mineral.

The U.S. Bureau of Mines projects that demand for primary zinc will grow at a rate of about 1.6 percent per year throughout this century. Such a growth rate would bring the demand to a level of 1.65 M t (1.82 million short tons) per year by the year 2000. At such a level the Crandon Project would supply about 9 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 wires, malleability, high corrosion resistance, and appearance make it an important industrial metal. The principal copper end uses 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 was approximately 7.5 M t (8.3 million short tons). The U.S. produced about 18 percent of the total, or 1.35 M t (1.49 million short tons). The Crandon Project is estimated to produce about 40,000 t/y (44,000 short tons per year) of copper metal when full production is achieved. As such, it represents about 3 percent of U.S. supplies and less than 1 percent of total world supply. While copper is an important source of revenue to the Project, the effect of the Project on the world market will certainly be far smaller than for zinc.

According to the U.S. Bureau of Mines, in 1978, the U.S. imports 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 as great as zinc, the monetary benefit to the U.S. balance of payments, attributed to Crandon's concentrate production, is approximately the same size.

The U.S. Bureau of Mines estimates that the demand for primary copper will grow at the rate of 2.4 percent per year from now 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 the jewelry and silverware trade. Progressively, silver has become a useful, if not critical, industrial product, with the principal uses being in electrical and electronics industry as a conductor, as a widely used constituent of brazing alloys in general industry, and as the basic chemical in photographic film.

About 55 percent of the western world silver supply is produced as a by-product of copper, lead, and zinc mining, with the remainder attributable to mines which principally produce silver metals. Total free world industrial consumption of silver in recent years has been 350 to 370 million ounces per year, with corresponding production being 250 to 270 million ounces. Accordingly, the typical short-fall in free world production of about 100 million ounces is made up from above ground stocks in the form of reprocessed coinage, investment bullion, and jewelry and silverware.

Silver available from mines in the U.S. represents an approximate balance with U.S. consumption. Mine production in the U.S. represents about 11 percent of western world consumption. In a typical year, the Crandon Project would produce approximately 2.4 million ounces of silver in all concentrates, most of which is ultimately recovered in smelting and refining. The dollar value of this silver metal does not, by any means, flow back in total to the mine because of the nature of smelter treatment charges.

Crandon does, however, represent a significant source for newly mined silver in the U.S. and would furnish 4 to 6 percent of domestic consumptive needs. 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, while supply and demand are now in balance, the U.S. can clearly support larger increases in silver production during the timeframe of mining the Crandon deposit.

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

According to the U.S. Bureau of Mines, world lead mine production in 1978 was approximately 3.4 M t (3.8 million short tons). The U.S. produced about 15 percent of this total, or 530,000 t (593,000 short tons). The Project's anticipated lead production of 11,000 t/y (12,320 short tons per year) represents an increase of about 2 percent in U.S. mine production and far less than 1 percent in total world production. Lead does, however, contribute to Project economics.

Gold - The Crandon Project expects to produce in all concentrates about 3.5 percent of United States mine production of gold and less than 0.1 percent of world-wide mine production.

According to the U.S. Bureau of Mines, the United States demand for fabricated gold from primary sources is about 3.4 million troy ounces per year. U.S. mine production provides only about 30 percent of that demand. Crandon's production would modestly increase U.S. coverage of its demand to 31 percent. The U.S. Bureau of Mines forecasts that demand will grow by about 75 percent by the year 2000, clearly indicating that there is a need for major increases in U.S. gold production capacity. As in the case of silver, the mine receives only a portion of the market value of the gold because of historic practices in the terms of precious metal smelting contracts.

1.1.3.2 Statutory Obligations

A summary of permits required to begin construction of the Project is presented in Table 1.1-2. The Applicant will submit the WPDES, mining, and air permit applications, and the Mine Waste Disposal Feasiblity Report with the EIR. The remaining applications will be filed within approximately 120 days of the initial filing.

1.1.3.3 Project Schedules

A mine/mill facility the type and size of the Crandon Project normally requires over 4 years to construct and start initial production of concentrates. Approximately 3 years are subsequently required to reach full production. Once in production, and based on estimated ore reserves, life of the mine/mill has been designed for 26 years. When the orebody is depleted and production ceases, another period of about 7 years will be required for closure and reclamation of the facilities. A condensed schedule for the Crandon Project is presented in Figure 1.1-4, which illustrates the time durations and relationships of major project activities, along with the estimated manpower required for each project phase. The schedule shown on Figure 1.1-4 represents practical dates. While the time intervals are achievable, the start date depends heavily on market and permitting factors as well as Exxon's corporate decision process.

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.

TABLE 1.1-2

PERMITS REQUIRED TO BEGIN CONSTRUCTION OF THE CRANDON PROJECT

Statutory Obligation	Administering Agency	Operating License	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	
30 U.S.C. 801 et seg	Dept. of Labor Mine Safety & Health Administration	File legal identity report	After issuance of mining permit prior to construction
STATE			
Wis. Stat. 23.11	DNR	EIR submittal	Determine adequacy
Wis. Stat. 30.12(2)(a)	DNR	Placement of structures	Permit issuance
Wis. Stat. 31.12(2)(d)	DNR	Placement of riprap	Permit issuance
Wis. Stat. 144.855(2)	DNR	Diversion of surface water	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

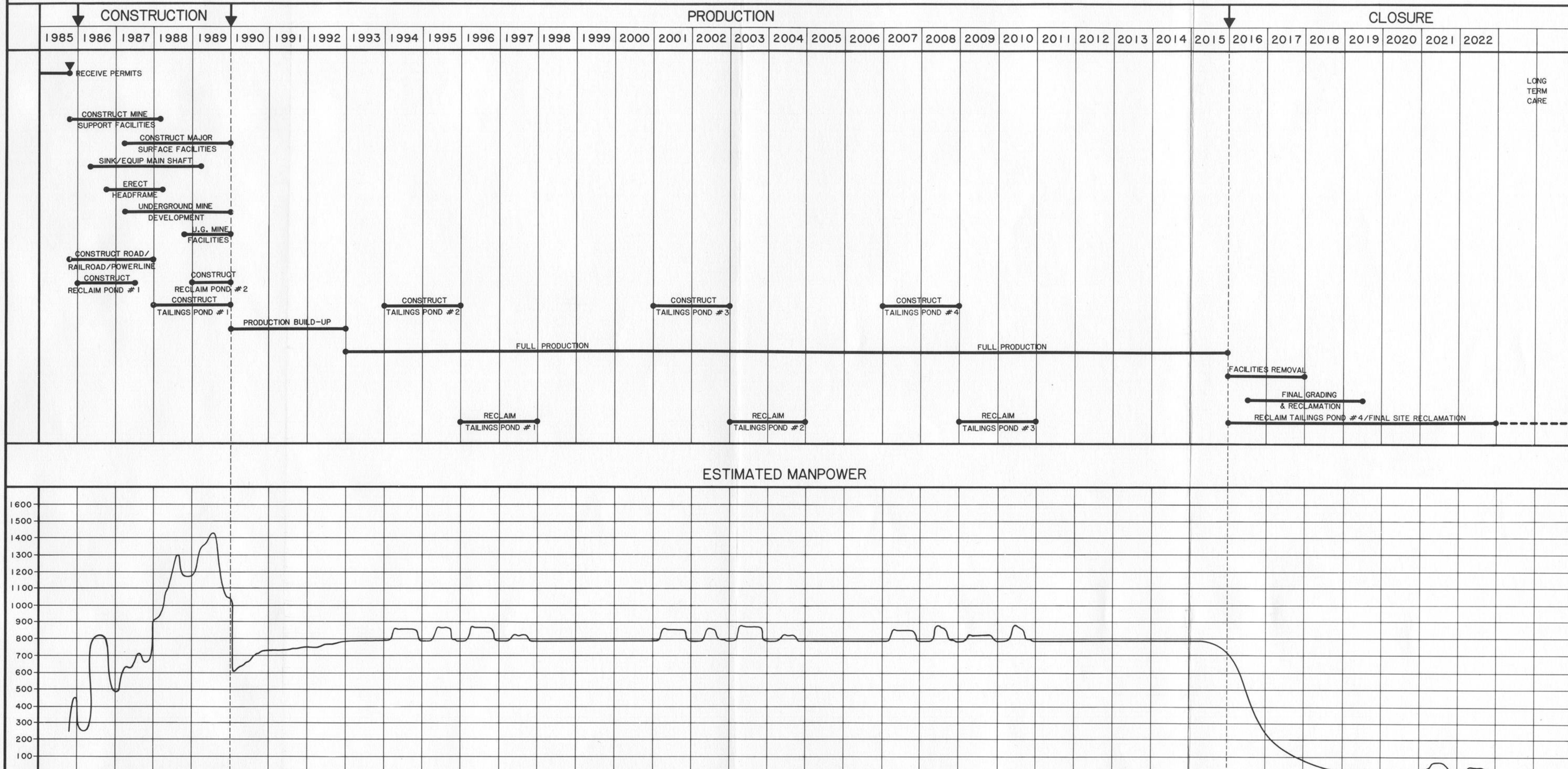
Table 1.1-2 (continued)

Statutory Obligation	Administering Agency	Activity	Action
Wis. Stat. 144.025(2)(e)	DNR	High capacity wells	Permit issuance
Wis. Stat. 144.04	DNR	Waste water treatment system	Plan approval
Wis. Stat. 144.20; 147.02	DILHR, Forest County and DNR	Private sewage system	Permit issuance (county) and review and approve final plans (DILHR)
Wis. Stat. 144.392	DNR	Air emission	Permit issuance
Wis. Stat. 144.44	DNR	Mine Waste Feasibility Report, Plan of Operation,	Approval
Wis. Stat. 144.85	DNR - Mining Permit		
Wis. Stat. 54.471; 144.46	DNR and Forest County	Shoreline/Floodplain zoning	Pipeline discharge route
Wis. Stat. Chap. 147	DNR	Water discharge	Permit issuance
Wis. Stat. Chap. 162	DNR	Potable water supply	Review and approve final plans

LOCAL

The Town of Lincoln has a zoning ordinance. It is expected that the Town of Nashville will have an ordinance relating to mining. Within 90 days, the Applicant will file for approvals with both towns and provide the Department with evidence of the filing.

EXXON MINERALS COMPANY
CRANDON PROJECT
SCHEDULE



	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
PEAK	447	867	717	1293	1442	712	746	775	782	868	879	884	822	782
AVG.	387	586	623	1077	1258	623	736	760	781	833	817	798	782	782

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
PEAK	782	782	869	867	893	822	782	782	858	886	822	880	782	782
AVG.	782	782	827	807	807	782	782	782	830	816	782	801	782	782

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022		
PEAK	782	782	782	800	250	80	25	25	78	58	1	1
AVG.	782	782	741	525	165	55	25	25	39	18	1	1

NOTE:

THE CONSTRUCTION STARTING DATE IS BASED UPON THE EXPECTED DATE OF PERMIT ISSUANCE AND THE DURATION OF SCHEDULED ACTIVITIES MAY VARY. THE ACTUAL CONSTRUCTION START DATE WILL VARY DEPENDING UPON PERMIT ISSUANCE AND ECONOMIC CONDITIONS.

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE **PROJECT SCHEDULE**

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY R.C. DIETZ	DATE 10/82	CHECKED BY H.S. [signature]	DATE 11/29/82
APPROVED BY	DATE	APPROVED BY	DATE
APPROVED BY	DATE	EXXON C.E. Fowler	DATE 11/29/82
DRAWING NO. FIGURE 1.1-4	SHEET OF		REVISION NO. 0

The time required for construction of the mine/mill surface facilities will be considerably 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 late in the second 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 3 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	5
Primary Crushing and Ore and Waste Hoisting	2	8	5
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, a period of approximately 7 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.

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 $715 million in 1982 dollars (Table 1.1-3). Capital and reclamation expenditures during operations are estimated to total $170 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 1.1-3 reflect current information and planning data. These numbers are expressed in 1982 dollars.

Each type of expenditure category is defined below:

Expenditure Category	Definition
Mine and Surface Facilities and Land	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.

TABLE 1.1-3

ESTIMATED PROJECT FACILITIES AND EQUIPMENT COSTS IN 1982 DOLLARS

Description	Construction ($M)	Operations ($M)	Total
Mine and Surface Facilities and Land	635	80	715
Pollution Control Facilities			
Water Treatment	40	---	40
Tailings	40	60	100
Reclamation	---	30	30
TOTAL	715	170	885

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.

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 1990 through the end of the Project life in 2015. 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 an 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 the local community development literature. The principal source of information was the North Central Wisconsin Regional Planning Commission (NCWRPC). In addition to the NCWRPC, representatives from Nicolet National Forest, Langlade County, and the Wisconsin Department of Transportation were contacted. The major goals identified are presented below.

One of these goals concerns the local educational system. 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 in Wisconsin.

The second specific plan identified was a proposed bypass to U.S. Highway 8 in the City of Crandon. This proposal was obtained from the Crandon Comprehensive Plan (NCWRPC, 1981a). 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. This is a long range project and is not expected to occur for 5 or more years.

At the county level, Forest, Langlade, and Oneida counties are working on Agricultural Land Preservation plans to be completed sometime in 1982. Under these plans, participants will be given the opportunity to apply for a state income tax credit for setting aside lands from economic development which have been zoned and identified as suitable for preservation for agricultural purposes (Jopek, 1982). The access road from State Highway 55 to the mine/mill site proposed by Exxon in its applications would be constructed across land which might be eligible for this program.

In addition to the specific items mentioned above, the Forest County Development Plan and the City of Crandon Comprehensive Plan contain general statements of goals, policies, and objectives regarding the proposed Project (NCWRPC, 1981a,b). 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 the greatest potential for new employment opportunities and that the City should promote diversification of industry and business and the development of new jobs.

In the process of identifying related governmental plans or goals, two additional items were examined, which, even though they are not related to the development of the Crandon Project, are mentioned in this subsection because of their scope. The first of these is the Nicolet National Forest Land Use Management Plan to be completed in late 1982 or early 1983. Even though details on this plan are not available at this time, the plan is not expected to include an expansion of the current boundaries of Nicolet National Forest (Moore, 1982). Since the mine/mill site is over 8 km (5 miles) from the nearest boundary, the development of the Crandon Project would not directly affect these planning activities. The second item is the potential abandonment of the Chicago and Northwestern Railroad line running from Rhinelander through Monico to Shawano. Abandonment of this line would not have any effect on the proposed Project since Exxon will be working with the Soo Line Railroad in its logistics planning.

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. Sludge from the sewage treatment will be removed from the site by a contractor to an approved disposal facility.

Part of the work force will be trained in fire fighting and fire protection will be provided from facilities on-site which will be capable of handling most fires that might occur. 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.

Security will be provided on-site by specially trained personnel. It is anticipated that outside law enforcement assistance would 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.

Road maintenance and snow removal will be performed by the work force or by contractors. Refuse will be removed from the site to an approved disposal area in the Town of Nashville by a contractor.

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 - On June 10, 1980, the Forest County Board of Supervisors approved and adopted a revised zoning ordinance prepared by the North Central Wisconsin Regional Planning Commission (1980). The new ordinance has not been accepted by any of the 14 towns in Forest County. However, any town ordinances affecting zoning must be submitted to, and approved by, the Forest County Board and the ordinance cannot be less restrictive than that currently in force for the County without specific County Board approval. In the proposed new ordinance there are no sections or requirements which would prohibit or unduly restrict the construction or operation of the Crandon Project.

Town of Lincoln - The Town of Lincoln Board of Supervisors has adopted a zoning ordinance written under the "Village Powers" concept adopted at the 1981 Annual Town Meeting (Town of Lincoln Zoning Ordinance, 1982).

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 currently has under consideration the adoption of some form of mining ordinance. There are currently no township regulations which would prohibit or restrict the construction or operation of the Crandon Project.

Langlade County - Langlade County is currently completing a comprehensive revision of the existing zoning ordinance (Langlade County Zoning Ordinance, 1982). Upon completion, the revised ordinance will be submitted to each township for adoption. The proposed ordinance had 3 overlay districts (Quarrying, Metallic Mining Exploration, and Mining) which could affect the operation of the Crandon Project if any segment should be located in or be part of a buffer zone requirement within Langlade County. The "Mining District" requirements of the proposed Langlade County ordinance include issuance of a Conditional Use permit by the Langlade County Zoning Office. Issuance of this permit requires the filing of a mining plan, a reclamation plan, and an adequate financial guarantee by bonding or the equivalent guarantee under NR 132.09.

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

Town of Ainsworth - The Langlade County Town of Ainsworth has not adopted current county zoning. However, on June 26, 1980, the Town Board imposed a moratorium on all metallic and uranium related mining activities in the Town of Ainsworth for a period of 10 years (Town of Ainsworth Mining Resolution, 1980).

Under current Exxon plans, this moratorium will not impact on the construction or operation of the Crandon Project because no Town of Ainsworth acreage is involved.

City of Crandon - The Crandon Municipal Code (1979) contains only one section which could affect the construction and operation of the Crandon Project. The Municipal Airport Zoning Ordinance (Chapter 21) restricts the height of structures within the approach paths and turning zones of the municipal airport. The height restrictions are established by, and are shown on, the "Zoning Map for the Crandon Municipal Airport, Forest County, Wisconsin," dated April 1959. The original FAA guidelines are still in effect and provide greater than 15 m (50 feet) of clearance above the height of the proposed headframe. At this time there are no plans to adopt more restrictive height limitations.

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 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

Bureau of Mines, 1980, Minerals facts and problems: U.S. Government Printing Office, Washington, D.C.

Crandon Municipal Code, 1979, Municipal Service Corporation, Madison. Chapter 21 Map: Zoning Map for the Crandon Municipal Airport, Forest County, Wisconsin.

Jopek, J., 1982, Langlade County Cooperative Extension Programs, Antigo, Wisconsin, personal communication (February 19).

Langlade County Zoning Ordinance, 1982, Draft in preparation.

Moore, T., 1982, Forest Planner, U.S. Forest Service, Rhinelander, Wisconsin, personal communication (February 16).

North Central Wisconsin Regional Planning Commission, 1980, Forest County Zoning Ordinance: Wausau, Wisconsin (Adopted June 10, 1980 by Forest County Board of Supervisors).

_________, 1981a, Crandon Comprehensive Plan Update 1981: Wausau, Wisconsin

_________, 1981b, Forest County Development Plan: Wausau, Wisconsin.

Scott, W. P., 1982, Metallic Mineral Exploration in Wisconsin, Summary of 1981 Activity: Mineral Resource Section Geological and Natural History, Madison, Wisconsin.

Town of Ainsworth Mining Resolution, 1980, Mining Moratorium - uranium and metallic mining, adopted June 26.

Town of Lincoln Zoning Ordinance, 1982, prepared by Donald Zuidmulder, Town Mining Attorney.

Travis, P. A., 1982, Director Mining Impact Center, Nicolet College and Technical Institute, Rhinelander, Wisconsin, letter communication (April 5).

1.2 DESCRIPTION OF FACILITIES

The facilities for the Crandon Project described herein are anticipated to include an underground mine, a mill to process a total nominal 9,100 t/d (10,000 short tons per day) of two types of ore, waste disposal, and ancillary facilities. Since the two types of ore (massive, a zinc-copper-lead ore in pyrite gangue and stringer, a copper-lead-zinc ore in a quartz matrix) will require somewhat different processing, the facilities will be constructed to mine, handle, store, and process the ores separately. The facilities will be designed based on proven and established technology and consistent with all applicable environmental and regulatory requirements.

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

The mine/mill surface facilities will be located in an area surrounding or adjacent to the main mine shaft and headframe. With the exception of the railroad spur and access road, the surface facilities require an area of about 81.3 ha (201 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.

The mine waste disposal facility will be located in an area approximately 2.4 km (1.5 miles) southeast of the mine/mill site. This facility, consisting of four tailing ponds, will be designed and constructed for safe surface disposal of waste 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 comprise about 202 ha (500 acres). Two reclaim water ponds will be located adjacent to the northwest side of the mine waste disposal facility and will ultimately encompass approximately 31 ha (77 acres).

The mine/mill site and the reclaim ponds and mine waste disposal facility will be connected by a 60 m (197 feet) wide corridor containing the waste rock haul road and the slurry and reclaim water pipelines. This corridor will be approximately 1 km (0.6 miles) in length from the interface point at the eastern side of the mine/mill site to the interface point at the northwest corner of reclaim pond No. R2.

The access road will connect the mine/mill site to State Highway 55 at a point about 4.8 km (3 miles) northwest of the site. The railroad spur will connect the mine/mill site to the Soo Line Railroad at a point about 4.3 km (2.7 miles) northeast of the site.

1.2.1 Mine

The underground mine will consist of the main shaft and ventilation shafts, extending from surface to the orebody, and of levels developed to gain access to portions of the orebody to be mined. Mining operations will be conducted in stopes, and the ore will be handled through a material handling and crushing system and hoisted up the main shaft to the surface. Mine surface facilities include a headframe with collar house, mine air heaters, backfill handling facilities, a change-house for underground personnel, and a source of compressed air. Each is described below.

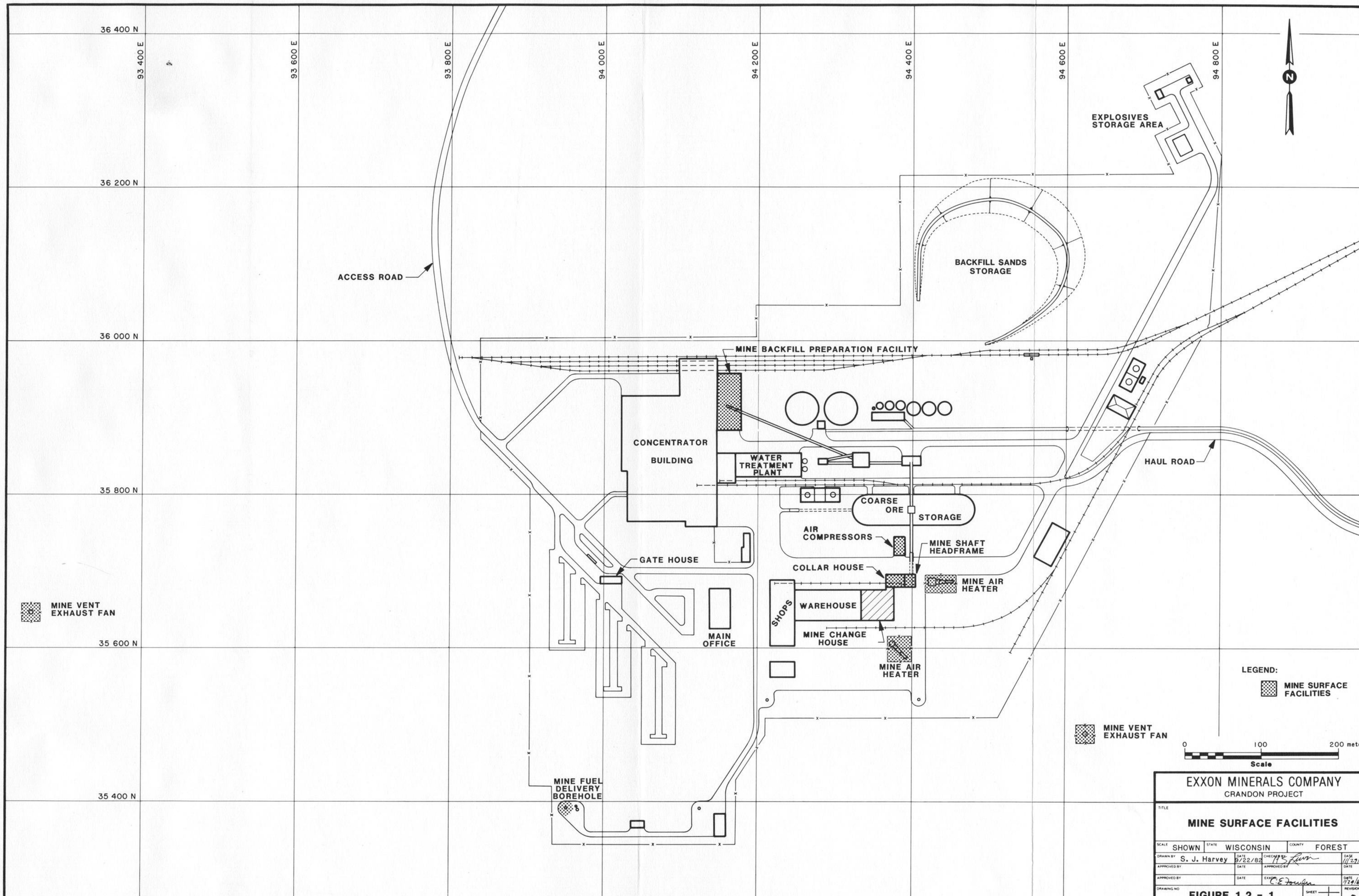
1.2.1.1 Mine Surface Facilities

The mine surface facilities are presented as shaded areas in Figure 1.2-1.

1.2.1.1.1 Headframe

A headframe structure will be positioned over the main shaft to house the shaft hoisting equipment, and to provide a discharge facility for the conveyances bringing rock up the shaft (Figure 1.2-1). This will be an enclosed structure approximately 78 m (258 feet) high with horizontal dimensions of about 15 m (48 feet) by 18 m (58 feet). An additional 8 m (26 feet) of the structure will extend below surface elevation (Figure 1.2-2). The headframe will house the production hoist, the main service hoist, and the auxiliary service hoist.

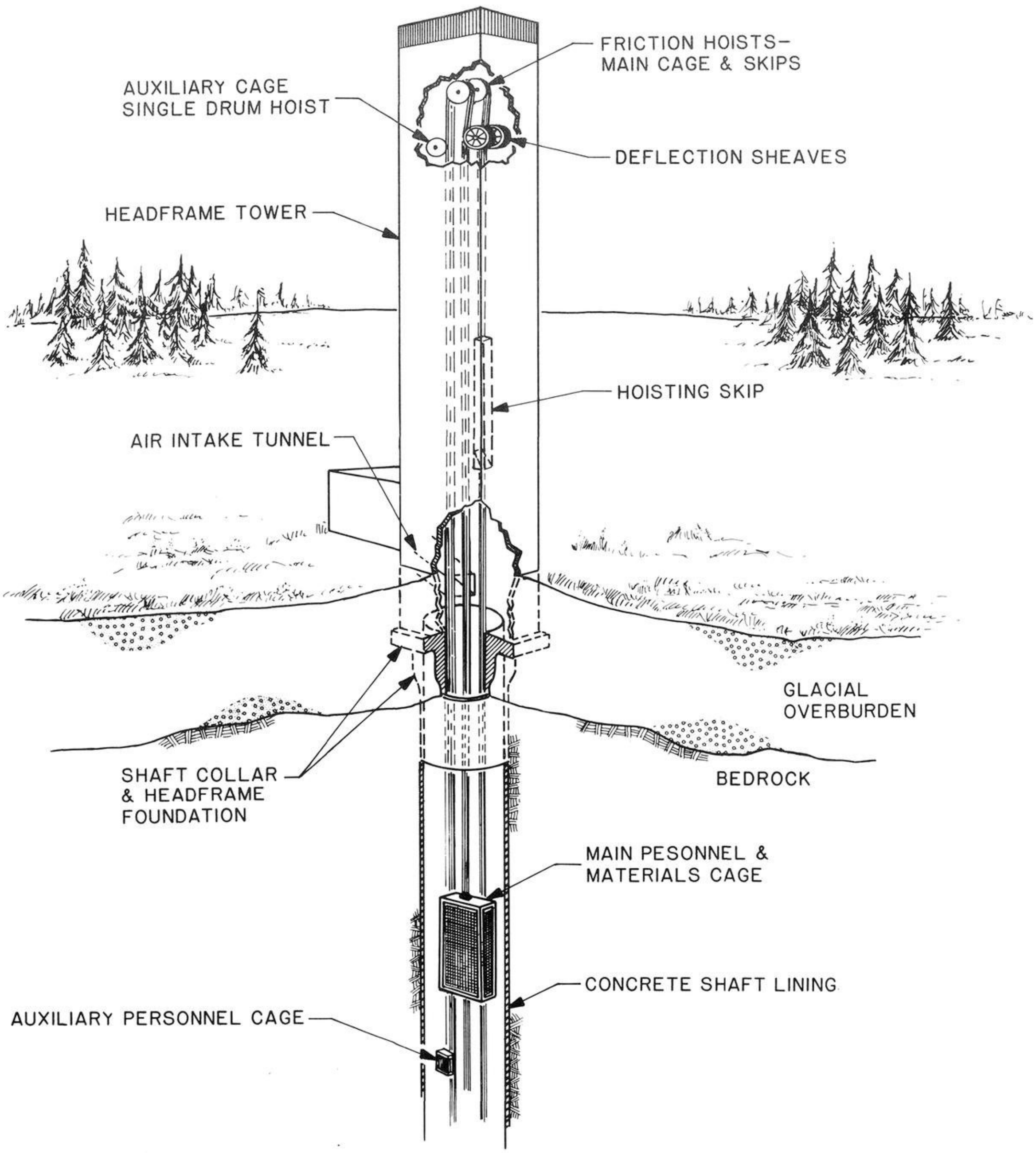
Two skips hoisted by the production hoist will empty mine rock into a discharge bin within the headframe. This bin will feed onto a conveyor belt, which will lead to the surface coarse ore storage building.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: MINE SURFACE FACILITIES

SCALE SHOWN	STATE WISCONSIN	COUNTY FOREST
DRAWN BY S. J. Harvey	DATE 9/22/82	CHECKED BY [signature] DATE 11/29/82
APPROVED BY	DATE	APPROVED BY DATE
APPROVED BY	DATE	EXXON C.E. Fowler DATE 11/29/82
DRAWING NO. FIGURE 1.2 - 1	SHEET 1 OF 1	REVISION NO. 0



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE			
MAIN SHAFT HEADFRAME			
SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY R.C. DIETZ	DATE 12/82	CHECKED BY J.E. GRIMES	DATE 12/8/82
APPROVED BY D.E. Moe	DATE 12/8/82	APPROVED BY	DATE
APPROVED BY	DATE	EXXON C.E. Fowler	DATE 12/8/82
DRAWING NO. **FIGURE 1.2-2**		SHEET 1 OF 1	REVISION NO. 0

Access to the shaft for equipment and materials will be through the headframe at the surface elevation. Mine services, such as compressed air, water, and electrical cables, also will enter through the headframe. The exterior of the headframe will be equipped with aircraft warning lights, as required by FAA regulations.

1.2.1.1.2 Collar House

The collar house will be located immediately adjacent to the mine hoist headframe structure. This facility will provide a protected collecting and laydown area for equipment and materials to be transported down the shaft into the mine.

1.2.1.1.3 Air Compressors

Compressed air requirements for the underground mine equipment have been combined with surface facilities air requirements. The surface and underground compressed air will be provided by compressors located in a compressor house shown on Figure 1.2-1. The compressors will be driven by electric motors.

1.2.1.1.4 Mine Air Heaters

A maximum of 873 m^3/s (1,850,000 cubic feet per minute) of fresh ventilation air entering the mine will be heated from ambient temperature to approximately 2°C (35°F) when necessary. Heating will be accomplished by direct-fired natural gas heaters positioned at the air intake portal of the main production shaft and at the fresh air intake shaft (Figure 1.2-1). Each heater will be equipped with a centrifugal fan to maintain the proper flow of

TABLE 1.2-1

APPROXIMATE DIMENSIONS OF SURFACE OPENINGS

Mine Opening	Dimensions
Main Shaft	7.3 m (24 feet) diameter
Intake Air Shaft	4.9 m (16 feet) diameter
Exhaust Ventilation Shafts	6.1 m (20 feet) diameter
Ventilation Raises	1.8 to 6.1 m (6 to 20 feet) diameter

air through the heater. The heated air will then mix with unheated air entering the shafts.

1.2.1.2 Mine Underground Facilities

1.2.1.2.1 Main Shaft

Principal access to the mine will be via the main shaft shown on Figure 1.2-1. This major facility will provide entry to and egress from the the mine for the purposes of transporting men and materials, as well as the hoisting of ore and waste rock to the surface. The facility will also house various services, including electric power conductors and water lines. A large percentage of the intake fresh air ventilation for the mine will be through this facility.

Present planning calls for a vertical shaft approximately 890 m (2,900 feet) deep. The diameter is as shown in Table 1.2-1. The upper 8 m (26 feet) will be incorporated in the headframe structure. An additional 25 m (82 feet) through glacial overburden and 9 m (30 feet) into bedrock will be lined with a reinforced concrete collar. The base of this collar will be grouted (inert grout) into the bedrock to provide a watertight seal.

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

The two skips will be used for hoisting ore and waste to the surface. Two personnel/materials cages also will be provided.

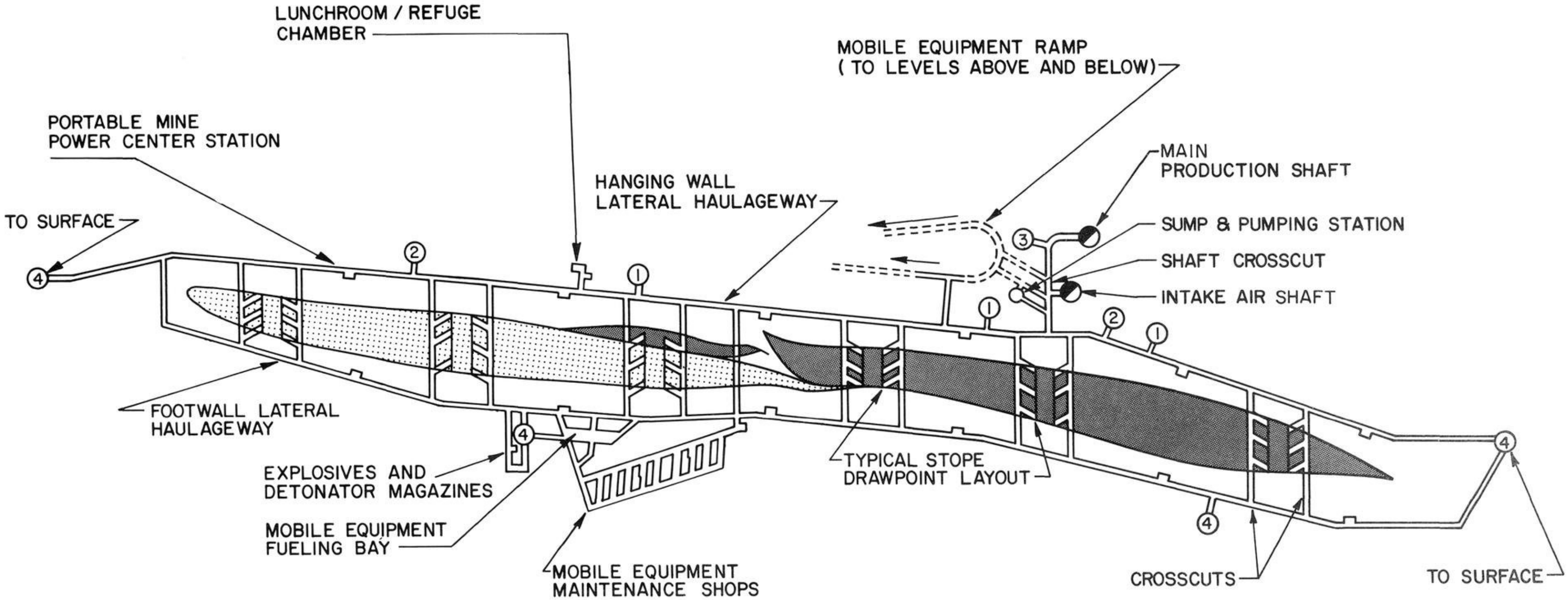
1.2.1.2.2 Ventilation Shafts

Fresh air will enter the mine through the main shaft and through an intake air shaft located between the main production shaft and the orebody (Figure 1.2-1; Table 1.2-1). The upper portion of this intake air shaft will consist of a reinforced concrete collar section supported on bedrock. The interface between the collar and the bedrock will be grouted to provide a watertight seal.

At each end of the orebody, exhaust air moved by fans will reach the surface through exhaust ventilation shafts (Figure 1.2-1). These shafts will be collared through the overburden using reinforced concrete. They will reach to the uppermost level of the mine. Below this level, a system of vertical and inclined shafts and horizontal passages will conduct the exhaust air from the mine workings to the fans at the top of the fans at the top of the exhaust air shafts.

1.2.1.2.3 Drifts

The nearly vertical Crandon orebody will be divided into mining levels by main mine levels approximately 120 m (394 feet) apart. The main level drifts will be large enough to provide clearance for the load-haul-dump (LHD) vehicles used in the mining process. All main levels will intersect both the main shaft and intake air shaft to aid in ventilation. A typical main level plan is shown on Figure 1.2-3. 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 extremity exhaust airways.



① MASSIVE ORE PASS
② STRINGER ORE PASS
③ WASTE PASS
④ EXHAUST AIR VENT

MASSIVE ORE
STRINGER ORE

NOTE: THIS DIAGRAM IS INTENDED TO BE REPRESENTATIVE OF A TYPICAL MINE LEVEL.

EXXON MINERALS COMPANY CRANDON PROJECT					
TITLE **UNDERGOUND MINE DRIFT PLAN**					
SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY S.J. HARVEY	DATE 7/82	CHECKED BY J.E. GRIMES		DATE 8/17/82	
APPROVED BY D. E. Moe	DATE 10/26/82	APPROVED BY C.E. Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO. **FIGURE 1.2-3**			SHEET 1 OF 1		REVISION NO. 0

A ramp decline will connect all mine levels to allow movement of equipment, supplies, and personnel throughout the mine. This centrally located ramp is presented in Figure 1.2-4.

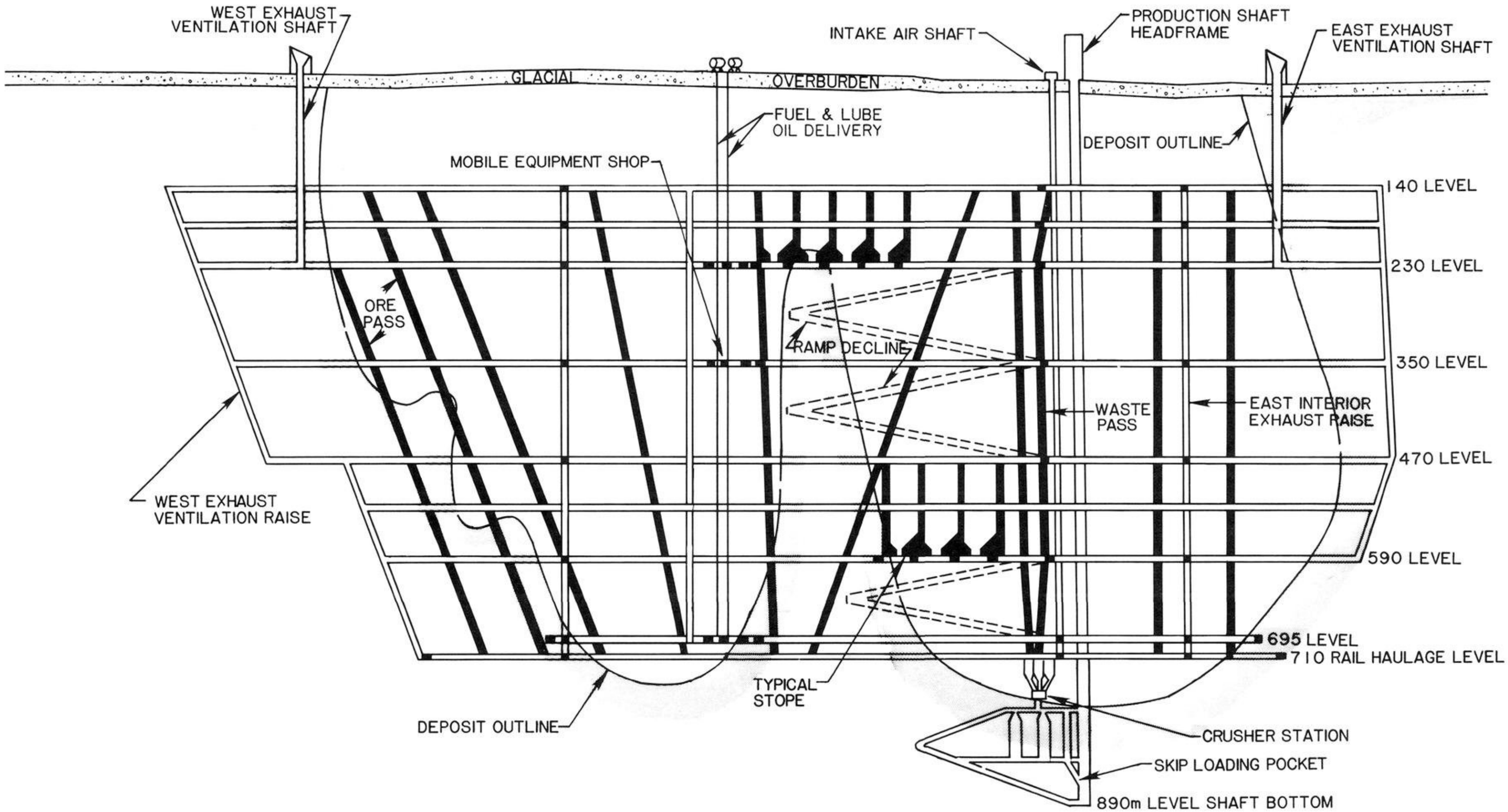
1.2.1.2.4 Stopes

For production purposes, the orebody will be divided into mining blocks or stopes. The main 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 broken ore removal (Figure 1.2-5).

1.2.1.2.5 Mine Electrical Power System

Electrical power will be supplied to the underground facilities from the surface facilities substation at 13,800 volts. In the event of a power outage on surface, 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 18,000 kva, including main production hoist. Separate electrical systems will be used to initiate all production blasts in the mine. Table 1.2-2 provides a representative list of major mine electrical equipment and estimated installed kilowatts and horsepower.



-NOT TO SCALE-

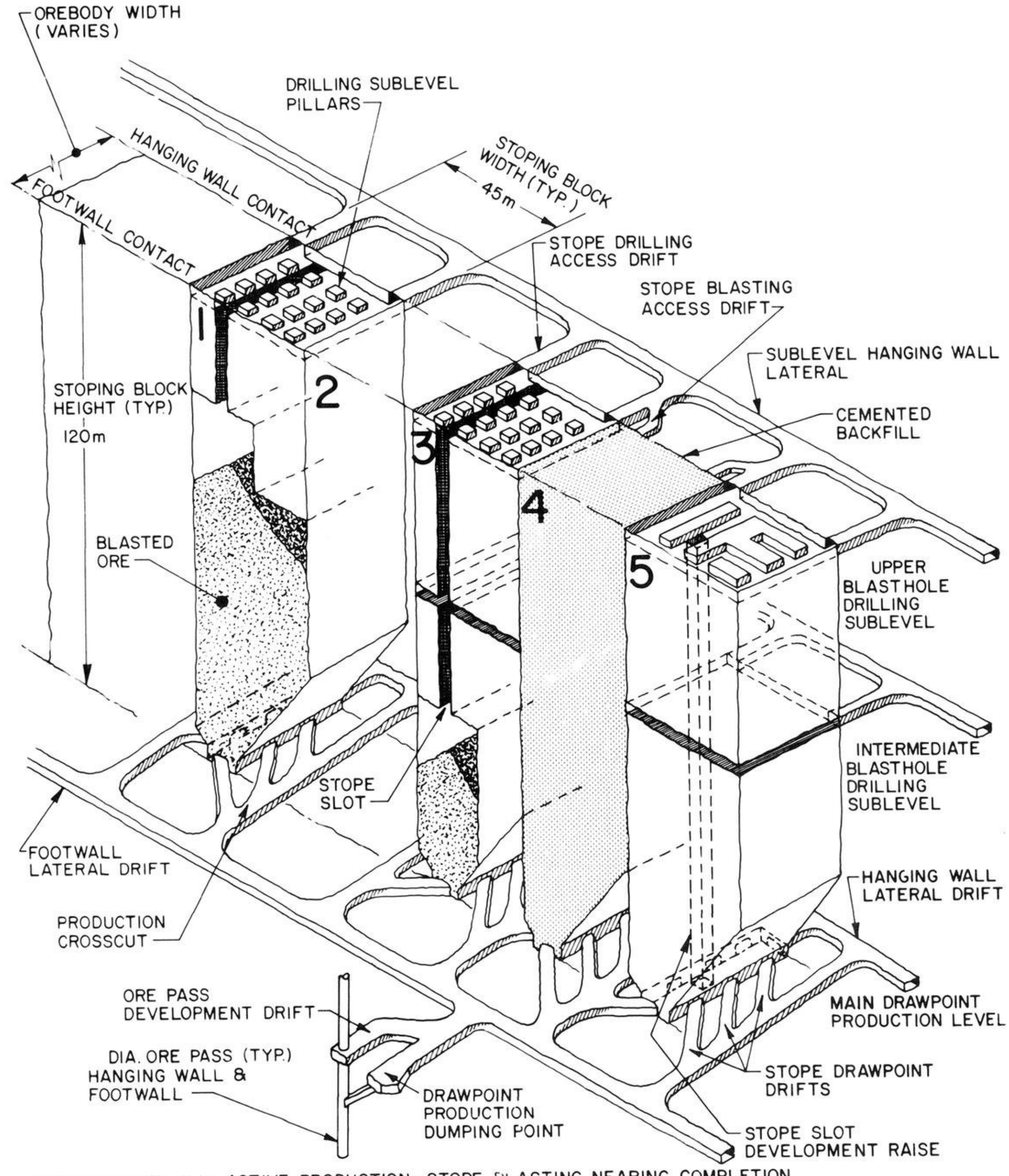
EXXON MINERALS COMPANY

CRANDON PROJECT

TITLE

UNDERGROUND MINE LONGITUDINAL SECTION SCHEMATIC

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY D.R.SPRINGBORN	DATE 9/82	CHECKED BY J.E. GRIMES		DATE 10/26/82	
APPROVED BY D.E. Moe	DATE 10/26/82	APPROVED BY C.E. Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO FIGURE 1.2-4			SHEET 1 OF 1	REVISION NO. 0	



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
UNDERGROUND MINE
TYPICAL STOPE BLOCKS

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY S.J. HARVEY	DATE 7/82	CHECKED BY J.E. GRIMES		DATE 8/17/82	
APPROVED BY D.E. Moe	DATE 10/26/82	APPROVED BY C.E. Fowler		DATE	
APPROVED BY	DATE	EXXON		DATE 10/26/82	
DRAWING NO.	**FIGURE 1.2-5**	SHEET 1 OF 1		REVISION NO. 0	

TABLE 1.2-2

MAJOR MINE ELECTRICAL EQUIPMENT

EQUIPMENT	KW	HP
Production Hoist	5300	7100
Cage Hoist	950	1275
Auxiliary Hoist	250	335
Crusher	298	400
Conveyors	298	400
Loading Pocket	179	240
Main Fans	2685	3600
Booster Fans	1400	1875
Main Pumps	2685	3600
Drills	1400	1900
Compressors	1790	2400
Locomotive	186	250

NOTE: This is a typical list of equipment and actual equipment may vary.

1.2.1.2.6 Communications System

Communications in the mine and between mine and surface will consist of telephone and/or radio systems.

1.2.1.2.7 Explosives

During operation of the mine, it will be necessary to store several days' supply of blasting materials (approximately 15,000-30,000 kg [33,000-66,000 pounds]) in underground magazines. Typically, two magazine areas will be located on 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 identified and constructed with non-sparking interiors and controlled access.

1.2.1.2.8 Maintenance Facilities

Daily service and inspection, periodic preventive maintenance, and component replacement and repair of mobile mining equipment will be conducted in two underground mobile equipment service shop areas. These areas will resemble a surface truck garage.

1.2.1.2.9 Mining Equipment

The proposed mining method will employ mobile mining equipment in all unit operations, including drilling, blasting, mucking, and support services. Most of the equipment will be rubber-tired and diesel-powered. The major exceptions will be the crawler-mounted production drills and electric rail haulage system rolling stock. Major mobile and portable equipment projections are presented in Table 1.2-3.

1.2.1.2.10 Ore Transport Facilities

Ore will be removed from the stopes on drawpoint levels at 120 m (394 feet) vertical intervals, using rubber-tired, diesel-powered load-haul-dump (LHD) units. The ore will be transported by the LHD's to nearly vertical ore passes leading down to the main rail 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 in Figure 1.2-6.

On the rail haulage level, railcars will be loaded through chutes. A train of 10 to 15 cars will be hauled by a locomotive to a central location near the production shaft, where the bottom dump cars will empty into a storage area and be fed into a crusher below.

At the crusher discharge, the minus 152 mm (6 inch) crushed rock will be conveyed to the storage bins. One of the bins will be used to store crushed waste rock. Feeders at the bottom of the bins will transport the rock to a conveyor and into a loading pocket at the shaft. This loading pocket will consist of two measuring flasks which will receive the broken rock until either a pre-set weight or a pre-set volume has been reached. When a hoisting conveyance is in position, the flask will discharge into it, and the rock will be hoisted to surface (Figure 1.2-6).

A dust control system consisting of dust collection hoods and ducting and/or water sprays will be installed at conveyor discharge points, the crusher opening and at other dust generation points. The entire crushing

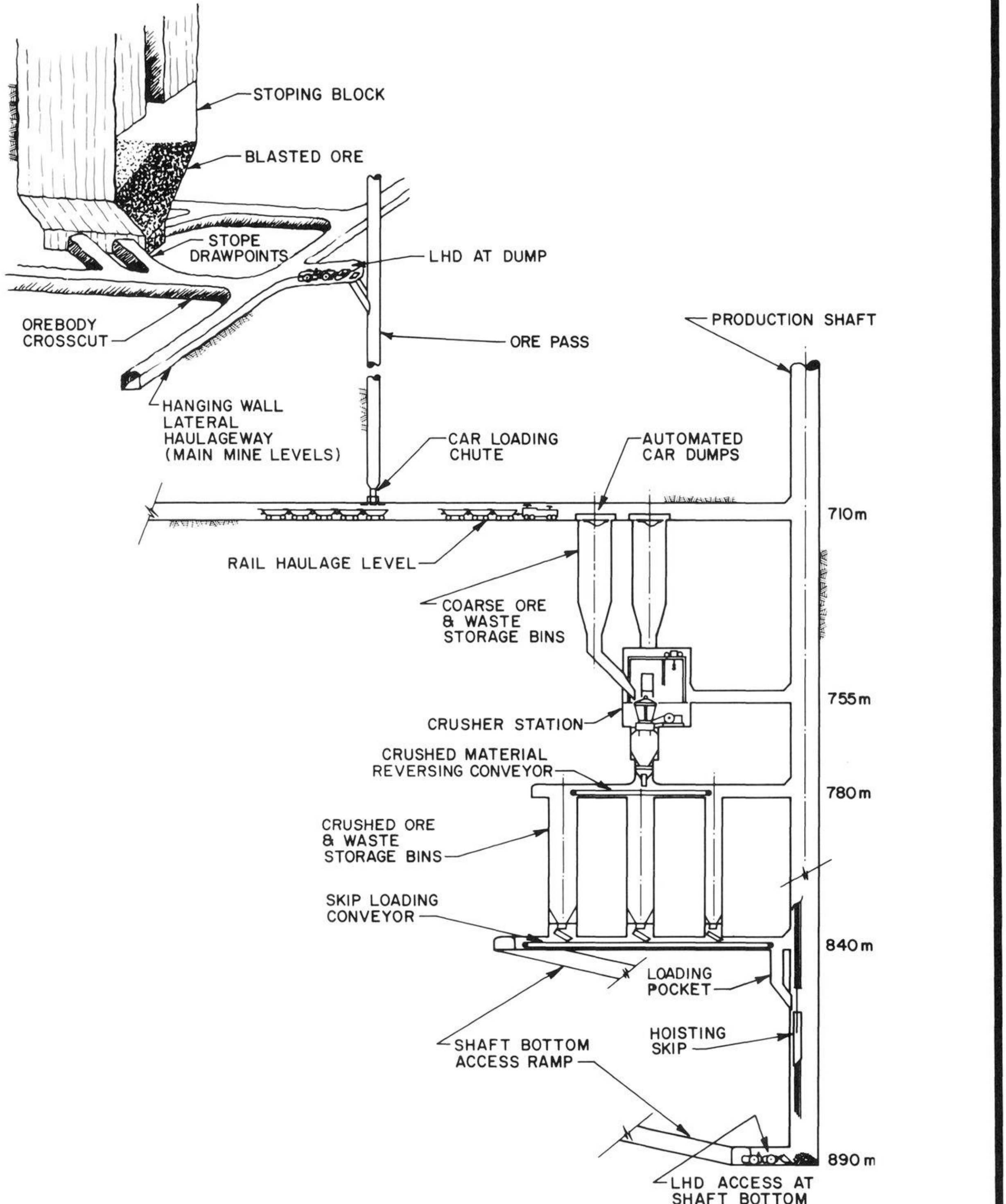
TABLE 1.2-3

ESTIMATED MOBILE EQUIPMENT REQUIREMENTS

DESCRIPTION	NO. REQUIRED*	HORSEPOWER (EACH)
Diesel Powered Rubber-tired Mobile Units		
Load-haul-dump (LHD) 6.1 m^3 (8 cubic yard)	28	250
Load-haul-dump (LHD) 3.8 m^3 (5 cubic yard)	6	180
Load-haul-dump (LHD) 1.5 m^3 (2 cubic yard)	3	140
Rear Dump Haulage Truck - 23.5 t (26 short tons)	3	270
Hydraulic Drill Jumbo - Twin Boom	6	140
Pneumatic Drill Jumbo - Triple Boom	1	140
Roofbolting Jumbo - Twin Boom	3	140
Fan Drill Jumbo - Twin Boom	2	140
Secondary Breakage Drawpoint Drill	3	50
Scissors Lift Service Truck	5	140
Utility Flatbed Truck	4	140
Explosives Transport/Loading Truck	9	140
Lubrication/Service Truck	2	140
Personnel Carrier (12 persons)	4	140
Utility Tractor	21	40
Ambulance/Emergency Vehicle	1	60
Utility End-loader - 0.4 m^3 (0.5 cubic yard)	2	60
Forklift - 2.7 to 5.4 t (3 to 6 short tons)	4	60
Road Grader/Dozer	3	140
Mobile Hydraulic Rock Breaker	2	50
Concrete Delivery Truck	4	140
Portable Mining Equipment		
Crawler Mounted Stope Blasthole Drill	6	80
Booster Air Compressor - 1723 kPa (250 pounds/inch^2)	6	300
Electric/Hydraulic Diamond Core Drill	5	50
Raise Boring Machine - 1.8 to 2.4 m dia. (6 to 8 feet)	2	250
Concrete/Shotcrete Placer	5	20
Grout Pumping Unit	2	60
500 kVA Mine Power Substation	17	---
Rail Haulage System Rolling Stock		
Locomotive - 22.7 t (25 short tons)	2	400
Waste/Ore Haulage Car - 10.0 m^3 (13 cubic yard)	25	---
Flatbed Material Transport Car	4	---

*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.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
TYPICAL ORE TRANSPORT SYSTEM

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY S.J. HARVEY	DATE 7/82	CHECKED BY J.E. GRIMES		DATE 8/17/82	
APPROVED BY D.E. Moe	DATE 10/26/82	APPROVED BY C.E. Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 1.2-6**		SHEET 1 OF 1		REVISION NO. 0	

and conveying system will be monitored and controlled from a central panel located in the crusher station.

1.2.1.2.11 Underground Primary Crusher

A crusher will be installed below the rail haulage level (Figure 1.2-6). Ore will be fed to this crusher by chain feeders and away from the crusher by a vibratory feeder onto a conveyor. Dust control will be provided as discussed in subsection 1.2.1.2.10.

1.2.1.2.12 Sanitation Facilities

Sanitation facilities compatible with modern U.S. Bureau of Mines approved facilities will be provided at several locations on each mine level within walking distance of most work locations.

1.2.1.2.13 Water Supply Facilities

Potable water and mine utility water will be individually distributed throughout the mine through pipes installed in the main shaft and the drifts. Potable water pipelines will be clearly identified.

Nominal mine consumption of potable water will be 0.006 m^3/s (10 gallons per minute). Mine utility and tool water will be recycled from the mine drainage system.

1.2.1.2.14 Fuel Handling and Storage

Diesel fuel for mine mobile equipment will be stored in one of two tanks located near the two underground mobile service shop areas. Each pair of tanks will be interconnected by piping so as to utilize one tank for live storage and the other for overflow capacity. The tanks will be filled from the surface through a steel pipe running through a steel casing in overburden and a borehole in rock. Fuel will be introduced to the top of the pipe from a measuring tank with a capacity less than the capacity of an individual tank underground. Valves controlling the filling and emptying of the tank will be interlocked to prevent placing fuel into the surface tank unless the line to underground is shut off. Thus, only the measured amount in the surface tank can be allowed to flow into the mine, and this will be done only when a pair of tanks is empty.

Each pair of tanks will be installed within a retaining wall with sufficient impoundment capacity to retain the entire capacity of the tanks in case of a leak. Adequate ventilation will be provided to each of the fueling stations to keep contaminates within the requirements of applicable codes. Tank ventilation will be discharged to the mine exhaust air system. Fire suppression equipment will be installed at each station. Individual vehicles can either be refueled at the fuel station by pumping directly from the storage tanks, or fuel can be hauled to remote parts of the mine in a tank truck.

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 include the following.

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

Warning System - The emergency warning system used to notify personnel underground utilizes an odor agent which, when released into the fresh air ventilation stream, quickly permeates 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 construction may be provided at shaft stations, mobile equipment repair shops, 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 shops for use there or for transport to a remote location.

In addition, each person underground will be provided with self rescuers and trained in their proper use, as well as the evacuation plan. Mine rescue apparatus with the necessary ancillary equipment will be located on the surface for use by properly trained personnel.

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

Water will enter the mine from ground water in the upper mine workings, backfill water, and water used within the underground mining process. Hydrologic studies indicate that unmitigated ground water flows into the mine due to the upper portion of the orebody being in close proximity to the main aquifer may result in a maximum flow of up to 0.126 m^3/s (2,000 gallons per minute) (Prickett, 1982). It is planned to reduce this flow from the ground water source by grouting through surface drill holes. The extent to which grouting may be applied is dependent upon both economic considerations and technical achievability. A reduction in the flow rate to 0.063 m^3/s (1,000 gallons per minute) may be attainable.

Mine waters, including those derived from backfill and underground mine processes, will be handled in two separate and independent systems. Mine waters will first be controlled by intercepting ground water as it enters the mine workings and, thus, prior to contamination. This will be accomplished by placing drill holes and drain galleries in the uppermost portion of the mine. This ground water interceptor system will have a separate pumping system with a capacity of 0.063 m^3/s (1,000 gallons per minute). This system is designated the ground water interceptor system.

Water which is not collectible in the above system will enter the mine as seepage and, along with all other mine water including backfill and that used in the underground mining process, will be collected in a separate system. This second system forms the normal mine-wide settling and pumping system, totally separate from the ground water interceptor system above. This water will be routed from these sumps to the water treatment plant through a system separate from the ground water interceptor system. The pumping station for this contaminated mine drainage will be located on the 350 M level and be designed to pump 0.1009 m^3/s (1,600 gallons per minute).

1.2.1.2.17 Personnel Facilities

Lunch rooms will be strategically located on each mine level within walking distance of most work locations, and will be provided as part of each mobile equipment shop and 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, screening and crushing of the ores hoisted to the surface, as well as the concentrator where the valuable minerals will be recovered from the ores to produce finished concentrates (Figure 1.2-7).

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

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

1) Ore handling facilities, consisting of a series of conveyors that will take the ore from the mine headframe and deliver it to the coarse ore storage;

2) Ore crushing facilities, where the ore is removed from the coarse ore storage, crushed and screened, and delivered to the fine ore bins;

3) Ore concentration, dewatering, and handling areas, where the ore is removed from the fine ore bins, ground, processed by flotation to concentrate the valuable minerals, and the concentrates dewatered and loaded for shipping;

4) Reagent mixing and storage facilities for the reagents used in the concentration process;

5) Backfill preparation system and spill control facilities, which will all be housed within the concentrator building; and

6) Tailing thickening and disposal.

A representative list of equipment associated with the mill is presented in Table 1.2-4. The approximate sizes, dimensions, and capacities are described, as appropriate, for each major phase of ore processing.

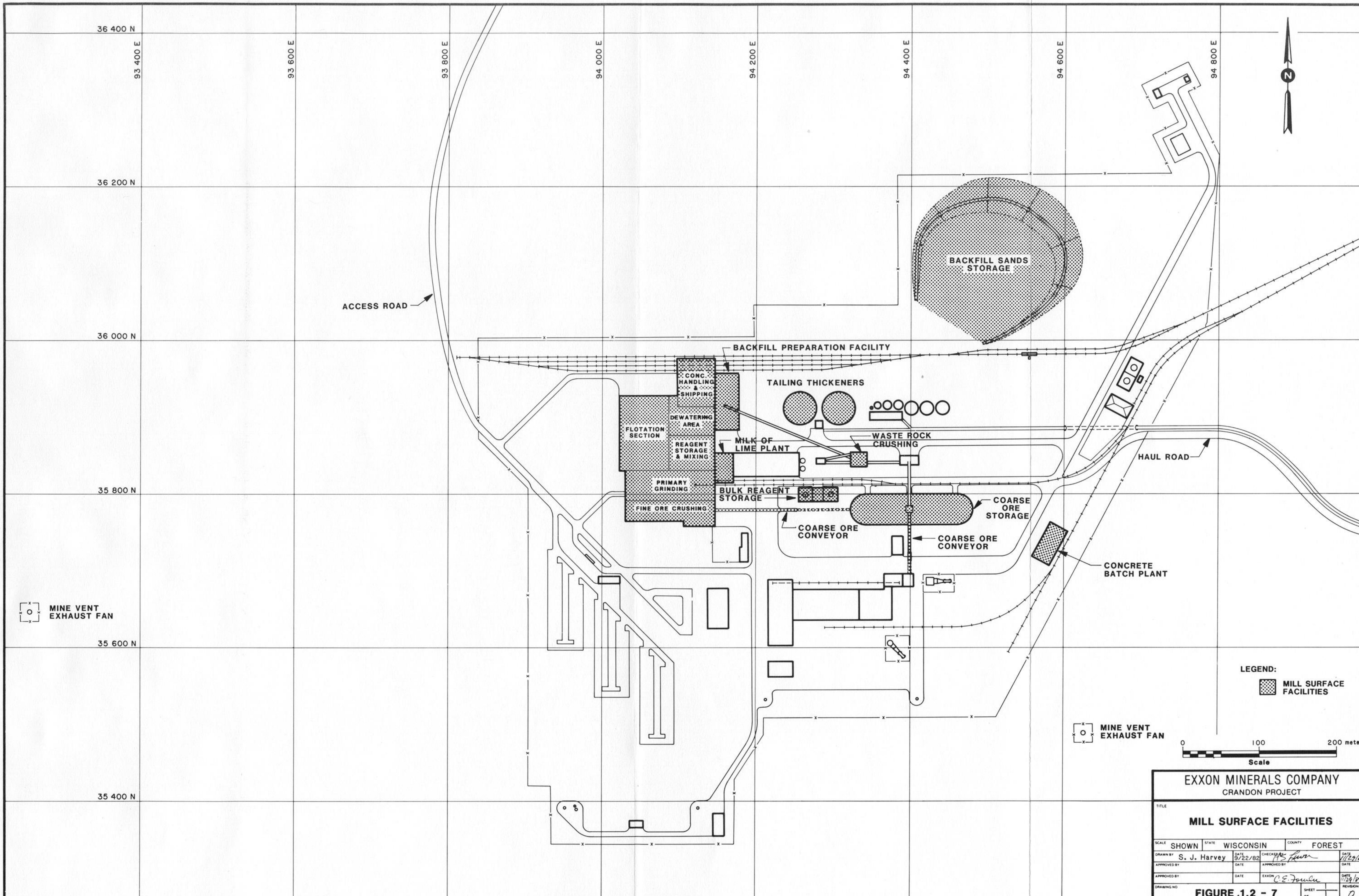

36 400 N
36 200 N
36 000 N
35 800 N
35 600 N
35 400 N
93 400 E
93 600 E
93 800 E
94 000 E
94 200 E
94 400 E
94 600 E
94 800 E
N
ACCESS ROAD
BACKFILL SANDS STORAGE
BACKFILL PREPARATION FACILITY
CONC. HANDLING & SHIPPING
TAILING THICKENERS
FLOTATION SECTION
DEWATERING AREA
REAGENT STORAGE & MIXING
MILK OF LIME PLANT
WASTE ROCK CRUSHING
PRIMARY GRINDING
FINE ORE CRUSHING
BULK REAGENT STORAGE
COARSE ORE STORAGE
COARSE ORE CONVEYOR
COARSE ORE CONVEYOR
HAUL ROAD
CONCRETE BATCH PLANT
MINE VENT EXHAUST FAN
MINE VENT EXHAUST FAN
LEGEND:
MILL SURFACE FACILITIES
0
100
200 meters
Scale
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
MILL SURFACE FACILITIES
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY S. J. Harvey
DATE 9/22/82
CHECKED BY
DATE 11/29/82
APPROVED BY
DATE
APPROVED BY
DATE
APPROVED BY
DATE
EXXON C. E. Fowler
DATE 11/29/82
DRAWING NO
FIGURE .1.2 - 7
SHEET 1 OF 1
REVISION NO 0

TABLE 1.2-4

MILL FACILITIES TYPICAL EQUIPMENT LIST

FACILITY	EQUIPMENT DESCRIPTION	SIZE	NUMBER UNITS	TOTAL HP
Ore Handling	Conveyor to Coarse Ore	914 mm x 97 m	1	150
	Conveyor Coarse Ore to Crusher	914 mm x 332 m	1	250
	Conveyors, Miscellaneous	-	16	200
	Miscellaneous	-	-	70
	TOTAL			670
Ore Crushing	Secondary Crusher	-	1	450
	Tertiary Crusher	-	1	450
	Bridge Crane	-	1	100
	Conveyor, Crusher Disc.	914 mm x 114 m	1	125
	Conveyor Screen Feed	914 mm x 100 m	1	125
	Conveyor Screen Disc.	914 mm x 112 m	1	75
	Conveyor to Fine Storage	914 mm x 117 m	1	50
	Screens	-	3	110
	Dust Collectors	-	5	110
	Miscellaneous	-	-	20
	TOTAL			1,615
Grinding	Rod Mill	3.7 Øm x 4.9 m	2	2,500
	Ball Mill	4.7 Øm x 7.6 m	2	6,000
	Pump, Cyclone Feed	-	4	800
	Aerator	-	2	450
	Blowers	-	2	120
	Miscellaneous	-	-	510
	TOTAL			10,380
Flotation	Flotation Machine	3 x 8.5 m^3	11	990
	Flotation Machine	4 x 8.5 m^3	5	600
	Flotation Machine	5 x 8.5 m^3	2	300
	Flotation Machine	7 x 8.5 m^3	3	630
	Flotation Machine	8 x 8.5 m^3	3	720
	Flotation Machine	9 x 8.5 m^3	3	810
	Flotation Machine	2 x 2.8 m^3	2	50
	Flotation Machine	3 x 2.8 m^3	3	120
	Flotation Machine	5 x 2.8 m^3	3	195
	Flotation Machine	6 x 2.8 m^3	2	160
	Flotation Machine	7 x 2.8 m^3	2	180
	Flotation Machine	8 x 2.8 m^3	3	300
	Flotation Machine	4 x 0.7 m^3	1	15
	Flotation Machine	10 x 0.7 m^3	1	40
	Blowers	6.7 m^3/s	3	900
	Blowers	4.2 m^3/s	1	150
	Pump, Tails Transfer	-	2	120
	Pump, Tails Transfer	-	2	150
	Pump, Dist. Feet	-	1	75
	Pump, Tails Transfer	-	2	200
	Miscellaneous Pumps	-	25	1,185
	Miscellaneous	-	30	100
	TOTAL			7,990

FACILITY	EQUIPMENT DESCRIPTION	SIZE	NUMBER UNITS	TOTAL HP
Regrind	Ball Mill, Regrind	2.1 mØ x 4.0 m	2	600
	Ball Mill, Regrind	2.4 mØ x 6.1 m	2	1,400
	Pump, Cyclone Feed	-	4	200
	Miscellaneous Pumps	-	4	70
	TOTAL			2,270
Concentrate Thickening & Shipping	Thickener	15.2 mØ x 3.1 m	1	5
	Thickener	21.3 mØ x 3.1 m	1	5
	Thickener	15.2 mØ x 3.1 m	1	5
	Thickener	30.5 mØ x 3.1 m	1	10
	Filters, Pressure	-	7	280
	Conveyors, Miscellaneous	-	9	50
	Pumps, Miscellaneous	-	19	170
	Miscellaneous	-	-	25
	TOTAL			550
Reagent Prep.	Ball Mill, Burnt Lime	1.5 mØ x 2.5 m	1	50
	Tank, $ZnSO_4$ Mixing	4.0 mØ x 4.0 m	1	5
	Tank, $ZnSO_4$ Storage	4.0 mØ x 4.0 m	1	-
	Tank, $ZnSO_4$ Storage	2.5 mØ x 3.0 m	1	-
	Tank, NaCN Mixing	3.0 mØ x 3.0 m	1	5
	Tank, NaCN Storage	3.0 mØ x 3.0 m	1	-
	Tank, NaCN Storage	2.0 mØ x 2.0 m	1	-
	Tank, NaEX Mixing	3.0 mØ x 3.0 m	1	2
	Tank, NaEX Storage	3.0 mØ x 3.0 m	1	-
	Tank, NaEX Storage	2.0 mØ x 2.0 m	1	-
	Tank, PAX Mixing	2.0 mØ x 2.0 m	1	2
	Tank, PAX Storage	2.0 mØ x 2.0 m	1	-
	Tank, PAX Storage	1.0 mØ x 2.0 m	1	-
	Tank, $CuSO_4$ Mixing	5.5 mØ x 7.5 m	1	15
	Tank, $CuSO_4$ Storage	5.5 mØ x 7.5 m	1	-
	Tank, $CuSO_4$ Storage	4.0 mØ x 6.0 m	1	-
	Tank, SO_2 Storage	44 m^3	3	-
	Tank, Floc Mixing	5.5 mØ x 7.5 m	1	2
	Tank, Floc Storage	5.5 mØ x 7.5 m	2	-
	Tank, Floc Storage	2.0 mØ x 3.0 m	1	-
	Tank, $Na_2Cr_2O_7$ Storage	91 m^3	1	-
	Tank, $Na_2Cr_2O_7$ Mixing	5.0 mØ x 4.0 m	1	10
	Tank, $Na_2Cr_2O_7$ Storage	5.0 mØ x 4.0 m	1	-
	Tank, $Na_2Cr_2O_7$ Storage	2.0 mØ x 3.0 m	1	-
	Tank, NaIX Mixing	3.0 mØ x 4.0 m	1	3
	Tank, NaIX Storage	3.0 mØ x 3.0 m	1	-
	Tank, NaIX Storage	2.5 mØ x 2.5 m	1	-
	Tank, CMC Mixing	4.0 mØ x 4.5 m	1	15
	Tank, CMC Storage	4.0 mØ x 4.5 m	1	-
	Tank, CMC Storage	3.0 mØ x 3.0 m	1	-
	Tank, D.A.D.C. Day Tank	1.0 mØ x 2.0 m	1	-
	Tank, D.A.D.C. Storage	1.0 mØ x 2.0 m	1	-
	Tank, Na_2SiO_3 Mixing	4.5 mØ x 5.5 m	1	10
	Tank, Na_2SiO_3 Storage	4.5 mØ x 5.5 m	1	-
	Tank, Na_2SiO_3 Storage	2.0 mØ x 3.0 m	1	-

FACILITY	EQUIPMENT DESCRIPTION	SIZE	NUMBER UNITS	TOTAL HP
Reagent Prep. (Con't)	Tank, Na_2CO_3 Mixing	5.5 mØ x 7.0 m	1	15
	Tank, Na_2CO_3 Storage	5.5 mØ x 5.0 m	1	-
	Tank, Na_2CO_3 Storage	5.0 mØ x 5.0 m	1	-
	Tank, Na_2S Mixing	5.5 mØ x 7.5 m	1	15
	Tank, Na_2S Storage	5.5 mØ x 7.5 m	1	-
	Tank, Na_2S Storage	4.5 mØ x 4.0 m	1	-
	Tank, P.P.E. Storage	2.0 mØ x 2.0 m	1	-
	Tank, P.P.E. Storage	1.0 mØ x 2.0 m	1	-
	Tank, MIBC Storage	2.0 mØ x 2.0 m	1	-
	Tank, MIBC Storage	1.0 mØ x 2.0 m	1	-
	Tank, H_2SO_4 Day Tank	91 m^3	1	-
	Tank, H_2SO_4 Storage	2.5 mØ x 3.5 m	1	-
	Pumps, Miscellaneous	-	36	105
	Tank, Slacked Lime Stor.	-	-	10
	Tank, Lime Distribution	-	-	10
	Miscellaneous	-	-	235
	TOTAL			509
Tailings Thickener	Thickener	41 mØ x 3.1 m	2	50
	Pump, Thickener Overflow	-	3	900
	Pump, Thickener Underflow	-	2	350
	Pump, From Reclaim	-	3	300
	Miscellaneous	-	-	100
	TOTAL			1,700
Batch Plant	Conveyor, Pneumatic	-	-	150
	Cement Batcher	-	-	40
	Miscellaneous	-	-	20
	TOTAL			210
Backfill Preparation & Handling	Conveyor	914 mm x 94 m	1	60
	Conveyor, Miscellaneous	-	3	70
	Pump, Cyclone Feed	-	2	500
	Pump, Cyclone Feed	-	2	200
	Pump, Transfer	-	2	200
	Pumps, Miscellaneous	-	5	180
	Crusher	-	2	500
	Screen, Single Deck	-	1	25
	Crane, Bridge	-	1	125
	Miscellaneous	-	-	110
	TOTAL			2,100
Backfill Storage	Tank, Sand Storage	6,900 m^3	1	-
	Tank, Cement Storage	2,000 m^3	3	-
	Tank, Crushed Waste Stor.	3,000 t	1	-
	Dust Collectors	-	2	60
	Miscellaneous	-	-	60
	TOTAL			120

FACILITY	EQUIPMENT DESCRIPTION	SIZE	NUMBER UNITS	TOTAL HP
Water Treatment Plant	Compressors, Vapor	-	2	4,000
	Pumps, R.O. Feed	-	6	1,050
	Pump, Discharge Water	-	2	300
	Pumps, Miscellaneous	-	-	600
	TOTAL			5,950
Lighting	-	-	-	1,300
Utilities, HVAC	-	-	-	2,750
	TOTAL			4,050
	GRAND TOTAL			38,194

NOTE: While this list is representative, it is only 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, availability, and design optimization.

1.2.2.1 Ore Handling

After hoisting coarse ore to the surface, it will be conveyed to one of the coarse ore stockpiles (massive or stringer) in the coarse ore storage building. The coarse ore building will be an unheated, enclosed steel structure. The stockpiles will hold approximately 40,000 t (44,100 short tons) of massive and stringer ore. A concrete tunnel below the stockpiles will house feeders for reclaiming the stockpiled ore. The feeders will transfer the coarse ore (either massive or stringer) onto a belt conveyor which will transport the material in a tunnel and conveyor gallery to the fine crushing facility.

Belt scales will be installed on appropriate conveyors to record the quantity of material flowing through the system. Metal detectors and magnets will also be provided on specific conveyors so that stray pieces of metal can be detected and removed, thus preventing equipment damage.

Water sprays and scrubbers will be used for dust control in the ore handling facility. Passive filter vents will be installed on top of the ore surge bins. A wet scrubber system will be used at the fine ore bins.

Preproduction ore will be transported by truck from the headframe to a prepared laydown area in the waste disposal facility. This prepared laydown area will provide storage for both preproduction ore and waste rock, and will be lined. Any precipitation on either the preproduction ore or waste rock will be collected for treatment prior to discharge.

1.2.2.2 Ore Crushing

Fine ore crushing facilities will reduce the ore from minus 152 mm (6 inches) as it comes from the mine, to approximately minus 19 mm (0.75 inch) in two stages of crushing. Coarse ore will be removed from the surge bin and screened to approximately minus 19 mm (0.75 inch), allowing the fine ore to bypass the crusher and be conveyed directly to the massive and stringer fine ore bins. Oversize material from the screen will be crushed in a secondary crusher, and then conveyed to a surge bin. From this bin, material will be conveyed to the tertiary crushing system, where two screens will separate the fines. The fines will be conveyed to the fine ore bins. The oversize material from the screen will be fed to the tertiary crusher. The crushed material will be returned to the surge bin. This re-cycling of material from the surge bin to the screen, through the tertiary crusher, and back to the surge bin, will ensure that only approximately minus 19 mm (0.75 inch) material will pass through to the grinding circuit.

1.2.2.3 Concentrating

The concentration of minerals from the ore will take place in a building located northwest of the mine production shaft (Figure 1.2-7). The equipment required for extracting the copper, lead, and zinc 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 levels 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 which will also help to attenuate the noise emanating from the equipment.

1.2.2.4 Ore Treatment

The facilities for concentrating the ore will include grinding and flotation circuits (Figure 1.2-7). The grinding mills will liberate, through size reduction, valuable mineral particles from the gangue particulates. The flotation circuits will concentrate the zinc, copper, and lead minerals into three separate concentrate products. This facility will also include thickeners and filters for dewatering the concentrates produced.

Grinding - Fine ore will be transported from the fine ore bins by a system of feeders and belt conveyors to their respective grinding circuits. Here the ore will be further reduced in size by wet grinding, the first step of liberating the copper, lead, and zinc minerals. Ore and water will be fed to a rod mill where the ore will be ground by the tumbling action of the rods. The rod mill discharge will be pumped to classifiers for particle sizing. Coarse particles will be transferred to a ball mill, ground still further, and then returned to the classifiers. Fine particles from these classifiers will flow to aerators in which the slurried ore will be conditioned by adding air and reagents before it is pumped to the flotation circuit for concentrate recovery.

Flotation - The conditioned ore slurry will be pumped 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 disposal. The final concentrates of the zinc, copper, and lead minerals will be delivered to separate dewatering and filtering facilities. All slurries will flow by gravity whenever 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 concentrates will be reground as part of the flotation process. The regrind mills will be in a closed circuit with classifiers which will separate the fine and coarse particles, advancing the fine particles to the flotation system for mineral concentration and the coarse particles back to the regrind mills for further grinding.

Dewatering, Handling and Shipping - The final step in the concentration process will be dewatering of the copper, zinc, and lead concentrates to a low moisture content for ease of handling and reduced cost in shipping. The three concentrates will be individually dewatered in a two-step process. Each concentrate will be pumped into a thickener. The solids will settle to the bottom of the thickener, and will be mechanically raked to the center for collection. The clarified water will overflow the top edge of the thickener and will be collected in a sump for pumping to the reclaim water pond, tailing thickener, or returned directly to the process. The thickened slurry from the center of each thickener will be pumped to pressure filters for final dewatering. The dewatered concentrates will be conveyed to the concentrate storage and loadout facilities.

1.2.2.5 Reagent Storage and Mixing

This facility will be designed for preparation of different reagents and will store enough prepared reagents for continuous operation of the concentrator and water treatment facility. The types and approximate quantities of reagents anticipated to be used in the mill and water treatment are described in Tables 1.2-5 and 1.2-6.

A variety of flotation and flocculation reagents will be required for the selective recovery and concentration of the zinc, copper, and lead minerals. The facility will be divided into two separate areas, one for the storage of bagged and drummed reagents, and one for the storage of bulk liquid reagents. Bagged and drummed reagents will be stored within the mill building adjoining the flotation circuits. This area will be designed for service by rail or by truck.

Sulfur dioxide (SO_2) will be received in liquid form in rail tank cars and will be stored in liquid form in three tanks located outside the concentrator building. These tanks will be enclosed to contain accidental spills. The liquid sulfur dioxide (SO_2) will be converted in an absorption tower to sulfurous acid in the concentrator where it is utilized in the flotation process.

A facility will be designed to prepare milk of lime (MOL) from burnt lime, and will be located in an enclosed section adjacent to the mill building. Lime will be delivered in the form of burnt lime by either truck or covered railcar. Dust control equipment will be provided as required. All material transfer points will be equipped with dust collection hoods connected to a wet scrubber. Dust will be collected in a wet scrubber and returned as a slurry to the process stream.

TABLE 1.2-5

TYPICAL PRIMARY REAGENT DATA

CHEMICAL	NORMAL RECEIPT MODE	NORMAL STORAGE	STORAGE CAPACITY kg	STORAGE CAPACITY POUNDS
Mill				
Sulfur Dioxide SO_2	Tank Car	Liquid	68,000	150,000
Copper Sulfate $CuSO_4 \cdot 5H_2O$	Railcar	Granular	136,100	300,000
Sodium Cyanide NaCN	Truck	Briquette	16,300	36,000
Polypropylene Glycol Methyl Ether	Truck	Liquid	22,700	50,000
Sodium Sulfide $Na_2S \cdot 9H_2O$	Railcar	60% Flake	104,300	230,000
Xanthates	Truck	Pellet	28,600	63,000
Zinc Sulfate $ZnSO_4 \cdot 7H_2O$	Truck	Granular	24,500	54,000
Starch	Truck	Powder	13,600	30,000
Sodium Dichromate $Na_2Cr_2O_7 \cdot 2H_2O$	Truck	Liquid	53,100	117,000

TABLE 1.2-5 (continued)

CHEMICAL	NORMAL RECEIPT MODE	NORMAL STORAGE	STORAGE CAPACITY kg	STORAGE CAPACITY POUNDS
Mill				
Sodium Silicate Na_2SiO_3	Tank Car	Liquid	79,600	175,000
Carbon	Railcar	Powder	34,000	75,000
Methyl Isobutyl Carbinol	Tank Car	Liquid	36,300	80,000
Lime CaO	Railcar	Pebble	1,200,000	2,640,000
Water Treatment				
Soda Ash Na_2CO_3	Railcar	Powder	340,100	750,000
Sulfuric Acid H_2SO_4	Truck	Liquid	30,600	67,500
Sodium Hexametaphosphate	Truck	Granular	3,200	7,000
Flocculant	Truck	Liquid	18,200	40,000

Table 1.2-6

SECONDARY PROCESS REAGENTS*

REAGENT	NORMAL STORAGE FORM	NORMAL RECEIPT MODE
Dialkyldithionocarbamate	Liquid	Drums
Sulfuric Acid	Liquid	Drums or Truck
Sodium Diethyl Dithiophosphate plus other organic homologs	Liquid	Drums
Flocculants - other polyacrylamide copolymers	Powder or Liquid	Drums or Bags
Dewatering Aid	Liquid	Drums
Aryldithiophosphoric Acid	Liquid	Drums
Starch	Powder	Drums or Bags
Lignin Sulfonates	Powder	Drums or Bags
Other Xanthates	Pellets	Drums

*The above list of reagents will be used in the process on an "as needed" basis. For this reason, the reagents have been classified as "Secondary Process Reagents."

Bulk shipments received will be transferred from truck or railcar to one of two 600 t (661 short ton) covered bins for storage. The lime will be reclaimed from the bins and fed into a lime slaking circuit. Milk of lime will be stored in tanks, and pumped as needed to a distribution tank located in the reagent mixing and handling area. Reagents requiring special storage will be discussed in subsection 1.4.3.10.

1.2.2.6 Concentrator Control Room

The main control room will be appropriately located within the concentrator building. The control system equipment will be tied into panels which will include start-up warning alarms, electrical and mechanical interlocks, emergency stop switches, controls, and alarms.

1.2.2.7 Mechanical Equipment

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

The other buildings comprising the surface facility will also have self-contained heating units, as may be required. Examples of buildings to be included are the maintenance shop, guard house, and waste water treatment plant.

1.2.2.8 Tailing Thickening

The tailing thickeners will be uncovered at grade level (Figure 1.2-7). The cyclone overflow from the backfill preparation facility, described in subsection 1.2.2.11 will be pumped to thickeners. Solids that settle to the bottom of the tank will be raked to the center for collection and pumping to the tailings pond for disposal. Excess water will overflow the top edge of the thickeners. A portion of this water will normally be recycled to the mine backfill preparation facilities and the remainder pumped to the water 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 1.2-7), and will be served by a railroad system. Each of the three final concentrates will have a separate, loadout facility. The final concentrates will normally be loaded directly into and shipped in covered railcars. Lead concentrate will be stored in a bin when it cannot be directly loaded into railcars. Separate surge storage areas for copper and zinc concentrates will also be available in the concentrator building to store approximately 8 day's production of each concentrate. The concentrates will be reclaimed from the surge storage by front-end loaders.

1.2.2.10 Spill Control Facilities

Liquid and slurry spill containment and disposal facilities will be located in each of the major processing areas. Process spills will be restricted to confined areas, collected in floor sumps, and pumped back into their respective separate processes, so that valuable materials can be recovered and to prevent surface water pollution.

Spills from the various reagent preparation and storage areas will be contained within curbed areas and pumped to a spill control surge tank. Recovered spills will either be reused or disposed off-site in an approved disposal facility.

In the lime slaking area, a sloping floor will channel spills into a sump from where the material will be pumped to the tailing thickeners for disposal.

Spills in corridors containing process piping (e.g., tailings lines and backfill lines) will be channeled into drainage trenches, collected in sumps, and returned to the process.

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 utilize essentially all of the coarse sands fraction of the mill tailings. A portion of the crushed waste rock may also will be utilized as backfill. The mine backfill sands will be pumped as a slurry from the backfill preparation facility to two boreholes connected to the underground handling facilities.

The probable locations of the backfill preparation plant, the waste rock crusher, and the backfill (sands) temporary storage area are shown on Figure 1.2-7.

The backfill preparation plant will include the equipment to classify and recover the coarse fraction from the concentrator tailings, which constitutes the major fraction of the mine backfill. Storage bins for crushed waste rock, cement and coarse tailings will also be provided. Facilities for metering and mixing coarse tailings, waste rock, and cement (when required) will be provided.

1.2.2.12 Backfill Transport, Storage, and Reclaim

The backfill storage facility will provide a surge area for temporary storage of approximately 150,000 t (165,000 short tons) of backfill. The backfill will be pumped as a slurry from the backfill preparation facility to the storage facility. The solids will be allowed to settle out, and the water decanted and pumped back to the backfill preparation facility.

When backfill is needed from the storage facility for use in the mine, it will be reslurried mechanically and pumped to the backfill preparation facility for transport to the mine.

The backfill storage facility will be lined to prevent seepage to ground water and will be enclosed within a berm. Precipitation falling on the backfill storage will be collected and pumped to the backfill preparation facility.

1.2.2.13 Concrete Batch Plant

A concrete batch plant will be installed in the northeast corner of the mine/mill site (Figure 1.2-7). This batch plant will be used to satisfy concrete requirements for the mine/mill.

Aggregate received by rail or truck will be transported by belt conveyor to aggregate storage hoppers, and cement received by railcar will be conveyed to a cement silo. The cement and aggregate will be mixed with water and transported by truck to the various areas of use.

1.2.3 Waste Disposal Facility

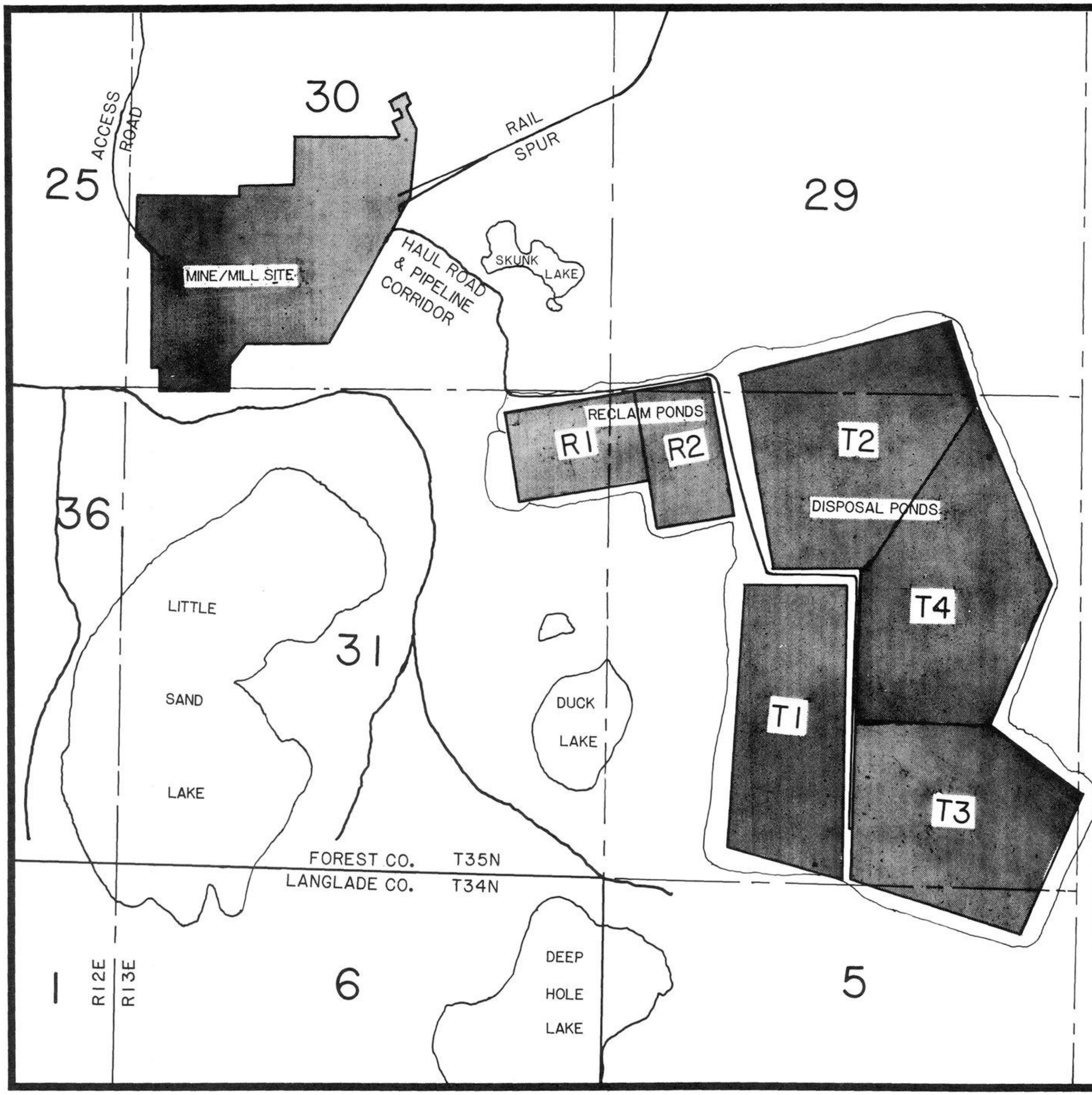
The primary function of the mine waste disposal facility (MWDF or facility) will be to provide for environmentally compatible surface disposal of the waste generated from the mining and processing of the ore. Nearly all of the waste will be ground rock produced during the milling of the ore. The MWDF will consist of earthen ponds constructed primarily from site area soil materials. The ponds will be lined with a bentonite modified soil mixture and sized to accommodate tailing fines, waste rock, reclaim pond sludge, and water treatment plant sludges.

Figure 1.2-8 shows the MWDF in relation to the mine/mill site, the access road, the railroad spur, and the adjacent water reclaim ponds. Four ponds with a total surface area of 202 ha (500 acres) inside the pond crests will be used over the productive life of the mine. The four ponds will be similar in size and sequenced in construction, operation, and reclamation to accommodate the production of tailing from the mill. A comprehensive description of the MWDF is presented in the Mine Waste Disposal Feasibility Report (Appendix 1.2A).

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 mine excavation in and around the orebody, and accordingly is variable in terms of its composition. Appendix 1.2A, Mine Waste Disposal Feasibility Report, contains specifics relative to mineral content.

During initial mine development most of the rock will be brought to the surface and disposed of in the MWDF. During production, however, a much



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY LOCATION

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY J P BECKER	DATE 8/82	CHECKED BY C.C. Schroeder	DATE 8-17-82
APPROVED BY	DATE	APPROVED BY C.E. Fowler	DATE 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO FIGURE 1.2-8	—	SHEET 1 OF 1	REVISION NO. 0

lesser volume of waste rock will be generated, and it will become possible to utilize part of this rock in underground road material and backfill underground. That portion of the rock which must be disposed of in the MWDF is presented in Table 1.2-7.

During early mine development, which occurs before the underground crusher is available, rock size will be about 0.6 m (2 feet) 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 152 mm (6 inches) or less in diameter.

1.2.3.2 Waste Rock Disposal and Preproduction Ore Temporary Storage

Waste rock volumes and approximate production schedule are presented in Table 1.2-7. The MWDF is designed to incorporate this total waste rock volume into the construction of the facility, where it is utilized as embankment fill and slope protection. Details concerning the use and placement are contained in Appendix 1.2A, Mine Waste Disposal Feasibility Report. Figures 1.2-9 and 1.2-10 show the general embankment area which will be utilized as a staging area for waste rock to be used in MWDF construction.

The pond lining system will be extended beneath the waste rock disposal area to provide appropriate containment for purposes of avoiding drainage or runoff to the environment.

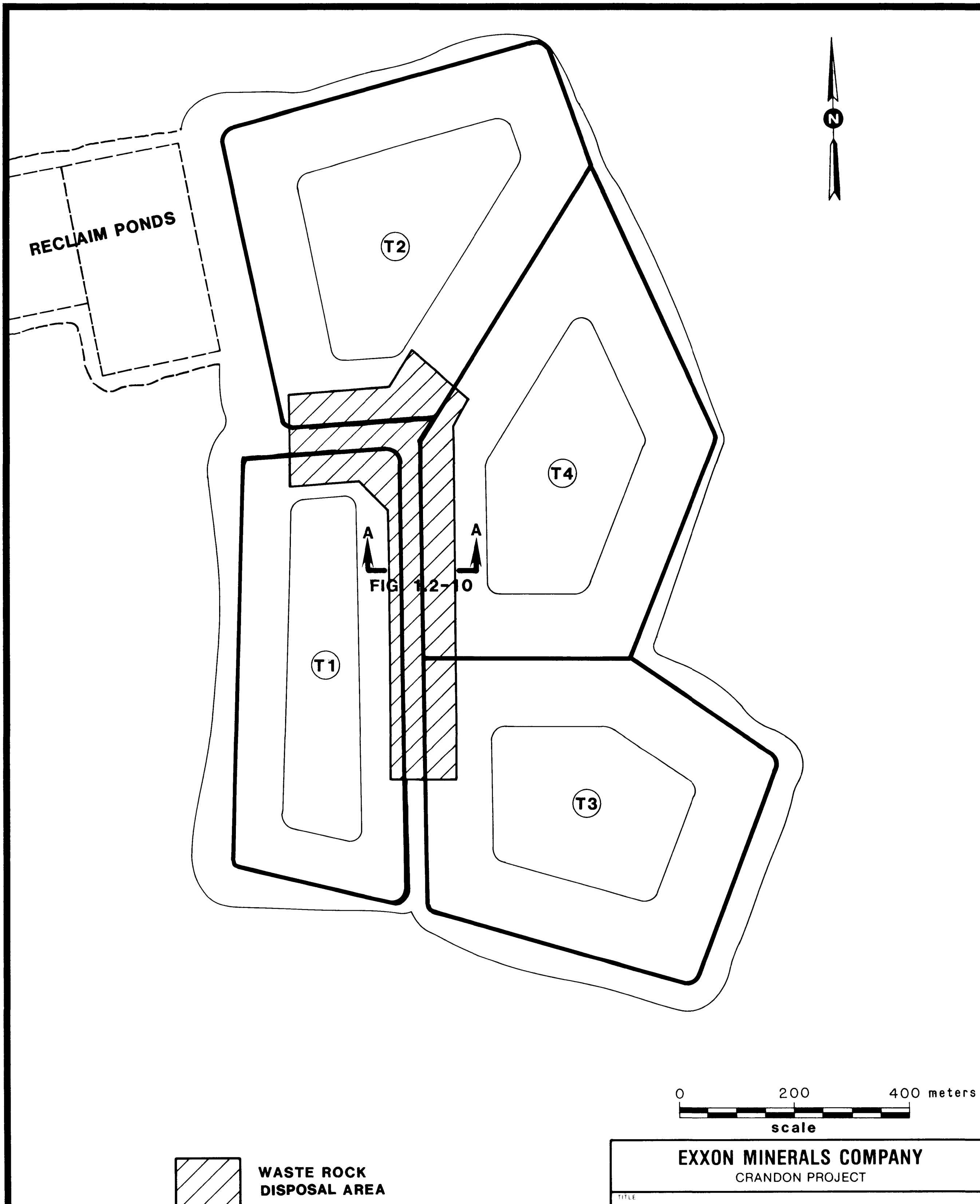
Figure 1.2-11 shows the overall facility configuration depicting embankment areas that will have waste rock facings. Typical installation of the rock on the slope is presented in Figure 1.2-12. The rip-rap facing will be applied to the ponded water sides of the tailing ponds.

TABLE 1.2-7

ESTIMATED YEARLY GENERATION OF WASTE ROCK VOLUMES FOR DISPOSAL AT THE MINE WASTE DISPOSAL FACILITY

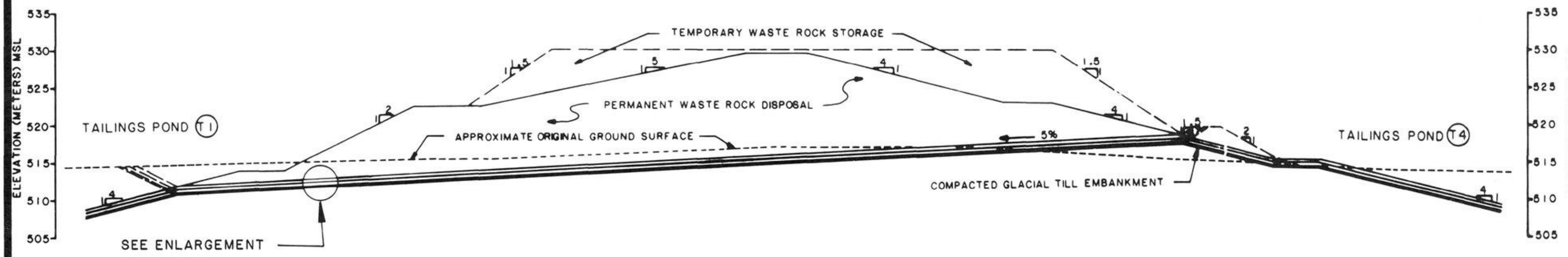
Year	Estimated Rock Volume* m^3	(cubic yards)		Approximate Size of Waste Rock
1985	11,000	(14,000)	-	-24 inch rock
1986	118,000	(154,000)	-	-24 inch rock
1987	307,000	(402,000)	-	-24 inch rock
1988	450,000	(589,000)	-	Underground crushing installed. All future rock is -6 inches
1989	311,000	(407,000)		
1990	212,000	(277,000)		
1991	212,000	(277,000)		
1992	71,000	(93,000)		
1993	18,000	(24,000)		
1994	35,000	(46,000)		
1995	7,000	(9,000)		
1996	10,000	(13,000)		
1997–2013 (17 Years at 10,000 m^3/y)	170,000	(222,000)		
2014	10,000	(13,000)		
2015	3,000	(4,000)		
TOTAL	1,945,000	(2,544,000)		

* Volumes based on estimated density of 1.7 t/m^3 (105 pounds per cubic foot).

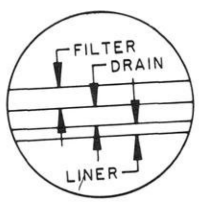


EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **WASTE DISPOSAL FACILITY WASTE ROCK DISPOSAL AREA**			
SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: S. J. Harvey	DATE: 7/82	CHECKED BY: C.C. Schmoam	DATE: 8-17-82
APPROVED BY:	DATE:	APPROVED BY: C.E. Fowler	DATE: 10/26/82
APPROVED BY:	DATE:	EXXON	DATE:
DRAWING NO: **FIGURE 1.2-9**		SHEET 1 OF 1	REVISION NO: 0

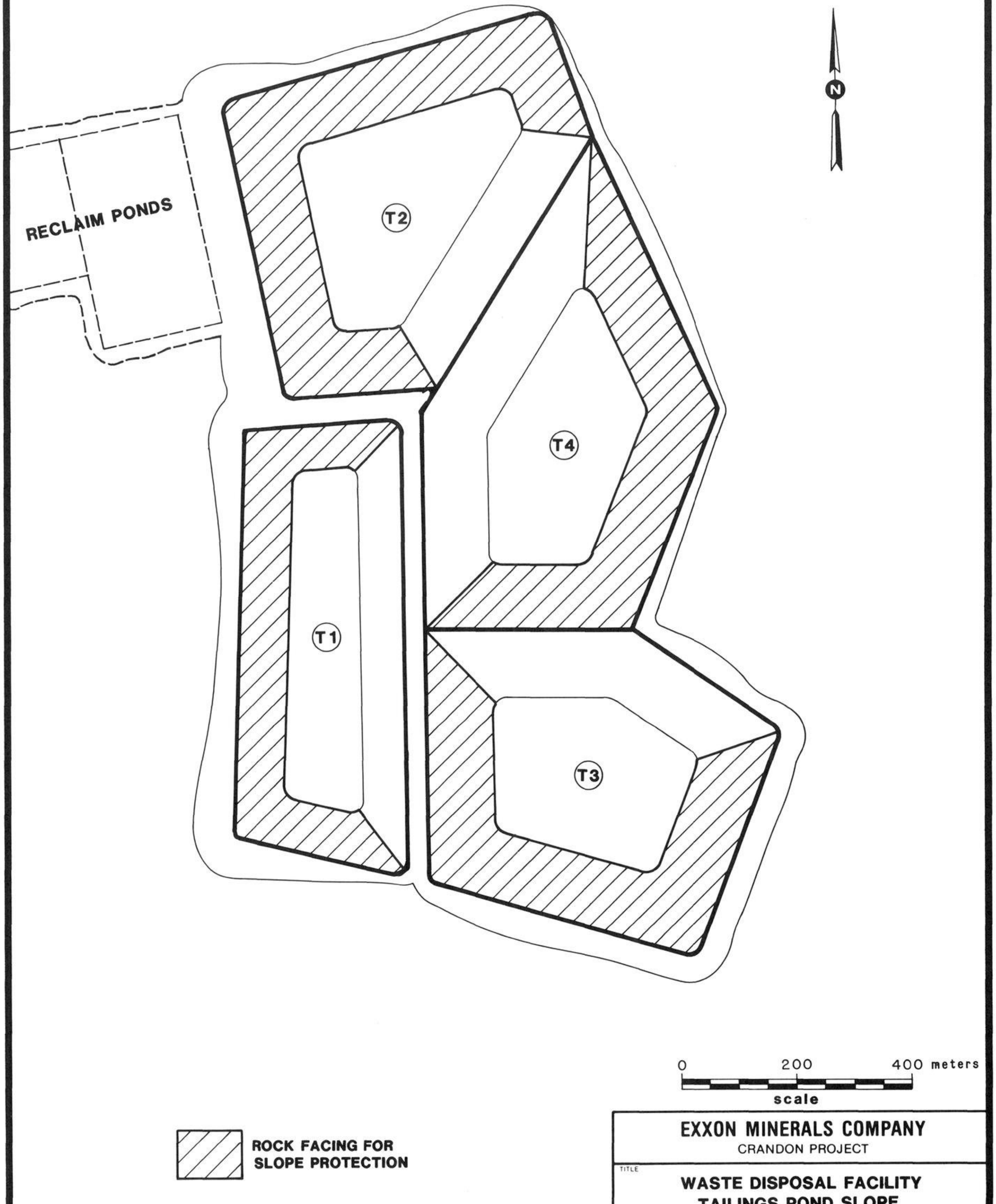


SECTION A-A
FIG. 1.2-9



-NOT TO SCALE-

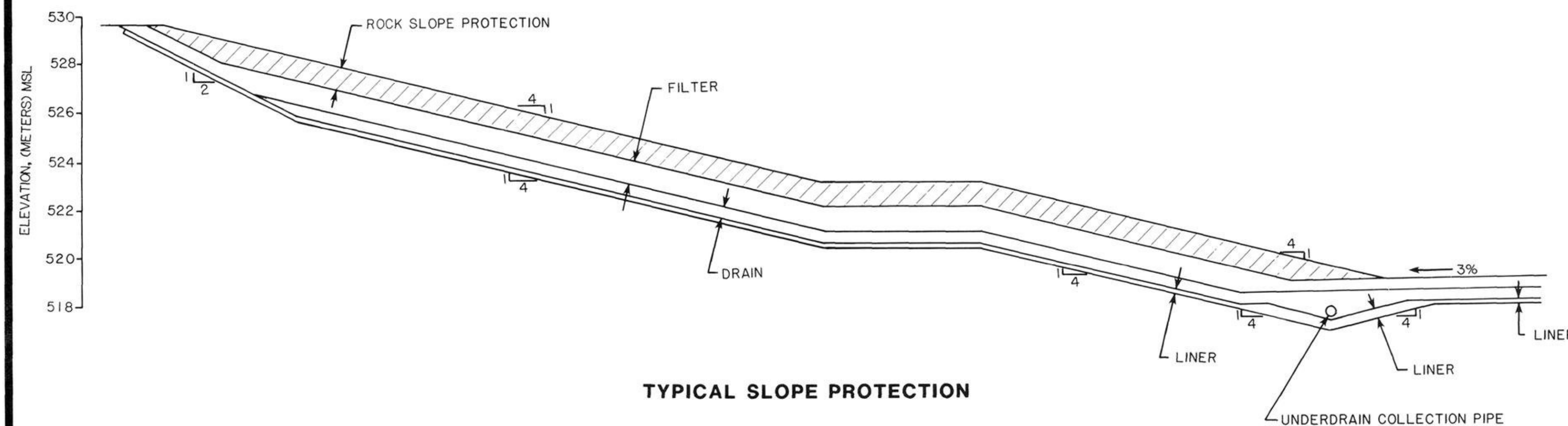
EXXON MINERALS COMPANY CRANDON PROJECT			
TITLE **WASTE DISPOSAL FACILITY WASTE ROCK DISPOSAL AREA**			
SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY D.R. SPRINGBORN	DATE 7/82	CHECKED BY C.C. Schroeder	DATE 8-17-82
APPROVED BY F.M. Lelli	DATE 10/82	APPROVED BY C.E. Fowler	DATE 10/29/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO **FIGURE 1.2-10**		SHEET 1 OF 1	REVISION NO 0



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY
TAILINGS POND SLOPE
PROTECTION FACING

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY S.J. HARVEY	DATE 7/82	CHECKED BY C.C. Schroeder	DATE 8-17-82
APPROVED BY	DATE	APPROVED BY C.E. Fowler	DATE 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO **FIGURE 1.2-11**		SHEET 1 OF 1	REVISION NO. 0



TYPICAL SLOPE PROTECTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
TYPICAL ROCK INSTALLATION FOR SLOPE PROTECTION

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY D.R. SPRINGBORN	DATE 7/82	CHECKED BY C.C. Schroeder		DATE 8-17-82	
APPROVED BY	DATE	APPROVED BY C.E. Farmer		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 1.2-12**		SHEET 1 OF 1		REVISION NO. 0	

The waste rock disposal area will be utilized during mine construction for the storage of approximately 500,000 t (551,000 short tons) of preproduction ore on a temporary basis. This ore, in total, will be removed from the waste disposal area and transported to the concentrator for milling when that facility is complete. All transport of waste rock and preproduction ore to the disposal area will be by truck.

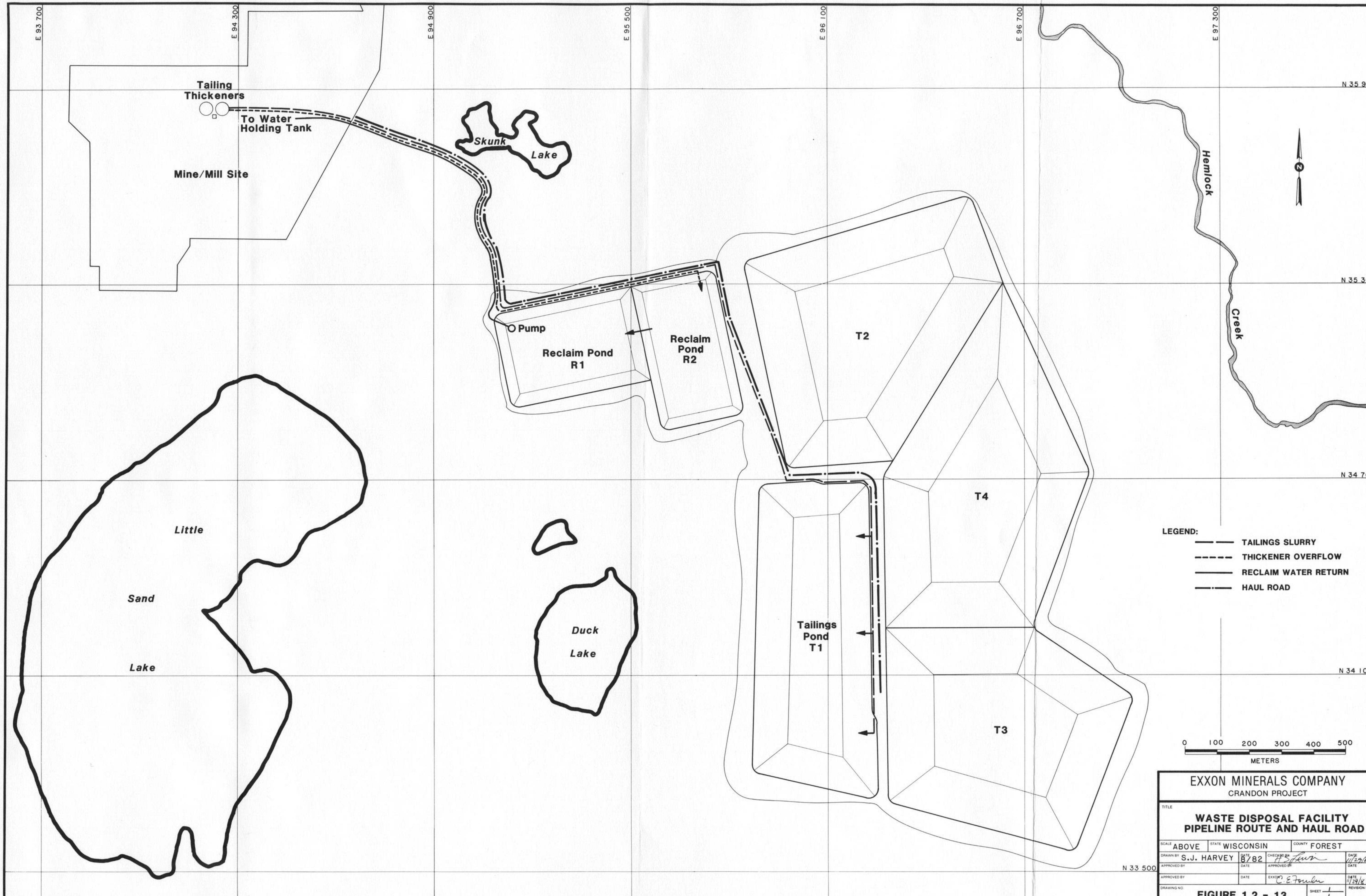
1.2.3.3 Tailings Transport

The tailings transport system will transfer the tailing fines by pipeline from the mill to the MWDF as a slurry. Figure 1.2-13 shows the proposed route for the pipeline from the mill to the MWDF. Pipes at the MWDF will be routed along the embankment crests. The haul road from the mine/mill area to the MWDF will share a common corridor with the pipeline system. From the eastern side of the mine/mill area to the northwest corner of reclaim pond No. R1 at the MWDF, the pipeline length is 1 km (0.62 mile).

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 has been designed to be restarted underload. The pumps will be located either at the mill or at the MWDF; there is no need for interim pumping along the pipeline.

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

1) 200 mm (7.85 inches) inside diameter high density polyethelene (HDPE) tailings slurry pipeline with two operating pumps and two standby pumps with a total installed horsepower of 600.


E 93 700
E 94 300
E 94 900
E 95 500
E 96 100
E 96 700
E 97 300
N 35 900
N 35 300
N 34 700
N 34 100
N 33 500
Tailing Thickeners
To Water Holding Tank
Mine/Mill Site
Skunk Lake
Pump
Reclaim Pond R1
Reclaim Pond R2
T2
T4
T3
Tailings Pond T1
Little Sand Lake
Duck Lake
Hemlock Creek
N
LEGEND:
TAILINGS SLURRY
THICKENER OVERFLOW
RECLAIM WATER RETURN
HAUL ROAD
0 100 200 300 400 500
METERS
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
WASTE DISPOSAL FACILITY
PIPELINE ROUTE AND HAUL ROAD
SCALE ABOVE
STATE WISCONSIN
COUNTY FOREST
DRAWN BY S.J. HARVEY
DATE 8/82
CHECKED BY
DATE 11/29/82
APPROVED BY
DATE
APPROVED BY
APPROVED BY
DATE
EXXON
DATE 11/29/82
DRAWING NO.
FIGURE 1.2 - 13
SHEET 1 OF 1
REVISION NO.
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2) 477 mm (18.77 inches) inside diamter HDPE reclaim water return pipeline with one operating and one standby pump with a total installed horsepower of 200.

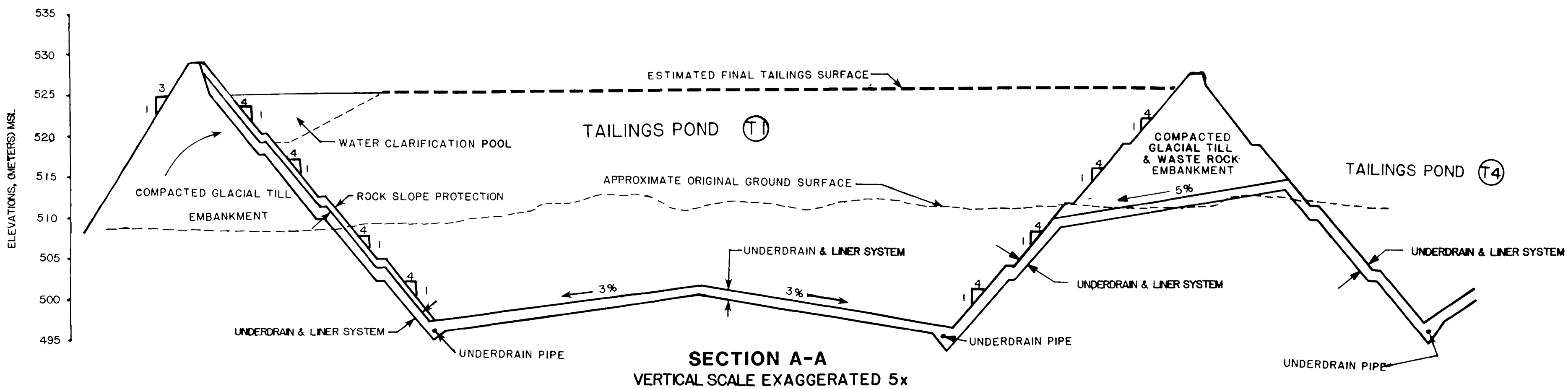
3) 477 mm (18.77 inches) inside diameter HDPE thickener overflow pipeline with one operating and one standby pump with a total installed horsepower of 200.

1.2.3.4 Tailings Disposal

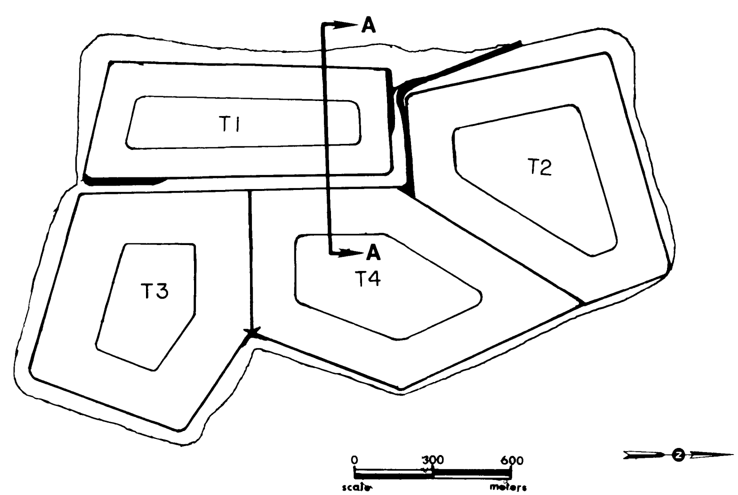
Waste Volume - Size of the MWDF is based on the amount of tailings and waste rock which cannot be returned to the mine. The Crandon Project orebody is estimated at 65.8 M t (72.6 million short tons), with a 17 percent contingency added for facility design. For the design basis it was estimated the following quantities would be generated: concentrates (10.8 M t [11.9 million short tons]); coarse backfill sands (33.1 M t [36.5 million short tons]); and tailing fines (33.1 M t [36.5 million short tons]). The 33.1 M t of tailing fines to be disposed of have an estimated volume of 22.1 M m^3 (17,600 acre-feet).

In addition to the tailing fines, the design has allowed for up to a volume of 1.0 M m^3 (800 acre-feet) for the carbonate sludge from the water treatment facility. The total volume is 23.1 M m^3 (18,400 acre-feet).

As the tailings are deposited in the ponds, they will form sloping beaches that result in unused pond storage volume of approximately 15 percent. Applying the 15 percent storage volume loss to the estimated waste volume will result in a total estimated waste disposal storage volume design requirement of approximately 26.5 M m^3 (21,000 acre-feet). Freeboard above the normal water level when the pond is full will be designed to meet the requirements of NR 182. Figure 1.2-14 shows a section through a typical tailing disposal pond.



SECTION A-A
VERTICAL SCALE EXAGGERATED 5x



25 0 25 50 75 100
scale meters

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY
POND SECTION

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY J P BECKER	DATE 8/82	CHECKED BY C.C. Schroeder		DATE 8-17-82	
APPROVED BY	DATE	APPROVED BY C.E. Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 1.2-14**			SHEET 1 OF 1	REVISION NO. 0	

Mine Waste Disposal Facility Location - An area approximately 2.4 km (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 (Figure 1.2-8).

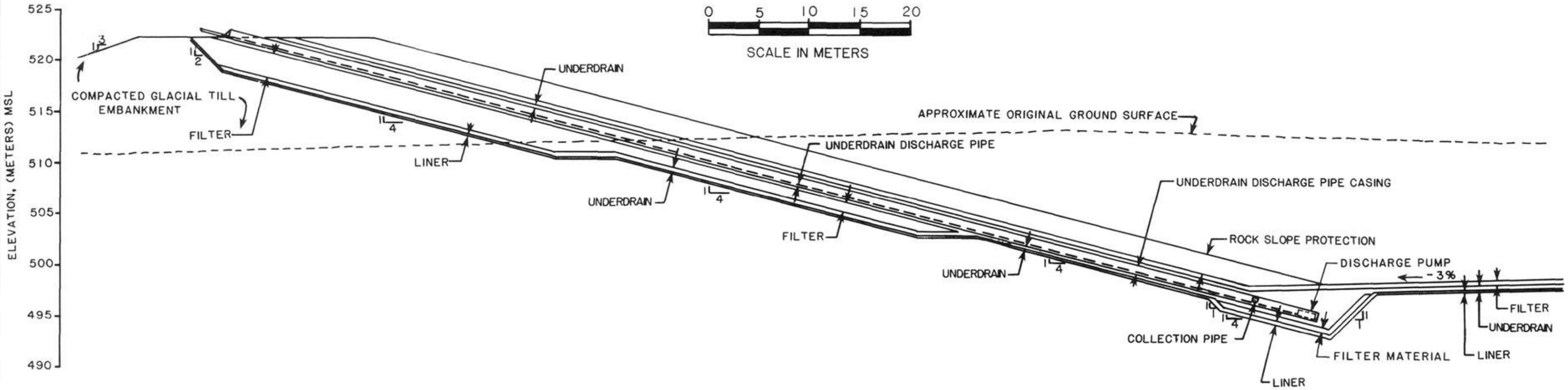
The major characteristics of this area (designated Area 41) are: an extensive upper soil layer of relatively low permeability till; low ground water gradients; the distance to the main ground water table averages approximately 30 m (100 feet); and little domestic use of ground water down-gradient from this area. With the considerable depth to ground water, any pond seepage from this area will have to pass through a large volume of soils that will provide considerable attenuation.

The design layout for the MWDF, designated as 41-114B, is shown in Figure 1.2-8. The facility will consist of four ponds that are constructed, operated, and reclaimed sequentially. Detailed information on the dimensions, elevations, and volumes of each pond in the facility is presented in the Mine Waste Disposal Feasibility Report (Appendix 1.2A).

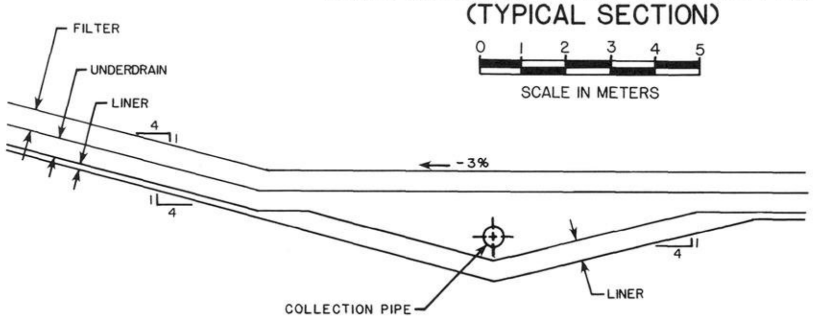
The inside slopes of the pond embankments will be 1 vertical in 4 horizontal to accommodate placement of the pond lining system. The outside slopes will be 1 vertical in 3 horizontal.

Seepage Control System - All of the ponds will utilize an underdrain system below the tailings to remove seepage water. The underdrain system will be underlain by a bentonite modified soil liner. Figure 1.2-15 shows a configuration of the underdrain system with a filter layer, a drain layer, and the bentonite modified soil liner.

UNDERDRAIN DISCHARGE PIPE
(TYPICAL SECTION)



UNDERDRAIN POND PERIMETER PIPE
(TYPICAL SECTION)



EXXON MINERALS COMPANY CRANDON PROJECT				
TITLE **WASTE DISPOSAL FACILITY SEEPAGE CONTROL SYSTEM**				
SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY D.R. SPRINGBORN	DATE 7/82	CHECKED BY C.C. Schroeder		DATE 8-17-82
APPROVED BY	DATE	APPROVED BY C.E. Fouche		DATE 10/26/82
APPROVED BY	DATE	EXXON		DATE
DRAWING NO **FIGURE 1.2-15**			SHEET 1 OF 1	REVISION NO. 0

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 drain layer to a perimeter collection pipeline.

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 1.2-16. Discharge pipes will be placed as required 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.

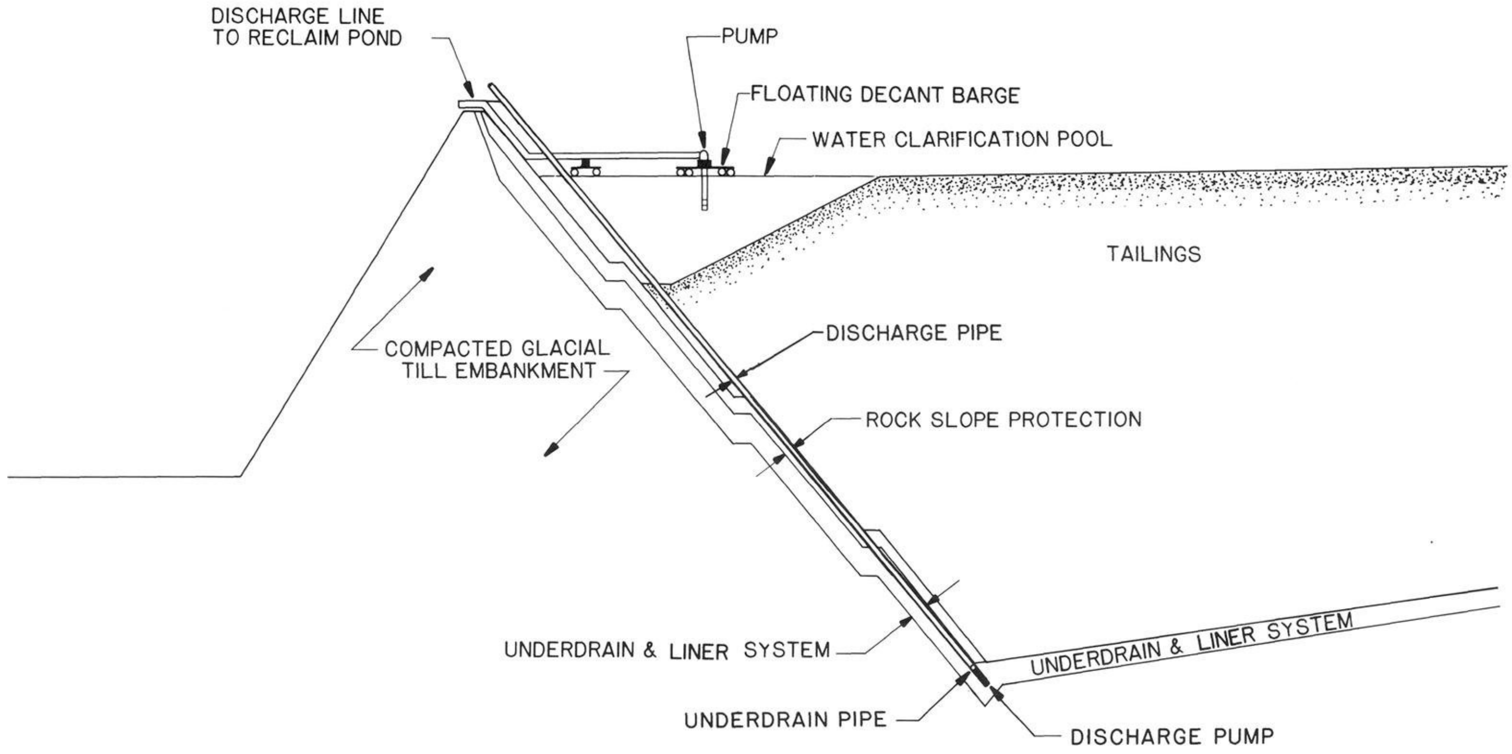
1.2.3.5 Water Treatment Waste Disposal

The water treatment process will produce two waste products in addition to high quality water. The first, a sludge resulting from the lime/soda ash softening, will be mostly calcium carbonate. This sludge will be added to the tailings and pumped to the MWDF for disposal. The other solid product will consist primarily of crystalline sodium sulfate.

Since sodium sulfate is used in the production of paper, this product will be recovered and marketed for that purpose or otherwise transported off site.

1.2.3.6 Reclaim Pond Sludge

During the life of operation, sludge will accumulate in the water reclaim ponds. This sludge will consist of fine sediments and particulate precipitates that settle from retention of the water. The sludge will be collected and disposed of in the MWDF.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY
TYPICAL TAILINGS POND
WATER DECANT SYSTEM

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY S. J. Harvey	DATE 8/82	CHECKED BY C. C. Schroeder		DATE 8-17-82	
APPROVED BY	DATE	APPROVED BY C.E. Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO. **FIGURE 1.2-16**			SHEET 1 OF 1	REVISION NO. 0	

1.2.4 Ancillary Facilities

Ancillary facilities, including offices, warehouses, shops, service building, fuel storage and handling, explosives storage, water systems, sewage treatment, and transportation and utilities facilities, required to support the operation of the mine/mill are shown in Figure 1.2-17. The general design objective was to unify as many of these facilities as practical and to locate them close to the major mine/mill process facilities, to reduce travel time for personnel and to prevent duplication of facilities.

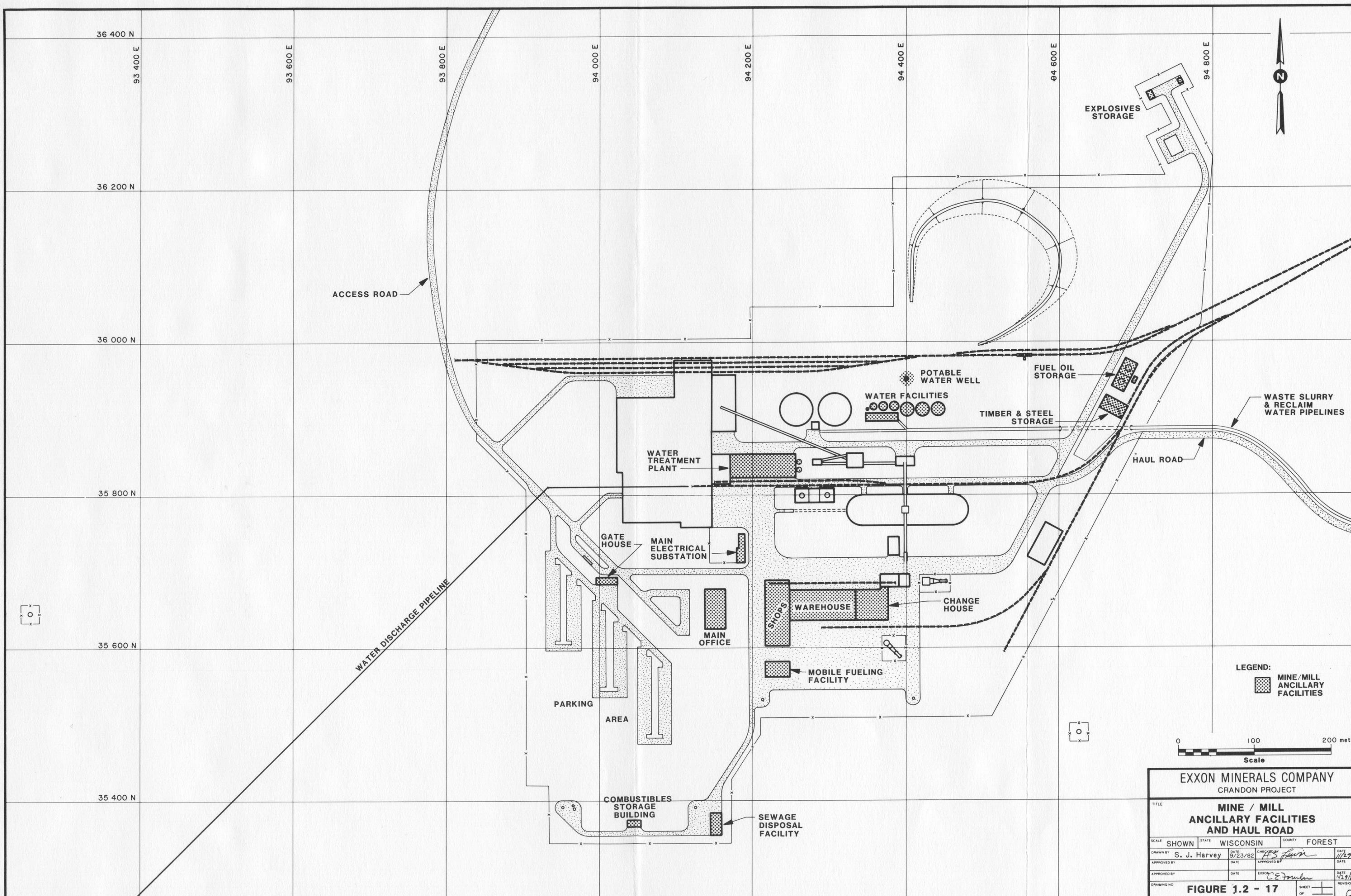
1.2.4.1 Rail Spur

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 4.3 km (2.7 miles) long and will include three 1,000 m (3,280 feet) sidings located near the connection to the trunk line (see Chapter 3, Figure 3.4-7). A single span bridge over Swamp Creek will be constructed of prestressed concrete girders supported on concrete abutments.

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

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 3.7 m (12 feet) lanes and 2.5 m (8 feet) wide shoulders. A single span bridge


36 400 N
36 200 N
36 000 N
35 800 N
35 600 N
35 400 N
93 400 E
93 600 E
93 800 E
94 000 E
94 200 E
94 400 E
94 600 E
94 800 E
N
EXPLOSIVES STORAGE
ACCESS ROAD
POTABLE WATER WELL
WATER FACILITIES
FUEL OIL STORAGE
TIMBER & STEEL STORAGE
WASTE SLURRY & RECLAIM WATER PIPELINES
HAUL ROAD
WATER TREATMENT PLANT
GATE HOUSE
MAIN ELECTRICAL SUBSTATION
WATER DISCHARGE PIPELINE
SHOPS
WAREHOUSE
CHANGE HOUSE
MAIN OFFICE
MOBILE FUELING FACILITY
PARKING AREA
COMBUSTIBLES STORAGE BUILDING
SEWAGE DISPOSAL FACILITY
LEGEND:
MINE/MILL ANCILLARY FACILITIES
0
100
200 meters
Scale
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
MINE / MILL ANCILLARY FACILITIES AND HAUL ROAD
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY S. J. Harvey
DATE 9/23/82
CHECKED BY
APPROVED BY
DATE
EXXON
DRAWING NO
FIGURE 1.2 - 17
SHEET OF
REVISION NO 0

constructed of prestressed concrete girders supported by concrete abutments will cross Swamp Creek.

The road will connect with State Highway 55 and proceed in a southeasterly direction for 4.8 km (2.9 miles) to the mine/mill site (see Chapter 3.0, Figure 3.4-9). The road will be contained in a 30 m (98 feet) 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 this corridor is not expected to be required.

1.2.4.3 Parking and Gate House

The employee and visitor parking area will be located to the south of the main approach drive. The total parking area will accommodate approximately 480 vehicles. The parking areas, constructed of paved surfaces and concrete curb and gutter, will drain into two retention basins located directly to the south. These retention basins will collect the surface runoff from all areas situated on the west slope of the ridge and south of the main approach drive for release into the natural drainage system.

A gate house will be positioned to control vehicular traffic into the mine/mill complex.

1.2.4.4 Administration Building

The administration (main office) building will house the laboratory, concentrator change room, managerial and administrative offices, and all necessary equipment and utilities.

1.2.4.5 Combustibles Storage Building

This facility will serve as a storage area for such combustibles as lubricants, paints, and cleaning materials, and will service both the mine and the mill. Location of the combustibles storage building follows Wisconsin Administrative Code.

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. The average daily flow rate of sanitary waste water has been estimated to be 0.002 m^3/s (31.9 gallons per minute).

The system will consist of a septic tank, dosing chamber, and soil absorption field. The absorption field will be located south of the mine/mill area (Figure 1.2-17).

1.2.4.7 Power Supply Facilities

Electrical power for the Crandon mine/mill facility will be delivered at 115 kV from the Wisconsin Public Service Corporation power grid serving the area to a substation located within the mine/mill site (Figure 1.2-17). The substation will include terminating structures, switching structures, and power circuit breakers for the 115 kV, and two transformers for reducing the 115 kV to 13.8 kV. The required medium voltage switchgear will be located in a concrete block building within the substation.

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, the 13.8 kV will be reduced to either 4.2 kV or 480 V for powering motors and other equipment.

The mine waste disposal facility 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 waste disposal facility.

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. It is anticipated that the emergency power generators will be diesel powered with a capacity of 5,000 kw. The emergency generators will be located in the switchgear building in the main substation.

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 above grade 189 m^3 (50,000 gallon) tanks will be located in the northeast section of the mine/mill site to provide storage for 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.

Both rail and truck access will be provided to the fuel oil storage tank area, with pumps to permit unloading of either tank cars or trucks.

Pumps and pipelines will be provided to offload and distribute the fuel oil to points of use within the mine/mill site.

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 Wisconsin Public Service Corporation from an existing pipeline running generally east-west approximately 14.5 km (9 miles) north of the mine/mill site. A 152 mm (6 inch) pipeline extension will be constructed from the existing pipeline to a reduction and metering station located within the mine/mill site. The gas will be distributed by underground pipeline from the reduction 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 Explosive Storage Magazine

An explosives magazine and storage area will be located inside the mine/mill perimeter fence, at an approved distance from all other facilities (Figure 1.2-17). An area for parking and storing loaded trailers will be included within the fenced security area. Buildings will be provided for separate storage of explosives and blasting caps.

The construction and safety distances required between the buildings within this facility will be in accordance with all applicable codes.

1.2.4.10 Potable Water Facilities

Potable water will be taken from a well on-site and pumped into water storage tanks (Figure 1.2-17). 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, in the event treatment is required, a chlorinator treatment system will be provided.

1.2.4.11 Water Treatment Facilities

The water treatment system will treat all contaminated water discharged from the mine plus a sufficient volume of water from the reclaim pond to enable recycle of process water. Effluent from the treatment system will, to the maximum extent possible, be recycled to the mill. Excess treated water will be transported to a surface water discharge system.

The treatement system will consist of the following unit processes, which will be used in proper combination on contaminated water from the mine and water from the reclaim pond. This will provide discharge water meeting applicable state and federal standards and uncontaminated water for recycle to the mill facility:

Unit Process	Primary Functions
Surge and Equalization	Permit steady-state flow rate to treatment processes. Provide tankage for pH adjustment.
Carbonate Preciptation (Lime-Soda Softening)	Remove suspended material in raw influent water. Precipitate metal hydroxides. Precipitate calcium as $CaCO_3$, thereby permitting higher water recovery in the reverse osmosis system.

Mixed Media Filtration	Remove suspended solids from water. (This is necessary to protect reverse osmosis membranes against fouling.)
Reverse Osmosis	Concentrate the dissolved inorganic constituents into a smaller brine stream.
Vapor Compression Evaporation	Further concentrate dissolved constituents into a highly concentrated brine stream.
pH Adjustment	Adjust effluent pH for discharge/recycle
Evaporator/ Crystallizer	Dry the inorganic solids residue for ultimate disposal.

Water entering the treatment system will be processed through some or all of the above units. In addition, there will be a surge tank to accept uncontaminated water from the mine so it can be monitored prior to discharge and treated if required.

The current plans are to have the treatment system located on the east side of the concentrator building, adjacent to the milk-of-lime preparation area (Figure 1.2-17).

The following chemicals will be used at the water treatment facility: lime (CaO); soda ash (Na_2CO_3); polymer; sulfuric acid (H_2SO_4); and hexametaphosphate.

Chemical storage and mixing will be done at the mill reagent preparation area and piped to the water treatment building.

Power consumption of the water treatment system will be approximately 22 M kilowatt-hours per year. Natural gas consumption will be approximately 52 M standard cubic feet per year.

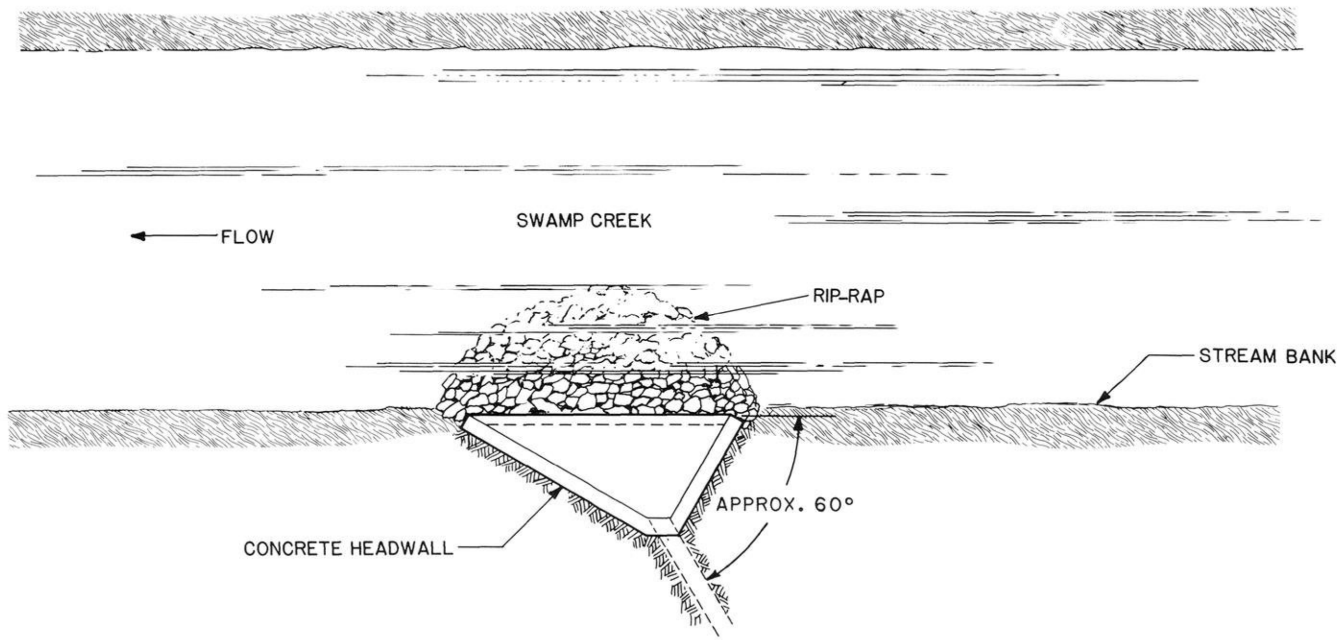
Excess water from the treatment plant will be discharged into Swamp Creek downstream from the bridge on County Trunk Highway M, about 8 km (5 miles) west of the mine/mill site. The discharge system will consist of pumps located at the mill water system, approximately 9.8 km (6.1 miles) of buried 356 mm (14 inch) diameter pipe, and a discharge structure at Swamp Creek.

Because the discharge water pipeline will be carrying water under low head, the operating pressures will be low, and the potential for ruptures or leakage will be minimal. The pipeline will be buried a minimum of 1.5 m (5 feet) below ground within a 15.24 m (50 foot) corridor. Water will be discharged into Swamp Creek through a suitable structure to prevent bank or stream bed erosion (Figure 1.2-18).

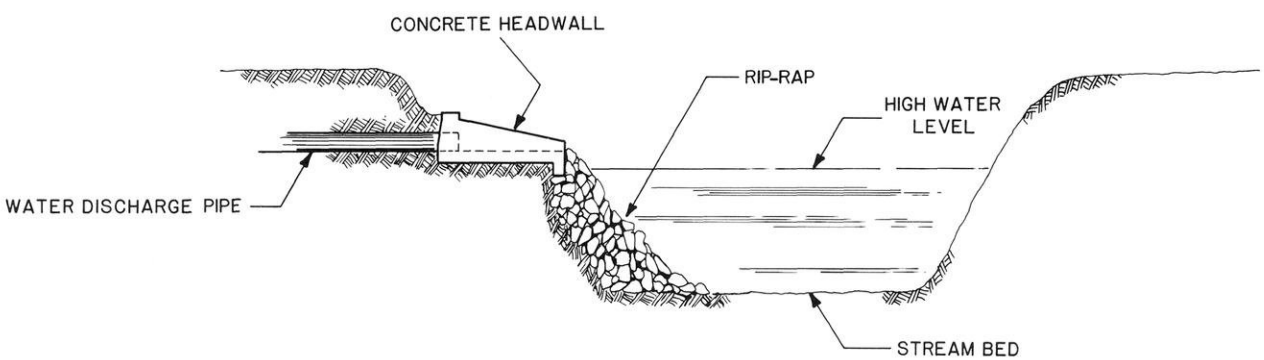
1.2.4.12 Reclaim Water Ponds

The location and orientation of the reclaim ponds No. R1 and No. R2 at the northwest side of the waste disposal system are shown on Figure 1.2-19. The ponds will be located close to the wastewater sources and facilities to reduce operating cost and land disturbance. 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 60 days).

The retention volume in both the reclaim ponds and 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 shut down of the mine or concentrator.

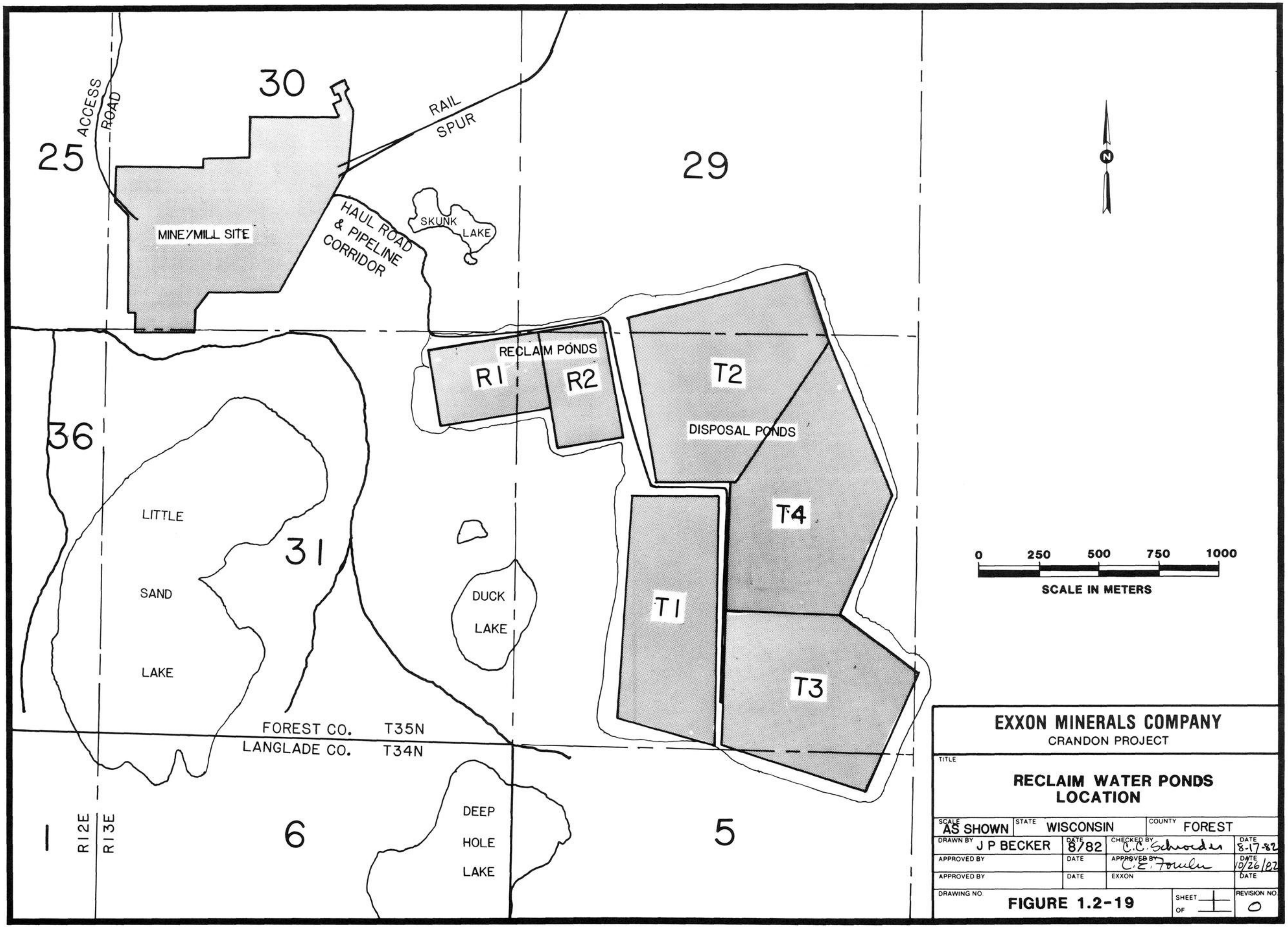


PLAN VIEW



TYPICAL SECTION

EXXON MINERALS COMPANY CRANDON PROJECT			
TITLE: **DISCHARGE STRUCTURE IN SWAMP CREEK**			
SCALE: NONE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: R. C. DIETZ	DATE: 9/82	CHECKED BY: [illegible]	DATE: [illegible]
APPROVED BY	DATE	APPROVED BY: C.E. Fowler	DATE: 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO.: **FIGURE 1.2-18**		SHEET ___ OF ___	REVISION NO.: 0


30
25
ACCESS ROAD
RAIL SPUR
29
MINE/MILL SITE
HAUL ROAD & PIPELINE CORRIDOR
SKUNK LAKE
RECLAIM PONDS
R1
R2
T2
DISPOSAL PONDS
T4
T1
T3
36
LITTLE SAND LAKE
31
DUCK LAKE
0 250 500 750 1000
SCALE IN METERS
FOREST CO. T35N
LANGLADE CO. T34N
DEEP HOLE LAKE
1
R12E
R13E
6
5
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
RECLAIM WATER PONDS LOCATION
SCALE AS SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY J P BECKER
DATE 8/82
CHECKED BY
DATE 8-17-82
APPROVED BY
DATE
APPROVED BY
DATE 10/26/82
APPROVED BY
DATE
EXXON
DATE
DRAWING NO.
FIGURE 1.2-19
SHEET OF
REVISION NO. 0

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

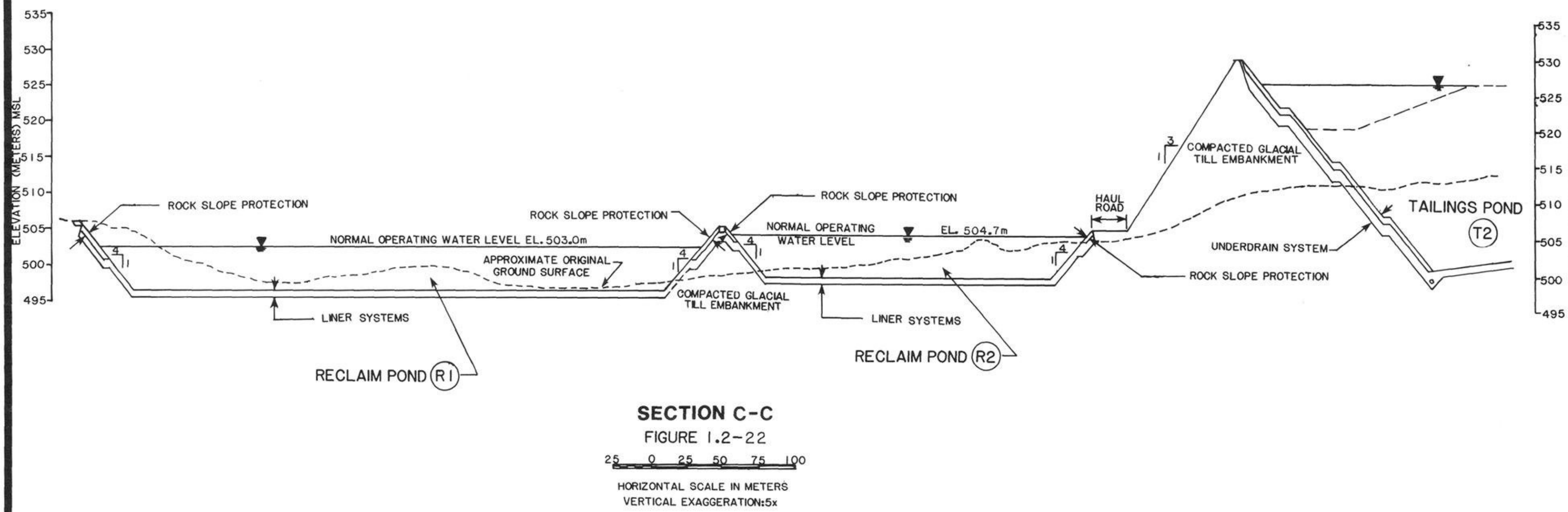
Retention of the recycle water in the reclaim pond promotes the natural oxidation of thiosulfate and other polythionates to sulfate. To neutralize the acid generated as a result of the thiosulfate oxidation, lime will be added to the water where it flows from pond R2 to pond R1.

The reclaim pond dimensions will be:

	Estimated Dimensions	
	Reclaim Pond No. R1	Reclaim Pond No. R2
Area Inside Crest (ha)	12.7	11.65
Bottom Area (ha)	8.14	8.13
Lined Slope Area (ha)	4.74	3.81
Maximum Depth (m)	8.7	7.0
Max. Exterior Fill Height (m)	13.1	13.0
Crest Elevation (m) MSL	505.6	505.6
Storage Volume ($\times 10^6$ m^3)	0.59	0.59

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 1 vertical in 4 horizontal to facilitate installing the pond lining system. The outside slopes will be 1 vertical in 3 horizontal. Figure 1.2-20 shows a section through the two reclaim ponds.

The two reclaim ponds will utilize the same type lining system. A two-part lining system will be used consisting of a bottom 152 mm (6 inch) bentonite modified soil liner and a synthetic membrane upper liner. The membrane will be protected by placing a 0.3 m (1 foot) sand cushion over the bentonite modified soil liner to serve as the membrane base; then the membrane



SECTION C-C

FIGURE 1.2-22

HORIZONTAL SCALE IN METERS
VERTICAL EXAGGERATION:5x

EXXON MINERALS COMPANY CRANDON PROJECT			
TITLE **RECLAIM WATER PONDS SECTION**			
SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY D.R. SPRINGBORN	DATE 8/82	CHECKED BY C.C. Schroeder	DATE 8-17-82
APPROVED BY	DATE	APPROVED BY C.E. Fowler	DATE 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO. **FIGURE 1.2-20**		SHEET 1 OF 1	REVISION NO. 0

will be covered by 0.5 m (1.5 feet) of sand. The lining system will be continuous across the pond bottom and sides. Rip-rap will be provided along the upper areas of the inside embankments to further protect the lining system. A cross-section of the lining design is presented on Figure 1.2-21.

1.2.4.13 Reclaim Water Pumping System

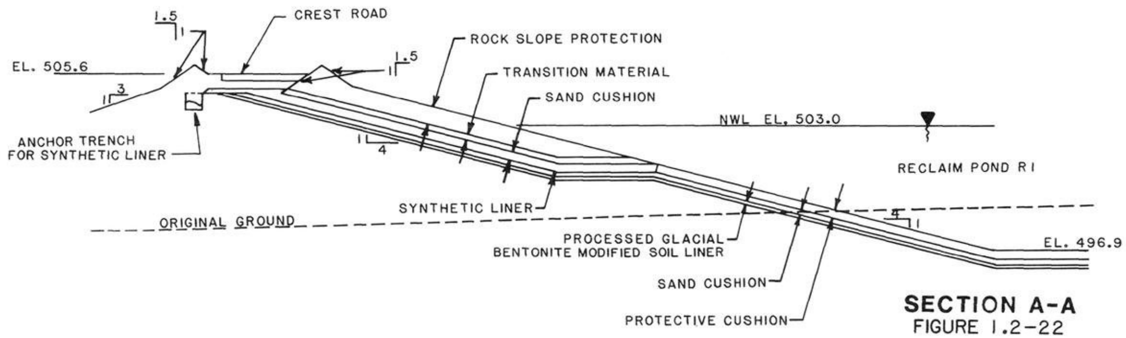
Location of the main features of the water handling systems at the reclaim ponds is shown in Figure 1.2-22. Thickener overflow and the secondary stream from the tailings pond underdrain and decant systems will provide primary flow to the reclaim ponds. Discharge points are shown on Figure 1.2-22. The locations were chosen to provide maximum retention time in the system. The water pumping system from reclaim pond No. R1 will return the reclaim water to the mine/mill site for reuse in the ore processing operations.

1.2.4.14 Shop, Garage, Warehouses

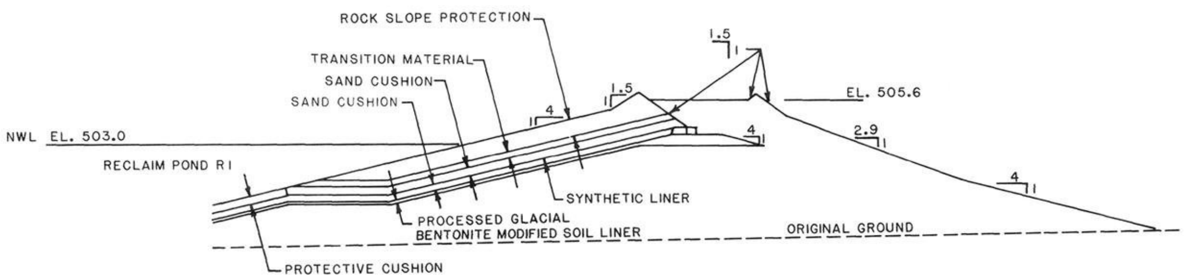
These facilities will provide support, service, and maintenance for the mine/mill process equipment and mobile equipment and will be located west of the headframe.

Two emergency vehicles will be housed in the shop building. The emergency vehicles will be a truck equipped for fire fighting, and an ambulance which would be used for transporting injury cases off-site.

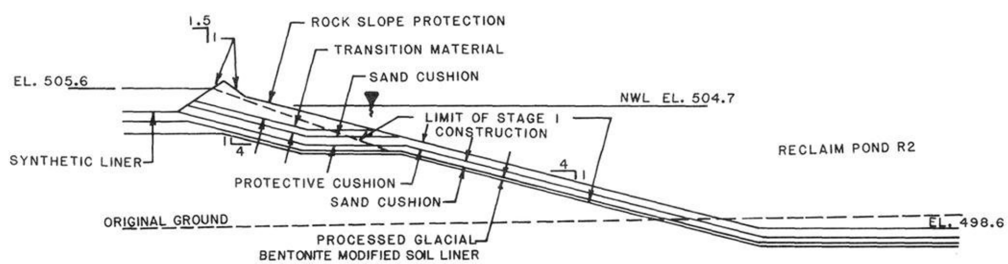
Provision will be made for railroad and/or truck unloading at the dock on the south side of the building, and truck access on the north side. Service cranes will be provided in the machine shop and the warehouse.



SECTION A-A
FIGURE 1.2-22



SECTION B-B STAGE 1
FIGURE 1.2-22
RECLAIM POND R1 CONSTRUCTED FIRST

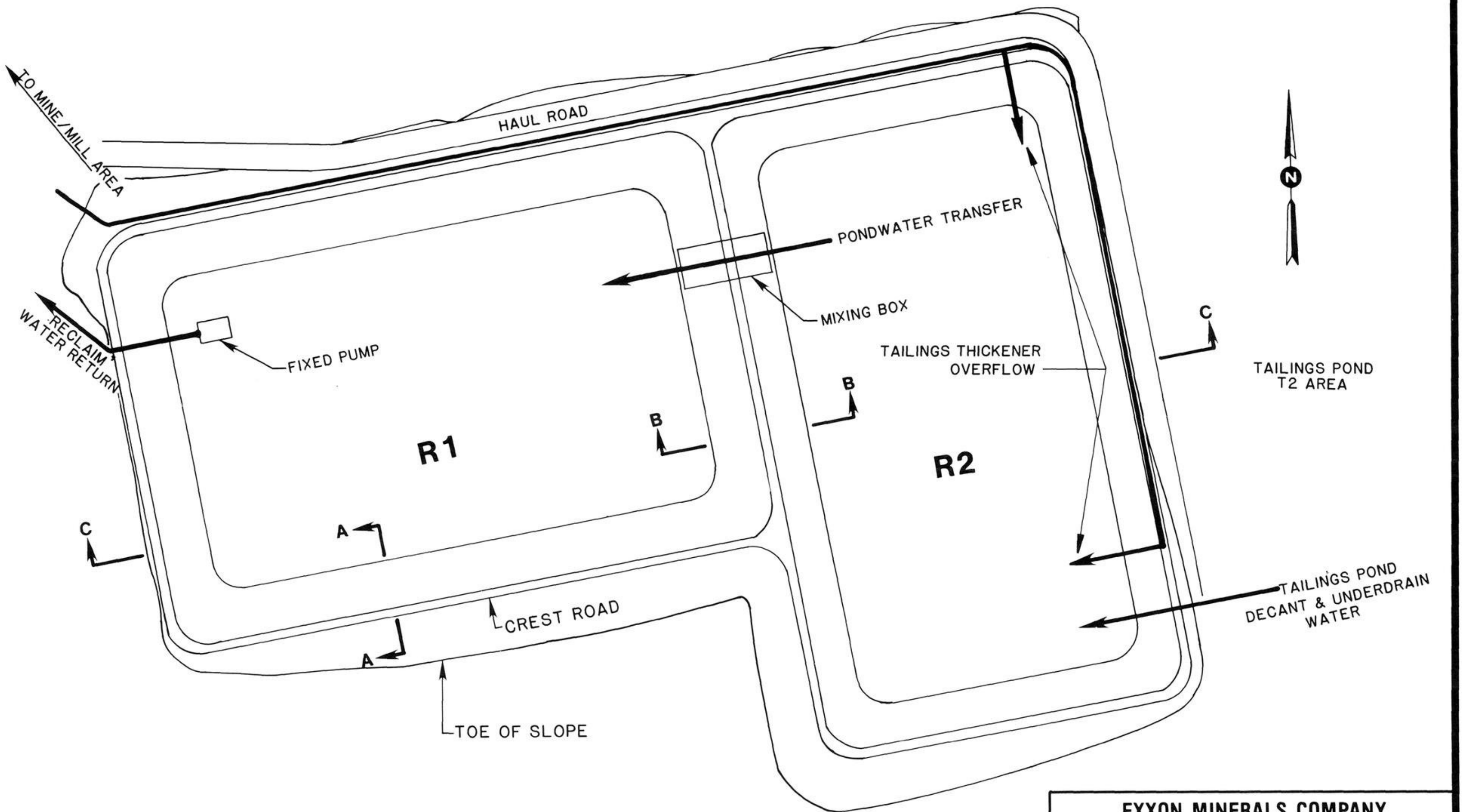


SECTION B-B STAGE 2
FIGURE 1.2-22
RECLAIM POND R2 CONSTRUCTED SECOND

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WATER RECLAIM POND
THREE CROSS SECTIONS
OF LINER DESIGN

SCALE NONE		STATE WISCONSIN		COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 11/82	CHECKED BY C.C. Schroeder			DATE 11/29/82
APPROVED BY	DATE	APPROVED BY			DATE
APPROVED BY	DATE	EXXON C.E. Fowler			DATE 11/29/82
DRAWING NO **FIGURE 1.2-21**		SHEET 1 OF 1			REVISION NO 0



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
RECLAIM WATER PONDS
WATER HANDLING SYSTEM

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY D.R. SPRINGBORN	DATE 8/82	CHECKED BY C.C. Schroeder		DATE 8-17-82	
APPROVED BY	DATE	APPROVED BY C.E. Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO	FIGURE 1.2-22		SHEET 1 OF 1	REVISION NO. 0	

The fueling station for on-site vehicles will be located south of the machine shop. This facility will have a center island pump station servicing two lanes, with diesel fuel and gasoline. Individual 9.46 m^3 (2,500 gallon) buried storage tanks will be provided for both diesel and gasoline fuel. The fueling station location will be designed in accordance with the State and Federal Codes.

1.2.4.15 Other Water Facilities

A corrugated plate interceptor will be installed in the paved area south of the fueling station to remove oil and gritty material from floor wash water collected in the oily water sewer system. The corrugated plate interceptor will remove all particles and oil, 45 microns in diameter or larger. Water effluent will be pumped to the reclaim pond described in subsection 1.2.4.13 and the oil particles removed will be transported to an approved off-site waste disposal area.

1.3 CONSTRUCTION

The construction plan contained herein emphasizes the equipment and techniques which are reflective of the Crandon Project specific facilities and the selection of realistic and representative construction techniques and equipment. The construction sequence is realistic for this stage of planning. The actual 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 shaft sinking operation 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 either burned or mulched and stockpiled for use in land restoration.

After clearing, grubbing and rough grading, the remaining topsoil will be stockpiled adjacent to the mine backfill holes No. 1 and 2 (Figure 1.3-1), to create a berm for containment of runoff water during site preparation. The topsoil will also be used in revegetation of the mine/mill site. An erosion control program has been developed for the entire mine/mill site and is described in the Reclamation Plan.

Clearing and grubbing will start in the southeastern portion of the site as an integral part of this erosion control program and will proceed

TABLE 1.3-1

AREA DISTURBANCE / RECLAMATION SCHEDULE

Calendar Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Elapsed Time (Years)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Start Construction	▼																		
Mine/Mill Site	59	(5)	(3)	(3)	(8)														
Access Road	15	(5)																	
Railroad Spur	18	(4)																	
Discharge Water Line		20 (10)	(10)																
Haul Road / Tailings Pipeline	8			(5)															
Waste Rock	18									(4)							(4)		
Reclaim Pond No. R1	20	(6)																	
Reclaim Pond No. R2				12															
Tailings Pond No. T1				38	(8)						(30)								
Tailings Pond No. T2									55	(13)								*(42)	
Tailings Pond No. T3																55	(15)		
Tailings Pond No. T4																			
Construction Support Area	10																		
Net Disturbed Area	148	138	125	167	151	151	151	151	206	189	159	159	159	159	159	214	195	153	153

Calendar Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Elapsed Time (Years)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Start Construction																		
Mine/Mill Site															(10)	(10)	(10)	(10)
Access Road																		
Railroad Spur														(14)				
Discharge Water Line																		
Haul Road / Tailings Pipeline																		(3)
Waste Rock				(4)														(6)
Reclaim Pond No. R1																(14)		
Reclaim Pond No. R2															(12)			
Tailings Pond No. T1																		
Tailings Pond No. T2																		
Tailings Pond No. T3					(40)													
Tailings Pond No. T4			50	(8)									(21)	(11)			(10)	
Construction Support Area				(10)														
Net Disturbed Area	153	153	203	181	141	141	141	141	141	141	141	141	120	95	73	49	29	10**

* PARTIAL RECLAMATION ONLY

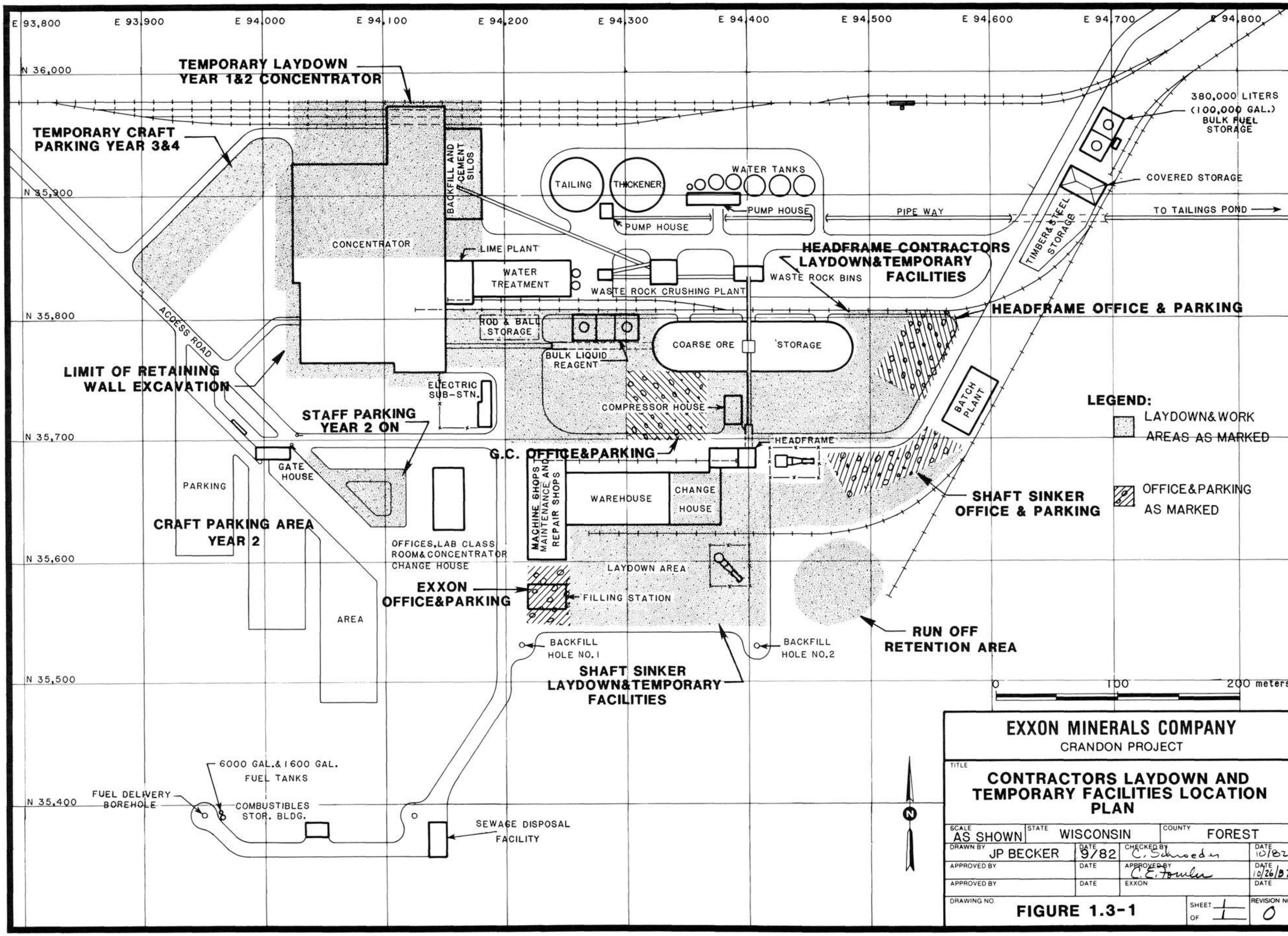
** ACCESS ROAD NOT RECLAIMED

NOTES:

AREAS IN HECTARES

AREAS IN PARENTHESIS INDICATE RECLAMATION

1 HECTARE = 2.47 ACRES



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CONTRACTORS LAYDOWN AND TEMPORARY FACILITIES LOCATION PLAN

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY JP BECKER	DATE 9/82	CHECKED BY C. Schroeder		DATE 10/82
APPROVED BY	DATE	APPROVED BY C.E. Fowler		DATE 10/26/82
APPROVED BY	DATE	EXXON		DATE
DRAWING NO **FIGURE 1.3-1**			SHEET 1 OF 1	REVISION NO. 0

generally northwest. Grading will start while grubbing is in progress, bringing the site to the required elevations, controlling water runoff, and expediting completion of this phase of work before the winter freeze.

As site grading proceeds, concurrent stormwater and erosion control measures will be implemented to prevent runoff effects; control features will be installed or provided as, for example, in catchment areas and desilting ponds, before clearing and grading related areas. Culverts will be installed to provide the earliest attainable drainage system operability. Through application of the erosion control program, the major effects of construction activity will be contained within the construction area boundaries.

To eliminate off-site erosion, the surface drainage and stormwater retention basins will be constructed first. The erosion control program described in the Reclamation Plan contains the specific techniques to be used. Existing access roads to the site area will be upgraded with additional gravel and utilized until permanent roads are completed. During the first year, permanent access and on-site roads will be paved and landscaped to minimize dust and erosion. 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.

1.3.1.2 Temporary Facilities

The need for temporary structures for construction use has been minimized by utilizing permanent facilities wherever possible. However, some temporary structures will be required. Temporary facilities will be provided for Exxon and contractor personnel during early development stages (Figure 1.3-1). The needs for contractors vary considerably and will be defined separately. Interim temporary parking for the automobiles used by workmen for commuting will be provided within the assigned work areas until permanent parking areas are completed.

Fire protection for all temporary facilities will be provided by a fire truck stationed on-site until the permanent facilities are placed in service during the first year of construction. The permanent fire protection facilities will have hydrants adjacent to the temporary structures.

Both potable and construction water will be supplied by on-site wells. Potable water will be treated as necessary prior to consumption.

During the first 18 months of construction, or until permanent power is installed, temporary on-site generated power will be required. Temporary power requirements will build up to approximately 6,000 kW during this period and will be supplied by diesel powered units.

In accordance with applicable regulations and good practice, chemical toilets for construction personnel will be provided on-site. Wastes will be collected and disposed of off-site by an approved contractor. When the sewage disposal system is completed near the end of the first year of construction, sanitary wastes will be disposed of at this facility.

A security fence enclosing the entire area will be installed by the end of the first quarter in Construction Year 1. A clear area on each side of this fence will be maintained.

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. Other wood waste material will be either burned or transported to an off-site landfill for disposal. Rough grading and final grading will closely follow grubbing.

Implementation of runoff and erosion control methods will be carried out 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.

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. Materials excavated from wetlands will be utilized on final graded fill surfaces as top cover.

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 brought in from an established commercial source.

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 headframe, complete with hoisting gear, collar house, mine air heaters, backfill handling facilities, change house, and a source of compressed air.

1.3.1.4.2 Shafts and Collar

The production shaft, fresh air intake shaft, and exhaust air shafts will be excavated through the glacial overburden to bedrock by similar construction techniques. The overburden in the area of each shaft will first be stabilized by freezing the soil moisture. This will be accomplished by drilling a ring of holes vertically through the overburden and into competent bedrock. Steel pipe casings will be installed in each hole and the bottom of each casing will be sealed. A cold brine solution will be circulated within the casing to build up an ice wall around each of the vertical holes. This ice wall will expand from each of the holes until it merges into a continuous ring of ice reaching from surface to bedrock, and completely surrounding the area to be excavated for the shaft. When the freezing process has been completed, the flow of brine will be modulated to maintain a uniform thickness of ice. This ice ring will support the unconsolidated glacial overburden and prevent influx of ground water from the aquifer into the area to be excavated.

Excavation will then commence using a crane and clam shell for excavating loose material, 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 0.6 m (2 feet) thick and will reach from finished surface elevation to a sufficient depth into competent bedrock 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 the collar sections of the main and intake air shaft have been completed, a headframe structure will be erected over each shaft. For the main production shaft, this will be a portion of the permanent headframe, whereas a temporary steel headframe will be installed for the intake air shaft. Conventional sinking through rock will commence at the main shaft and at the fresh air intake shaft. The two exhaust air shafts will be developed in rock by different methods which are described later in this subsection.

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

Pumps installed at the shaft bottom and on the workstage will transport to the surface water treatment system any water that might flow into the bottom of the shaft from the rock formations. Less than 0.0003 m^3/s (5 gallons per minute) additional water will be used during the drilling operation to flush cuttings from the holes, to suppress dust, and to cool the drill bits.

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. 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 vibration, 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 (USBM) limits for avoidance of structural damage and human annoyance.

At specified intervals, openings will be left in the concrete shaft lining, and rock will be excavated from the shaft wall to form level stations. These will extend laterally and will be used to gain access for level development activities.

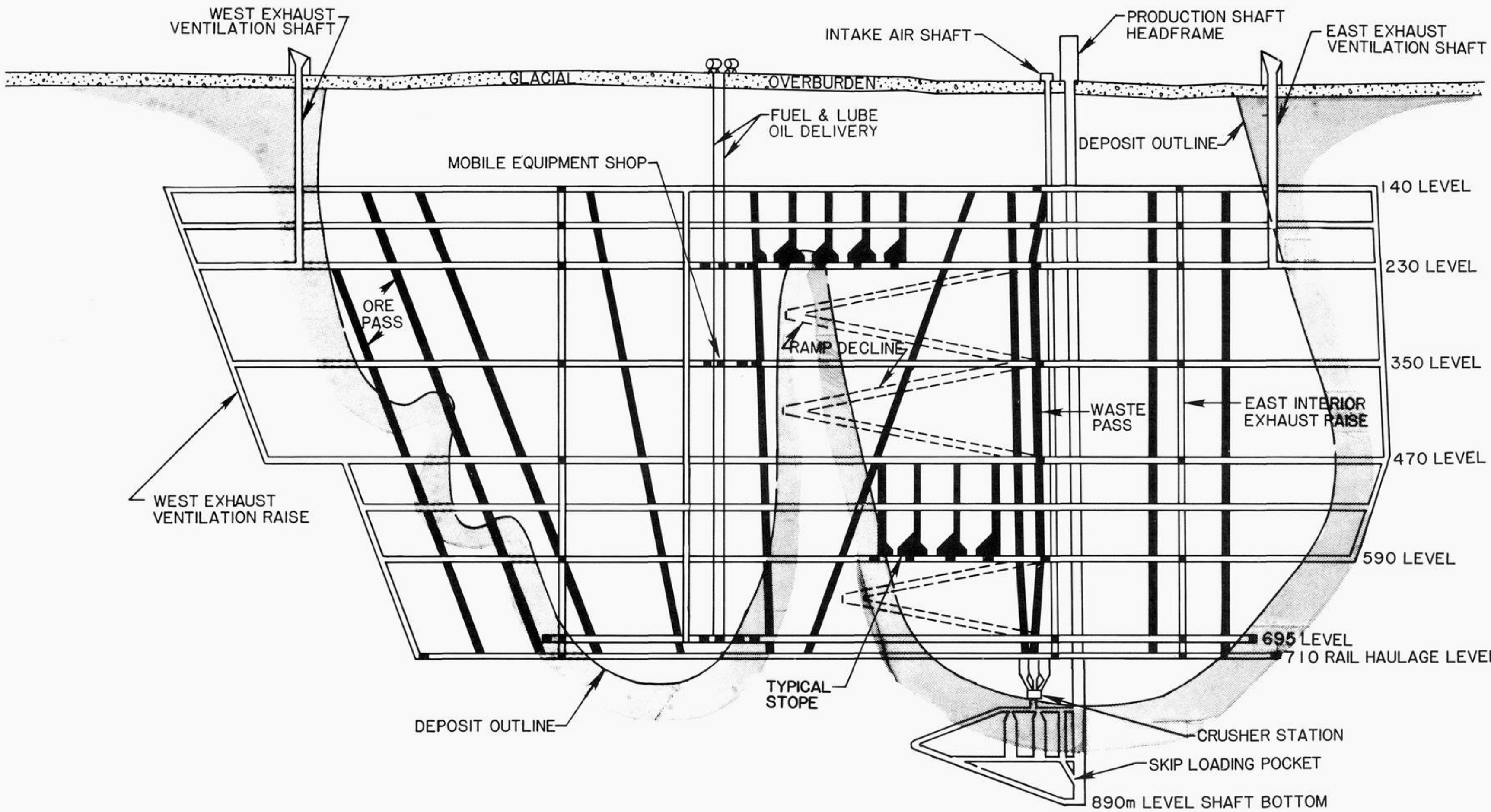
After excavation through the glacial overburden, construction in rock of the two exhaust ventilation shafts will be accomplished by boring methods as compared to the methods described above for the production and fresh air shafts. When underground development reaches the shaft location, a raise boring machine will be used to bore holes about 1.8 m (6 feet) in diameter from the the uppermost mining level to the bottom of the shaft collar sections. The exhaust ventilation shafts will not be lined below the concrete collar sections.

Ground water entering these shafts will flow out on a mine level and be directed into the regular mine drainage system. Small amounts of water will be used to eliminate dust during the raise boring operations.

1.3.1.4.3 Underground Development

Upon completion of the fresh air intake shaft to below the 350 m (1,150 feet) horizon, main level development will commence on the 230 and 350 m Levels. A typical vertical section of the mine is shown in Figure 1.3-2. On the 230 Level, horizontal passages termed drifts will be driven to the east and west extremities of the orebody, and the exhaust air shafts completed from the collar sections to this level. The other two levels will be interconnected by internal exhaust raises to complete a ventilation circuit. Stope development will commence with the driving of cross cuts, drawpoints and drill drifts. A ramp will be constructed to provide movement of mobile equipment between these three levels. It will ultimately be extended downward to provide access to the lower Level.

Upon completion of the main production shaft, the underground ore handling facilities will be constructed. These facilities will consist of coarse ore bins, crusher facilities, belt conveyors, fine ore storage bins and a loading pocket installation. Ore and waste passes willlconnect these facilities to the upper levels (Figure 1.3-2).



-NOT TO SCALE-

EXXON MINERALS COMPANY

CRANDON PROJECT

TITLE

UNDERGROUND MINE LONGITUDINAL SECTION SCHEMATIC

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY D.R.SPRINGBORN	DATE 9/82	CHECKED BY J.E. GRIMES		DATE 10/26/82	
APPROVED BY D.E. Moe	DATE 10/26/82	APPROVED BY C.E. Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO. **FIGURE 1.3-2**			SHEET 1 OF 1		REVISION NO. 0

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). 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 3.5 to 5 m (11 to 16 feet), and in height from 3 to 3.5 m (10 to 11 feet). On each of the drawpoint levels, laterals will be driven on both sides of the orebody. These will then be connected with cross cuts through the ore at appropriate intervals to provide access to individual stoping blocks.

Initially, air for mine ventilation will be provided by fans on the surface forcing air through ducts down the shafts and into the various working places. Once the connections have been made to the exhaust shaft system, the main mine fans will be installed, and fresh air will be drawn down through the production and air intake shafts, through the working places, and exhausted up the exhaust air shafts. Localized ventilation requirements will be provided by auxiliary fans and ducts. Any required heating of air will be done on the surface by gas fired air heaters.

Concurrent with the sinking of the two access shafts, measures will be taken to control ground water seepage into the mine. These measures will consist of introducing inert bentonite grout from the surface through drill holes to establish an impermeable blanket at the contact between glacial overburden and bedrock in those areas where the naturally-occurring impermeable layer is known not to be present.

The inflow of water to the mine workings may increase during the first 3 years of underground development to as much as 0.126 m^3/s (2,000 gallons per minute). This unmitigated rate is that potential maximum rate which could occur if grouting or other methods are not used to reduce the seepage rate. Temporary water containment and pumping facilities will be installed as needed during early development until the main water handling facilities are completed on the 350 m and 840 m Levels and the separate ground water interception system is installed on the uppermost mine levels. All water inflow will be directed to these facilities for separate collection and pumping from the mine.

1.3.1.4.4 Waste Rock and Preproduction Ore

During the preproduction period of mine development, approximately 15,000 t (16,500 short tons) of glacial overburden, 1,777,000 t (1,960,000 short tons) of waste rock, and 487,000 t (536,700 short tons) of ore will be produced. This material will be hoisted to the surface during the construction period and transported to a storage site which will ultimately form part of the embankment between the tailings disposal ponds. Preproduction ore will be brought back to the mill for processing at an appropriate time.

1.3.1.5 Mill Construction

The method of construction for all buildings in the mine/mill site will be similar, as all buildings will consist of a concrete foundation and a structural steel frame with metal siding. The equipment required for mill construction is discussed in subsection 1.3.3.2.

1.3.1.6 Mine Waste Disposal Facility and Reclaim Pond Site Preparation

Site preparation for the waste disposal facility and reclaim ponds will be carried out in phases so that only the area actually required for construction in a particular phase will be cleared and grubbed. A small percentage of the total area will be under development at any one time. At no time is the total disturbed area greater than 147 ha (363 acres), which is 59 percent of the ultimate total of 248 ha (613 acres).

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 and 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. If suitable topsoil is encountered, it will be stockpiled for future use.

The outside faces of the containment berms of the tailings and reclaim ponds will be graded at 3:1 and stabilized by application, hydromulching, and revegetation.

The township road located at the southeast corner of tailings pond No. T3 will be relocated during the construction period of pond No. T3. Approximately 500 m (1,640 feet) of single lane gravel road will be relocated. Clearing, grubbing, grading, and mixing a coarse material for the road surface will be included. Straw bale sediment traps will be used as necessary to control runoff during this minor construction.

1.3.1.7 Mine Waste Disposal Facility and Reclaim Pond Construction

Construction of the mine waste disposal facility has been scheduled in such a way that completion of each of the tailings 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 effort during the May through November period to meet the schedule in each phase of the work.

Excavation will be by scraper and the excavated material will be hauled either directly to the embankment for placement and compaction or to a stockpile area for later use. A portion of the excavated material will be stockpiled in the construction support area for use in 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 15 m (50 feet). The storage area required is approximately 10 ha (25 acres).

Upon completion of the excavation in a particular area, the subgrade will be brought to grade followed by placement of the bentonite modified soil liner. The liner material will be hauled by dump trucks, dumped, spread by dozer and grader, and compacted.

Following placement of the bentonite modified soil liner, the underdrain and filter material will be placed to protect the liner from damage. The underdrain and filter will be placed by end dumping from dump trucks and by pushing the drain or filter material out over the liner. 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 carried out during the same time period as placement of the liner, drain, and filter.

Exxon will implement quality assurance and quality control procedures 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 Mine Waste Disposal Feasibility Report for the Crandon Project.

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

For the reclaim ponds, the installation of the bentonite modified soil liner and synthetic top liner will be a mechanical and a manual operation, respectively. 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 0.46 m (1.5 feet) thick sand cushion. An additional layer of transition material approximately 0.3 m (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 in the area in which tailings pond No. T4 will eventually be built. 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 10 ha (25 acres) in size. The pad will be sloped to drain, with the runoff diverted into a lined retention pond. The surface of the support area will consist of natural glacial till. Dust will be controlled by sprinkling with water as needed.

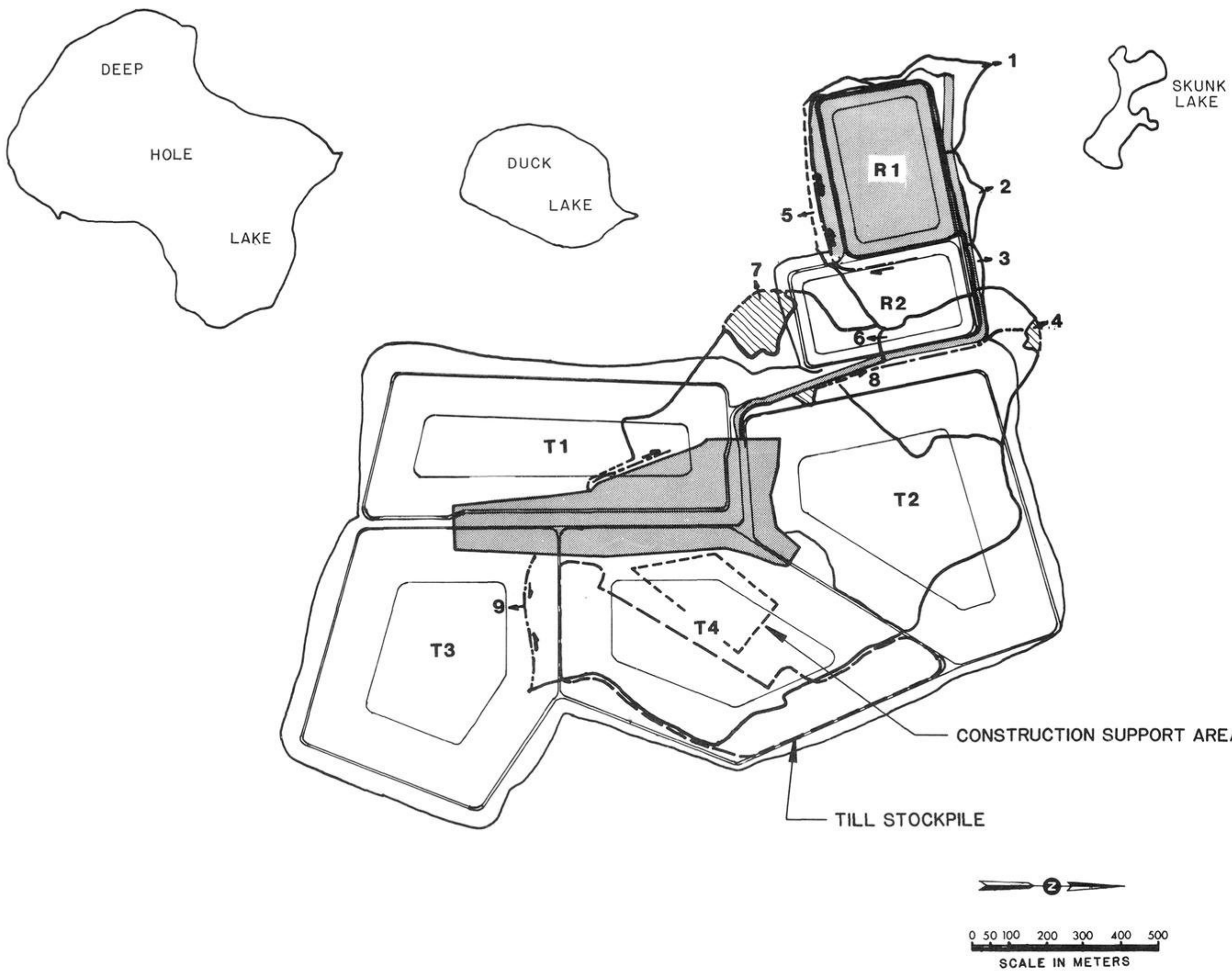
A specially designed batching and mixing plant will be used to mix the processed glacial till, powdered bentonite and water for the liner and topseal for the reclaim and tailings ponds. This batching plant is not the same plant to be used for preparing structural concrete.

A screening plant will be used to process local materials for the liner and underdrain system. A series of conveyors and radial stackers will distribute the finished product to the appropriate stockpile in the construction support area.

Powdered bentonite will initially be shipped by enclosed railcar to the existing Woodlawn rail siding southeast of the Project site and hauled to the site by truck. When completed, the mine/mill site railroad siding will be used. A pneumatic unloading system will be used to transfer the bentonite from the railcar to silos and then to cement-type tank trailers. The system will be completely contained and virtually no bentonite powder will be released to the atmosphere. The trailers will haul the bentonite to the batching plant at the MWDF and will pneumatically discharge it into an enclosed batching hopper.

A list of equipment representative of that required for the construction of the waste disposal facility and reclaim ponds 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 in Figures 1.3-3 through 1.3-8. 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. Bales of hay will be used as needed to provide small dikes for control of drainage in localized areas.



EROSION CONTROL SCHEDULE	
1	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
2	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
3	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
4	SEDIMENT POND WITH OVERFLOW PIPE. DISCHARGE ELEV. 500
5	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
6	PONDS TO DISCHARGE ELEV. 503.4 AND THEN DISCHARGES INTO DRAINAGE BASIN 7
7	SEDIMENT POND WITH OVERFLOW PIPE. DISCHARGE ELEV. 496
8	PONDS TO DISCHARGE ELEV. 507 AND THEN DISCHARGES THRU DITCH TO DRAINAGE BASIN 4
9	DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE THRU CULVERT

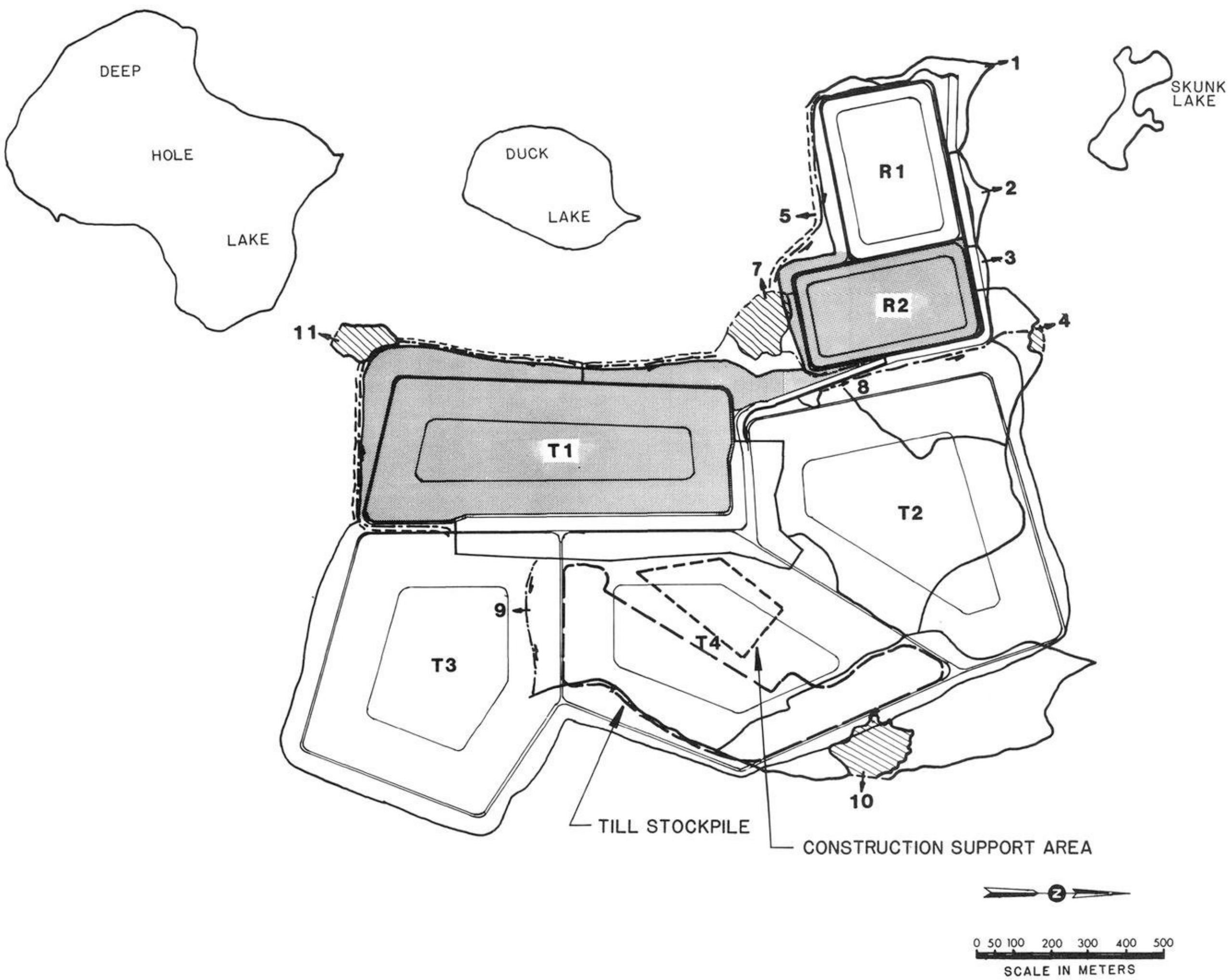
LEGEND:

- DIKE
- DITCH WITH DIRECTION OF FLOW SHOWN
- DRAINAGE BASIN
- 2 DRAINAGE BASIN DISCHARGE POINT WITH I.D. NUMBER
- RETENTION POND
- FACILITY CONSTRUCTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114B
EROSION CONTROL PHASE 1

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY D.R.SPRINGBORN	DATE 9/82	CHECKED BY C. Schroeder	DATE 10/82
APPROVED BY	DATE	APPROVED BY C.E. Fowler	DATE 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO. FIGURE 1.3-3		SHEET ___ OF ___	REVISION NO. 0



EROSION CONTROL SCHEDULE	
1	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
2	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
3	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
4	SEDIMENT POND WITH OVERFLOW PIPE. DISCHARGE ELEV. 500.
5	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
7	SEDIMENT POND WITH OVERFLOW PIPE. DISCHARGE ELEV. 496
8	PONDS TO DISCHARGE ELEV. 507 AND THEN DISCHARGES THRU DITCH TO DRAINAGE BASIN
9	DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE THRU CULVERT
10	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 517
11	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV 494

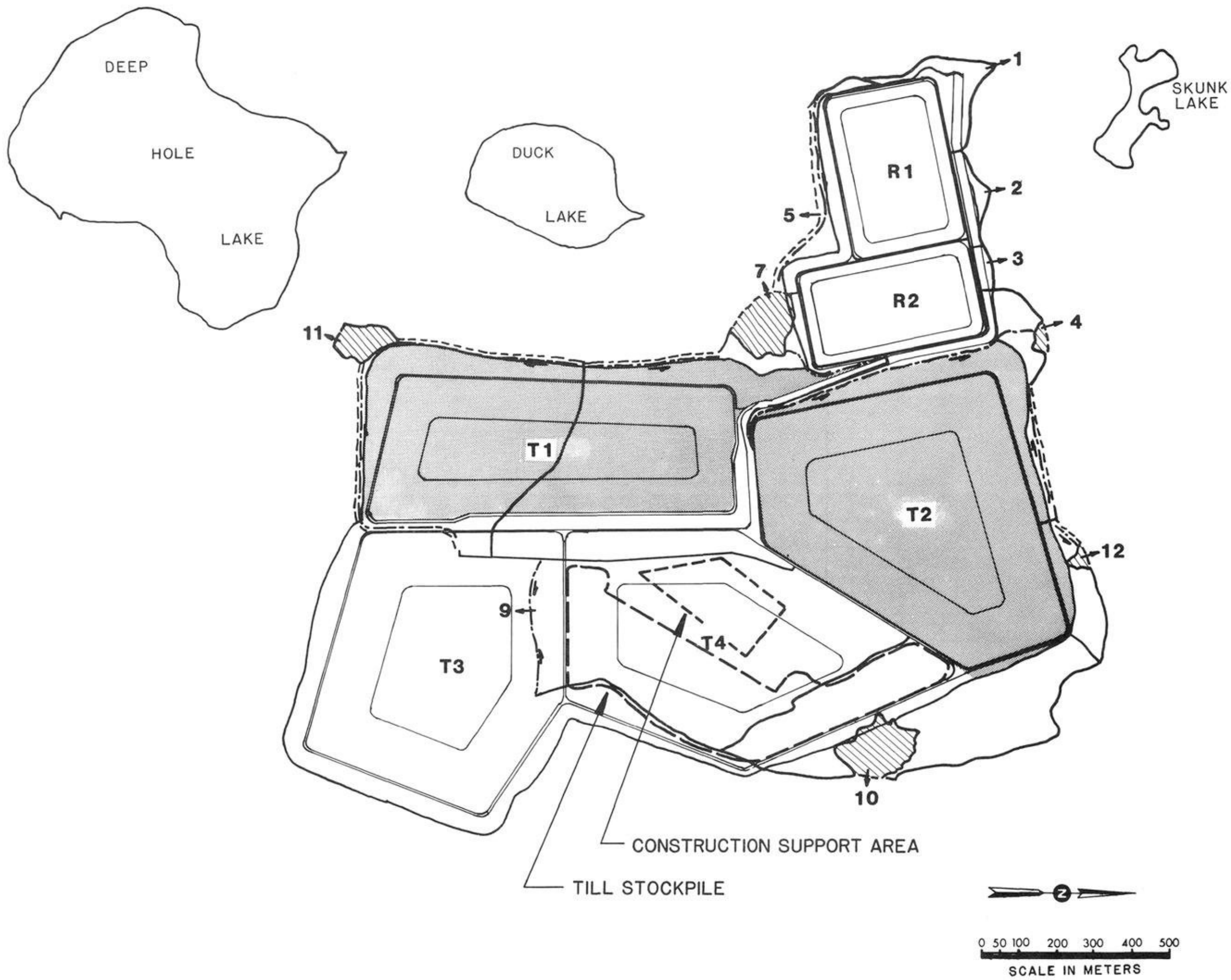
LEGEND:

- DIKE
- DITCH WITH DIRECTION OF FLOW SHOWN
- DRAINAGE BASIN
- 2 DRAINAGE BASIN DISCHARGE POINT WITH I.D. NUMBER
- RETENTION POND
- FACILITY CONSTRUCTION

EXXON MINERALS COMPANY
CRANDON PROJECT

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

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY D.R.SPRINGBORN	DATE 9/82	CHECKED BY C. Schroeder		DATE 10/82
APPROVED BY	DATE	APPROVED BY C. E. Fowler		DATE 10/26/82
APPROVED BY	DATE	EXXON		DATE
DRAWING NO. **FIGURE 1.3-4**			SHEET ___ OF ___	REVISION NO. 0



EROSION CONTROL SCHEDULE	
1	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
2	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
3	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
4	SEDIMENT POND WITH OVERFLOW PIPE. DISCHARGE ELEV. 500
5	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
7	SEDIMENT POND WITH OVERFLOW PIPE. DISCHARGE ELEV. 496
9	DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE THRU CULVERT
10	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV 517
11	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV 494
12	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV 516

LEGEND:

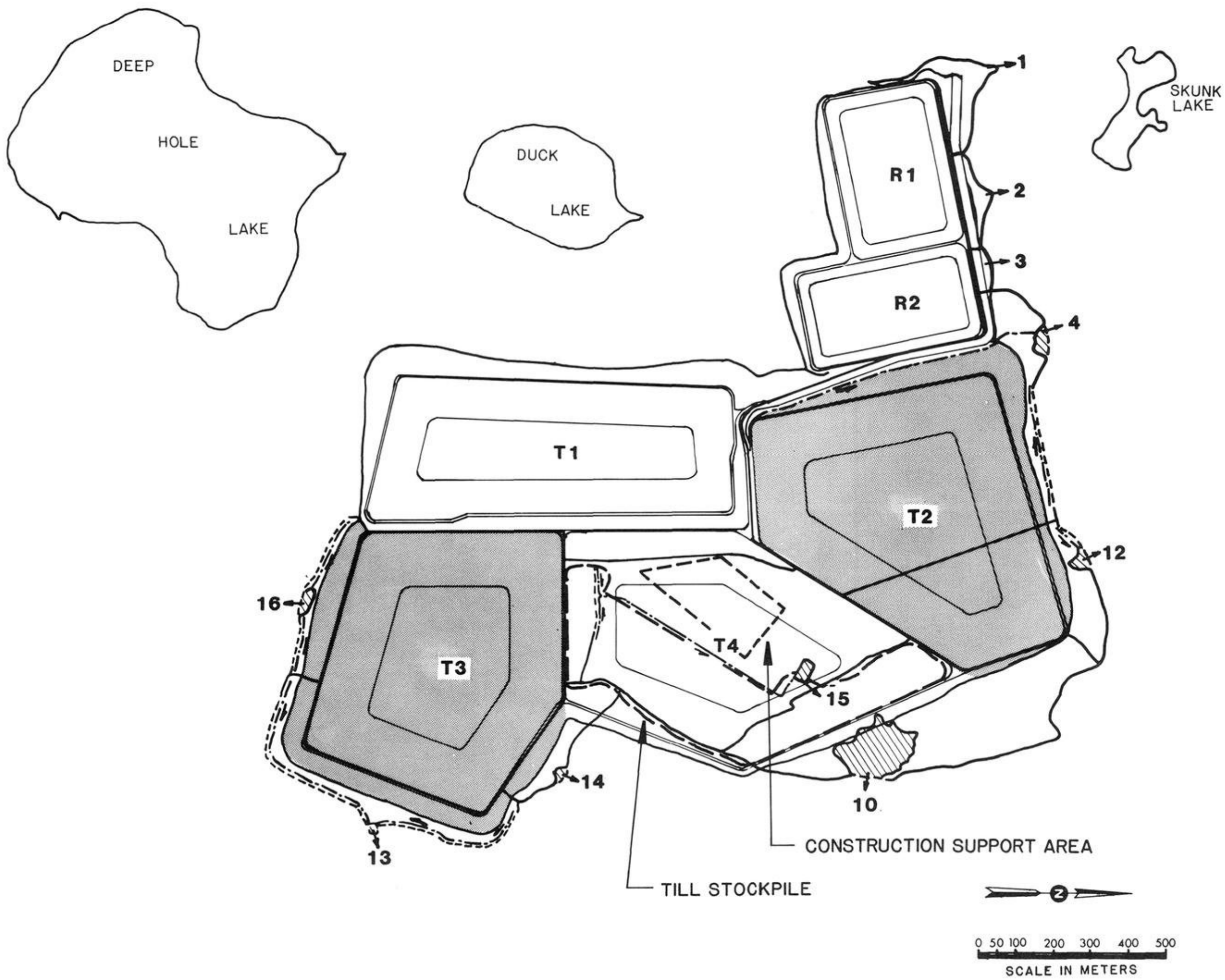
- DIKE
- DITCH WITH DIRECTION OF FLOW SHOWN
- DRAINAGE BASIN
- 2 DRAINAGE BASIN DISCHARGE POINT WITH I.D. NUMBER
- RETENTION POND
- FACILITY CONSTRUCTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114B
EROSION CONTROL PHASE 3

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY D.R.SPRINGBORN	DATE 9/82	CHECKED BY C. Schroeder	DATE 10/82
APPROVED BY	DATE	APPROVED BY C.E. Fowler	DATE 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO. **FIGURE 1.3-5**		SHEET ___ OF ___	REVISION NO. 0

EROSION CONTROL SCHEDULE	
1	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
2	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
3	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
4	SEDIMENT POND WITH OVERFLOW PIPE. DISCHARGE ELEV. 500
10	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 517
12	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 516
13	BALED HAY OR STRAW DITCH CHECKS AND SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 508
14	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV 510
15	SEDIMENT POND WITH PUMPED OVERFLOW TO BASIN 10 DISCHARGE ELEV 514
16	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 503



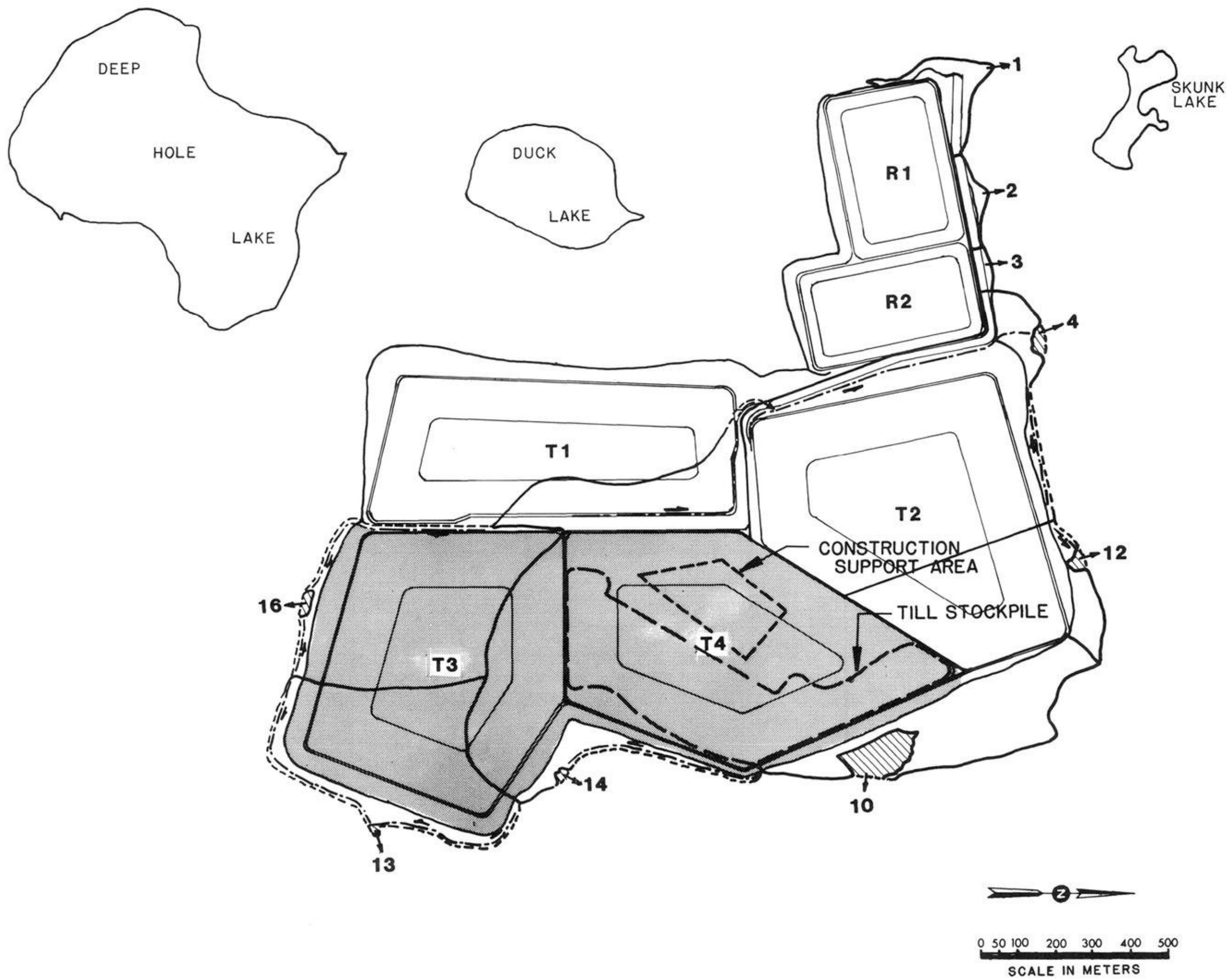
LEGEND:

- DIKE
- DITCH WITH DIRECTION OF FLOW SHOWN
- DRAINAGE BASIN
- 2 DRAINAGE BASIN DISCHARGE POINT WITH I.D. NUMBER
- RETENTION POND
- FACILITY CONSTRUCTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114B
EROSION CONTROL PHASE 4

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY D.R.SPRINGBORN	DATE 9/82	CHECKED BY C Schroeder	DATE 10/82
APPROVED BY	DATE	APPROVED BY C E Fowler	DATE 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO. FIGURE 1.3-6		SHEET ___ OF ___	REVISION NO. 0



EROSION CONTROL SCHEDULE	
1	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
2	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
3	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
4	SEDIMENT POND WITH OVERFLOW PIPE. DISCHARGE ELEV. 500
10	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 517
12	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 516
13	BALED HAY OR STRAW DITCH CHECKS AND SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 508
14	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 510
16	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 503

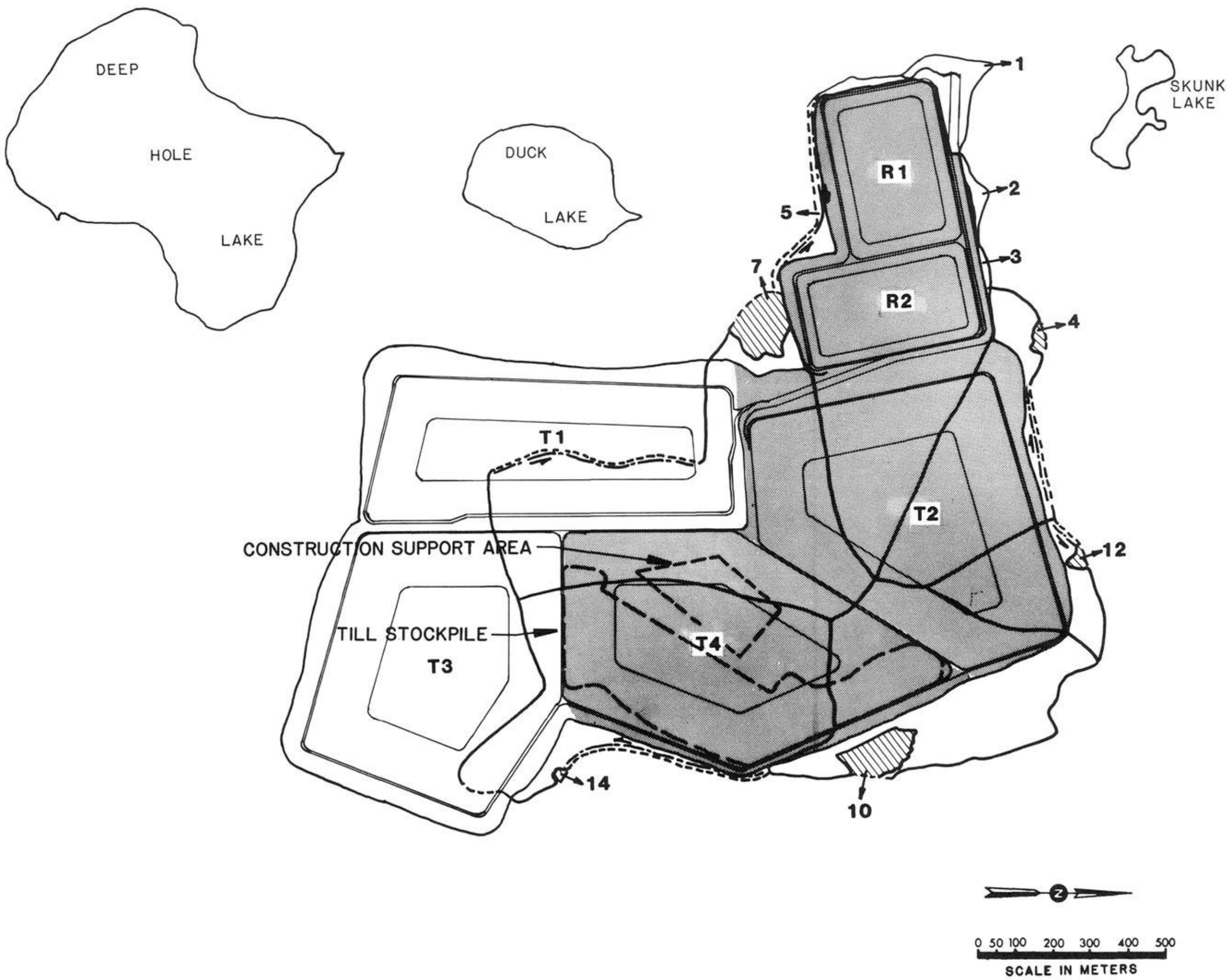
LEGEND:

- DIKE
- DITCH WITH DIRECTION OF FLOW SHOWN
- DRAINAGE BASIN
- 2 DRAINAGE BASIN DISCHARGE POINT WITH I.D. NUMBER
- RETENTION POND
- FACILITY CONSTRUCTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114B
EROSION CONTROL PHASE 5

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY D.R.SPRINGBORN	DATE 9/82	CHECKED BY C. Schroeder		DATE 10/82
APPROVED BY	DATE	APPROVED BY C.E. Fowler		DATE 10/26/82
APPROVED BY	DATE	EXXON		DATE
DRAWING NO. **FIGURE 1.3-7**			SHEET ___ OF ___	REVISION NO. 0



EROSION CONTROL SCHEDULE	
1	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
2	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
3	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
4	SEDIMENT POND WITH OVERFLOW PIPE. DISCHARGE ELEV, 500
5	BALED HAY OR STRAW DITCH CHECK DISCHARGING INTO EXISTING DRAINAGE
7	SEDIMENT POND WITH OVERFLOW PIPE. DISCHARGE ELEV, 496
10	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 517
12	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 516
14	SEDIMENT POND WITH OVERFLOW PIPE DISCHARGE ELEV. 510

LEGEND:

- DIKE
- DITCH WITH DIRECTION OF FLOW SHOWN
- DRAINAGE BASIN
- 2 DRAINAGE BASIN DISCHARGE POINT WITH I.D. NUMBER
- RETENTION POND
- FACILITY CONSTRUCTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114B
EROSION CONTROL PHASE 6

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY D.R.SPRINGBORN	DATE 9/82	CHECKED BY C. Schroeder		DATE 10/82
APPROVED BY	DATE	APPROVED BY C E Fowler		DATE 10/26/82
APPROVED BY	DATE	EXXON		DATE
DRAWING NO. **FIGURE 1.3-8**			SHEET ____ OF ____	REVISION NO. 0

1.3.1.8 Pipeline Construction

Pipelines to transport tailings slurry to the tailings ponds, thickener overflow water to the reclaim ponds, and water from the reclaim ponds to the mill. Where appropriate, pipelines will be buried below the frost line to avoid frost damage and for improved visual effect.

Because the depth of the trench will be such that excavation will be in glacial till, blasting will not be required and all excavation can be by backhoe or similar equipment. The trench will be backfilled with till.

The pipeline area width, approximately 2.4 m (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 frost line within a 15 m (50 foot) right-of-way. Excavation will be either by 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 the 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 shortly after trench backfilling.

1.3.1.9 Railroad Construction

Clearing, grubbing, and earth moving for the railroad will be similar to that planned for site preparation and for the main access road.

Satisfactory topsoil will be removed and stockpiled for use during revegetation. Cut and fill will follow the grubbing operation. Erosion and runoff will be controlled by hydroseeding and topsoil application, together with permanent culverts and a system of retention basins to eliminate the unrestricted flow of runoff. Rip-rap and hay matting in conjunction with settling basins will minimize the sediment flow into adjacent wetland areas.

Organic peat materials excavated from wetlands and not suitable for roadbed construction will be placed on surface areas to aid in revegetation and will be replaced with selected cut materials from elsewhere on the railroad alignment. A cut-and-fill balance will be attained which will essentially eliminate the need for borrow or waste areas. Sub-ballast and ballast placed on the subgrade will complete the railroad bed before ties and rail are installed.

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

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

1.3.1.10 Power Line 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 will be constructed by WPSC from the Venus substation, about 27 km (17 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 will be included as part of their Certificate of Public Convenience and Necessity (CPCN) 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 or concrete poles constructed to WPSC standards. The transmission line will have the capacity to serve the 40-45 MW mine/mill load.

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 18 to 24 months of construction. During this interim period, power will be supplied by on-site diesel powered generators.

1.3.1.11 Water Supply

A temporary water system will be necessary during the first year of construction. This water requirement will be met from on-site wells. As water from these wells is expected to be potable without treatment, no distinction is made between construction and potable water. Distribution of potable water will be accomplished by tank trucks which will take water directly from the wells to water dispensers located adjacent to the work areas.

The heaviest water demands will occur during the first 2 years of construction, from May through December, when an estimated 45.4 m^3 (12,000 gallons) per working day will be consumed. From January through April, water consumption is estimated to decrease to 5.7 m^3 (1,500 gallons) per day.

During the remaining 3 years, construction progress will have reduced the need for dust control to the point that water consumption during the peak manloading period will approximate 16.5 m^3 (7,000 gallons) per working day.

1.3.1.12 Equipment Storage and Laydown

During the mine and mill construction there will be designated laydown areas for equipment storage and contractor usage. These areas are shown on Figure 1.3-1.

1.3.1.13 Sanitary Facilities

The sewage treatment facility will be installed and placed in service during the first year of construction. However, limited use of chemical toilets will be required throughout construction of the Project. Until the sewage plant is in operation, a contractor will transport sewage off-site. During the first 2 years when the construction activities will be peaking, sewage is estimated at 5.7 m^3 (1,500 gallons) per day.

The shaft sinking contractor's restrooms, lavatories, and shower facilities will utilize a temporary septic tank until the sewage treatment facility is in operation. At that time, the facilities will be tied directly into the sewage system permanent lines.

1.3.1.14 Haul Road Construction

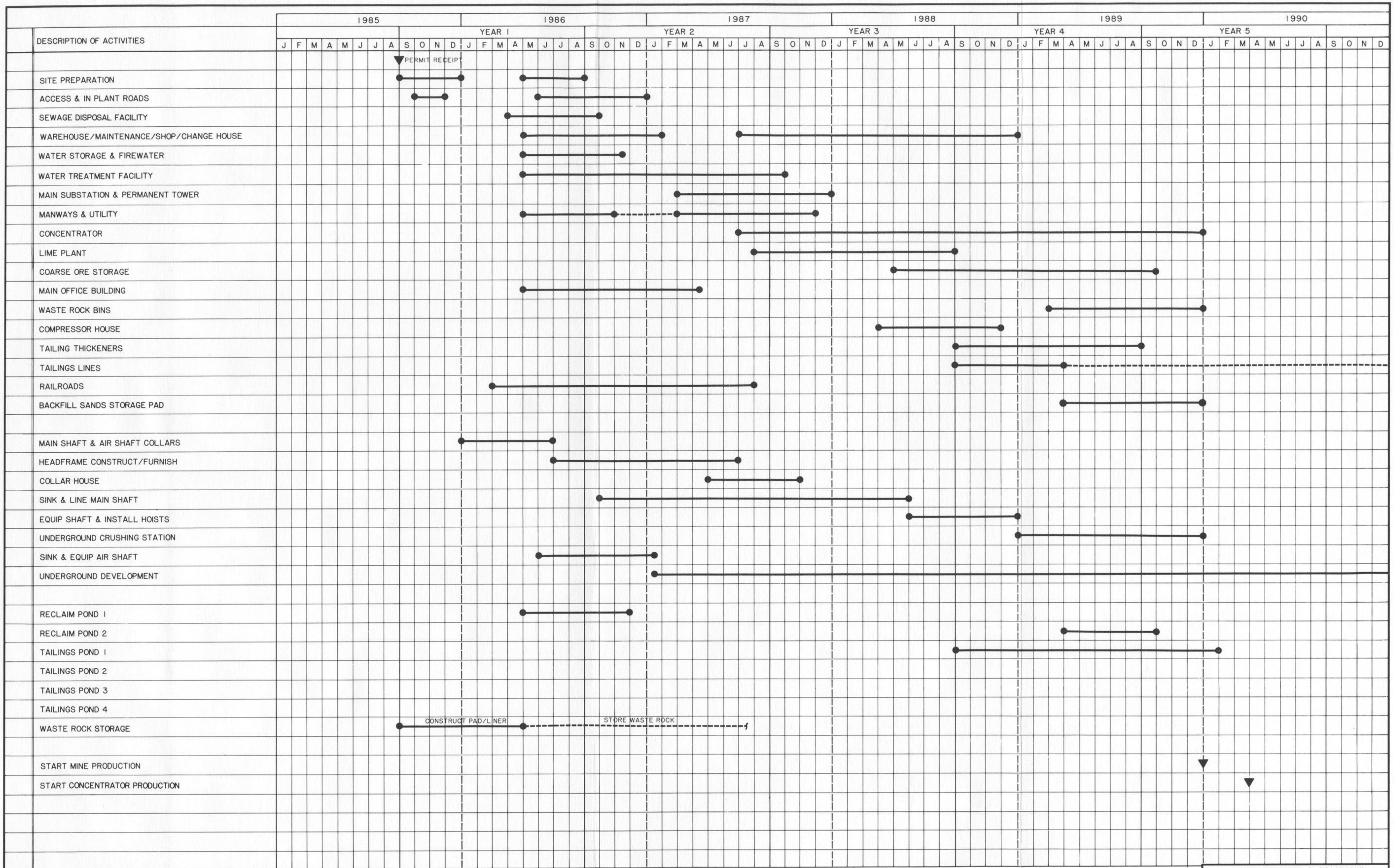
A haulage road will be constructed from the mine/mill site to the waste disposal area. The alignment for this road will also accommodate the tailing slurry and reclaim water pipelines. A dividing berm will ensure that vehicular traffic is confined to that portion of the alignment not occupied by the pipelines. Construction methods employed in building the haulage road will be similar to those used in the construction of the mine/mill site access road described in subsection 1.3.1.3.

1.3.2 Construction Schedule

The duration of the construction phase of the Project is controlled by the time required to develop the main shaft and headframe, the fresh air and exhaust shafts, and to perform the subsequent underground mine development activities. Thus, the sequence of key activities consists of site preparation for construction of the main shaft and air shaft collars, erection of that portion of the main shaft headframe required to install the sinking hoists, sinking the shafts to the appropriate levels, followed by on-going underground development.

The time needed for the construction of the surface facilities is considerably less than that required to complete the previously described key activities. As a result, the sequence of construction of the surface facilities will initially be governed by the need to provide, in a timely manner, the facilities required to support the shaft sinking operation. Thus, site preparation, the provision of environmental protection systems, such as the waste water treatment and sewage treatment facilities, and installation of temporary power and concrete batching facilities are the first priorities. Construction of the principal process facilities (the concentrator, lime plant, and coarse ore storage) will be sequenced to minimize peaks and valleys in manpower levels.

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. A graphic presentation of the schedule for individual construction activities is given in Figure 1.3-9. Figures 1.3-10 through 1.3-14 illustrate the yearly construction activities.



ON GOING ACTIVITIES

YEARS	
1994–97	CONSTRUCT TAILINGS POND T2 – RECLAIM TAILINGS POND T1
2001–04	CONSTRUCT TAILINGS POND T3 – RECLAIM PART OF TAILINGS POND T2
2007–10	CONSTRUCT TAILINGS POND T4 – RECLAIM TAILINGS POND T3
2016–22	FINAL RECLAMATION OF TAILINGS POND T2 – RECLAIM TAILINGS POND T4 – FINAL SITE RECLAMATION

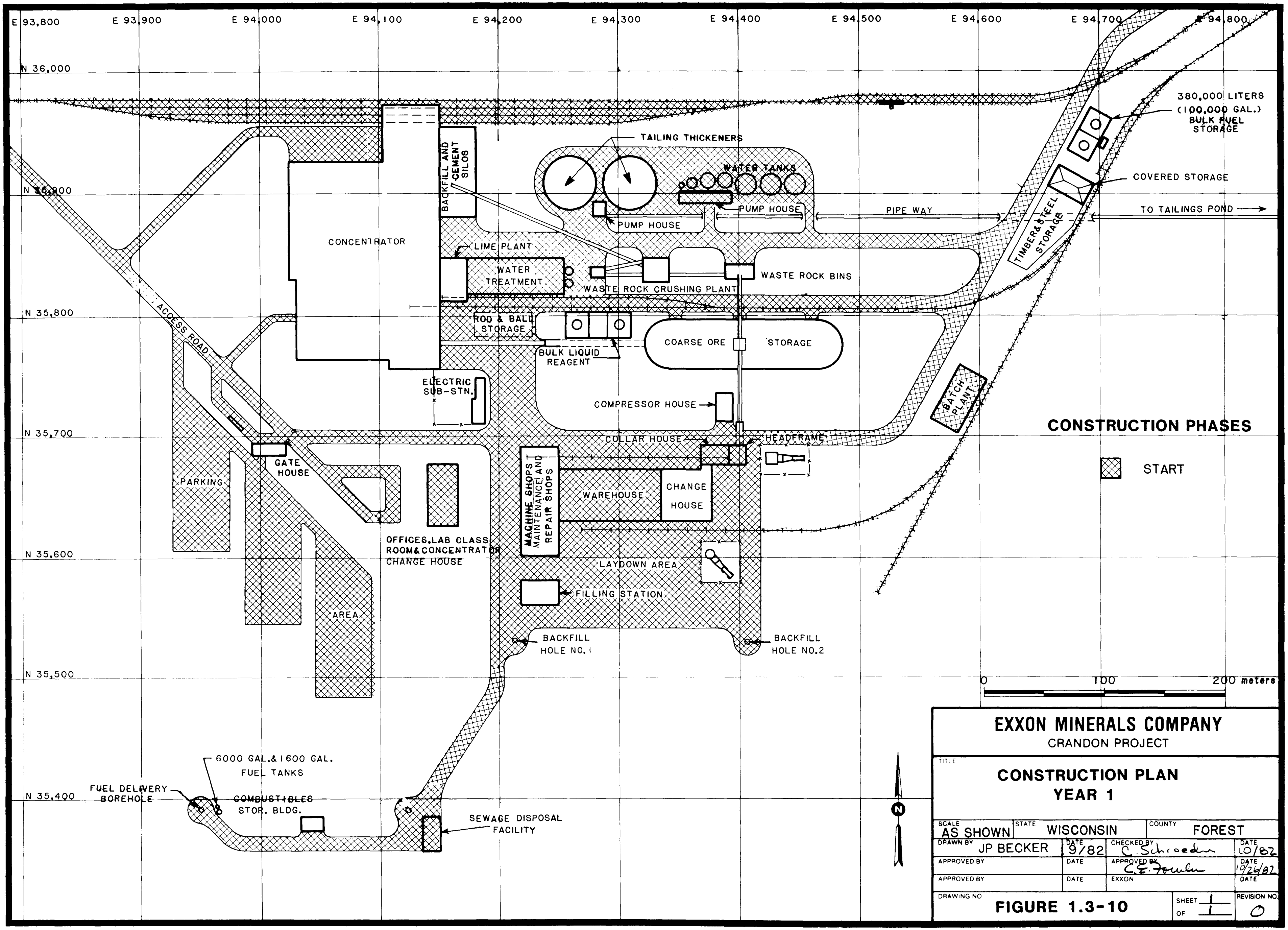
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CRANDON PROJECT CONSTRUCTION SCHEDULE

SCALE NONE | STATE WISCONSIN | COUNTY FOREST
DRAWN D.R.SPRINGBORN | 10/82
REVISED | DATE | BY | DESCRIPTION

FIGURE 1.3-9

REVISION 0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E 94,800
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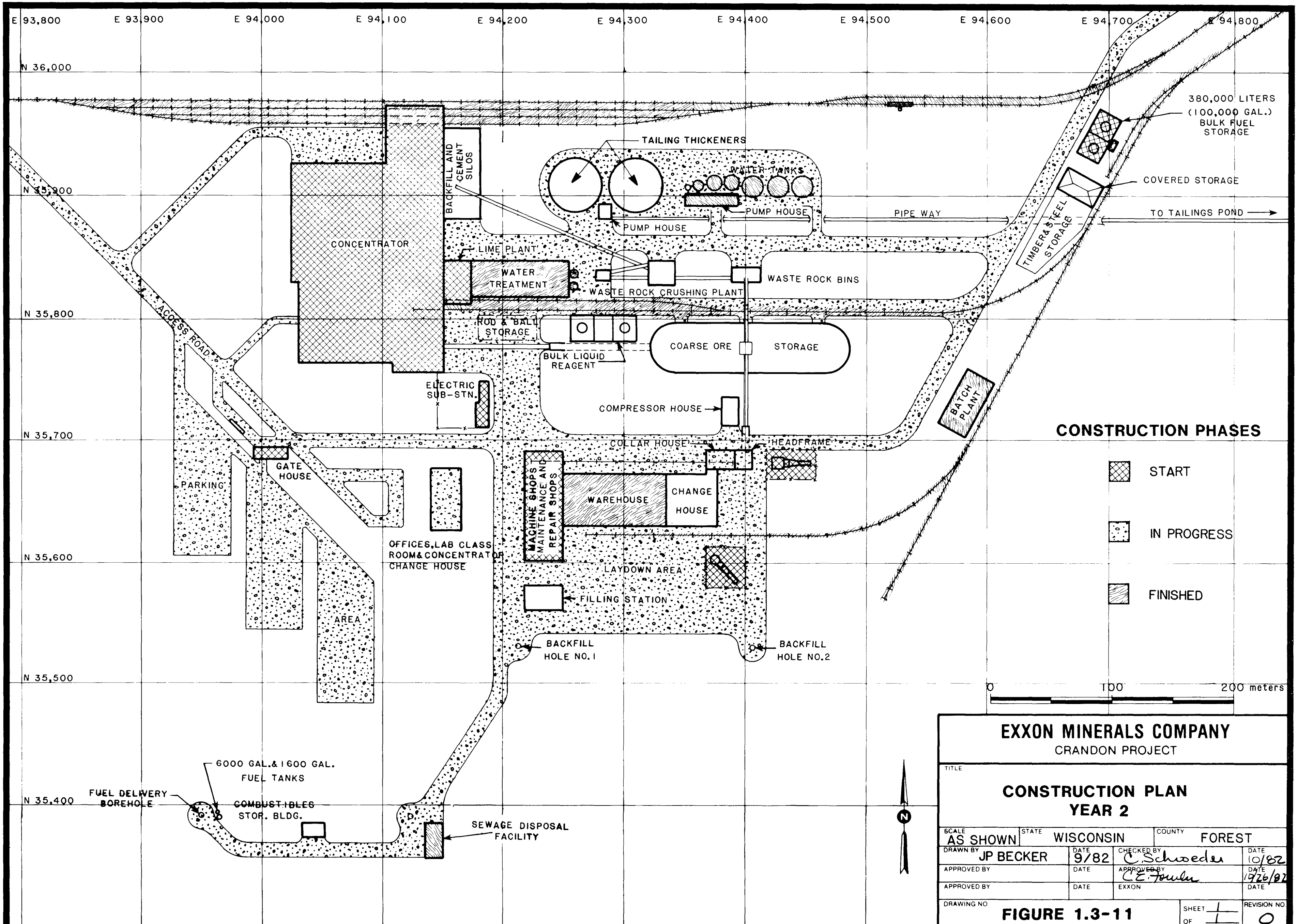
N 35,700
N 35,600
N 35,500
N 35,400
380,000 LITERS (100,000 GAL.) BULK FUEL STORAGE
TAILING THICKENERS
WATER TANKS
BACKFILL AND CEMENT SILOS
CONCENTRATOR
PUMP HOUSE
PUMP HOUSE
PIPE WAY
COVERED STORAGE
TO TAILINGS POND
TIMBER & STEEL STORAGE
LIME PLANT
WATER TREATMENT
WASTE ROCK CRUSHING PLANT
WASTE ROCK BINS
ROD & BALL STORAGE
BULK LIQUID REAGENT
COARSE ORE STORAGE
ACCESS ROAD
ELECTRIC SUB-STN.
COMPRESSOR HOUSE
BATCH PLANT
CONSTRUCTION PHASES
START
COLLAR HOUSE
HEADFRAME
GATE HOUSE
PARKING
MACHINE SHOPS
MAINTENANCE AND REPAIR SHOPS
WAREHOUSE
CHANGE HOUSE
OFFICES, LAB CLASS ROOM & CONCENTRATOR CHANGE HOUSE
LAYDOWN AREA
FILLING STATION
AREA
BACKFILL HOLE NO. 1
BACKFILL HOLE NO. 2
0 100 200 meters
6000 GAL. & 1600 GAL. FUEL TANKS
FUEL DELIVERY BOREHOLE
COMBUSTIBLES STOR. BLDG.
SEWAGE DISPOSAL FACILITY
N
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
CONSTRUCTION PLAN
YEAR 1
SCALE AS SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY JP BECKER
DATE 9/82
CHECKED BY C. Schroeder
DATE 10/82
APPROVED BY
DATE
APPROVED BY C.E. Fowler
DATE 10/26/82
APPROVED BY
DATE
EXXON
DATE
DRAWING NO
FIGURE 1.3-10
SHEET 1 OF 1
REVISION NO. 0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(100,000 GAL.)
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STORAGE
TAILING THICKENERS
WATER TANKS
BACKFILL AND CEMENT SILOS
COVERED STORAGE
PUMP HOUSE
PUMP HOUSE
PIPE WAY
TO TAILINGS POND
TIMBER & STEEL STORAGE
CONCENTRATOR
LIME PLANT
WATER TREATMENT
WASTE ROCK CRUSHING PLANT
WASTE ROCK BINS
ROD & BALL STORAGE
COARSE ORE
STORAGE
BULK LIQUID
REAGENT
ACCESS ROAD
ELECTRIC
SUB-STN.
COMPRESSOR HOUSE
BATCH PLANT
CONSTRUCTION PHASES
START
IN PROGRESS
FINISHED
COLLAR HOUSE
HEADFRAME
GATE
HOUSE
PARKING
MACHINE SHOPS MAINTENANCE AND REPAIR SHOPS
WAREHOUSE
CHANGE
HOUSE
OFFICES,LAB CLASS
ROOM & CONCENTRATOR
CHANGE HOUSE
LAYDOWN AREA
FILLING STATION
AREA
BACKFILL
HOLE NO. 1
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HOLE NO. 2
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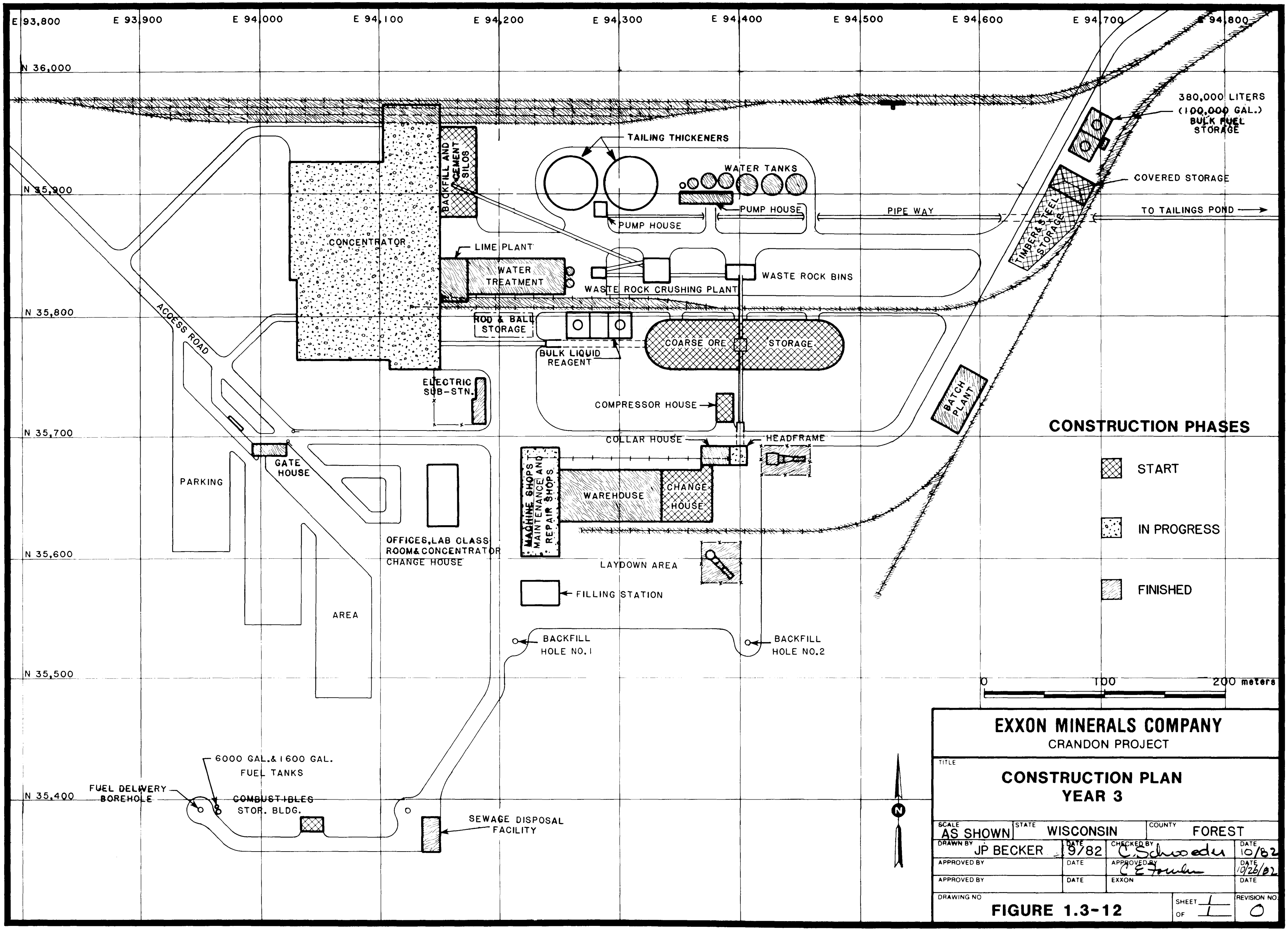
200 meters
6000 GAL. & 1600 GAL.
FUEL TANKS
FUEL DELIVERY
BOREHOLE
COMBUSTIBLES
STOR. BLDG.
SEWAGE DISPOSAL
FACILITY
N
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
CONSTRUCTION PLAN
YEAR 2
SCALE AS SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY JP BECKER
DATE 9/82
CHECKED BY C. Schroeder
DATE 10/82
APPROVED BY
DATE
APPROVED BY C.E. Fowler
DATE 10/26/82
APPROVED BY
DATE
EXXON
DATE
DRAWING NO
FIGURE 1.3-11
SHEET 1 OF 1
REVISION NO 0



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E 94,800
N 36,000
N 35,900
N 35,800
N 35,700
N 35,600
N 35,500
N 35,400
380,000 LITERS
(100,000 GAL.)
BULK FUEL
STORAGE
TAILING THICKENERS
WATER TANKS
COVERED STORAGE
BACKFILL AND CEMENT SILOS
PUMP HOUSE
PUMP HOUSE
PIPE WAY
TO TAILINGS POND
CONCENTRATOR
LIME PLANT
WATER
TREATMENT
WASTE ROCK CRUSHING PLANT
WASTE ROCK BINS
TIMBER & STEEL STORAGE
ROD & BALL
STORAGE
COARSE ORE
STORAGE
BULK LIQUID
REAGENT
ACCESS ROAD
ELECTRIC
SUB-STN.
COMPRESSOR HOUSE
BATCH
PLANT
CONSTRUCTION PHASES
START
IN PROGRESS
FINISHED
COLLAR HOUSE
HEADFRAME
GATE
HOUSE
PARKING
MACHINE SHOPS
MAINTENANCE AND
REPAIR SHOPS
WAREHOUSE
CHANGE
HOUSE
OFFICES, LAB CLASS
ROOM & CONCENTRATOR
CHANGE HOUSE
LAYDOWN AREA
FILLING STATION
AREA
BACKFILL
HOLE NO. 1
BACKFILL
HOLE NO. 2
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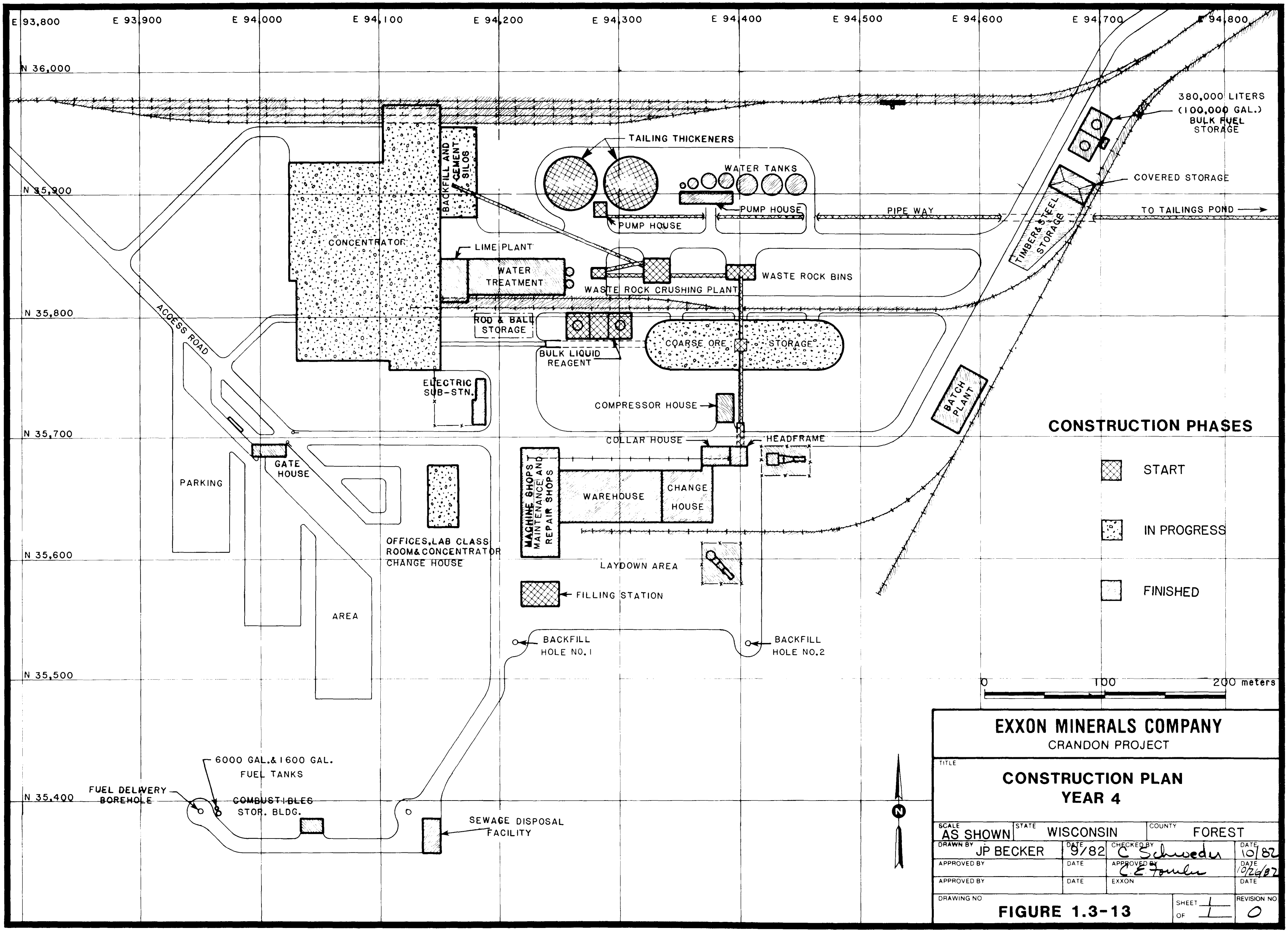
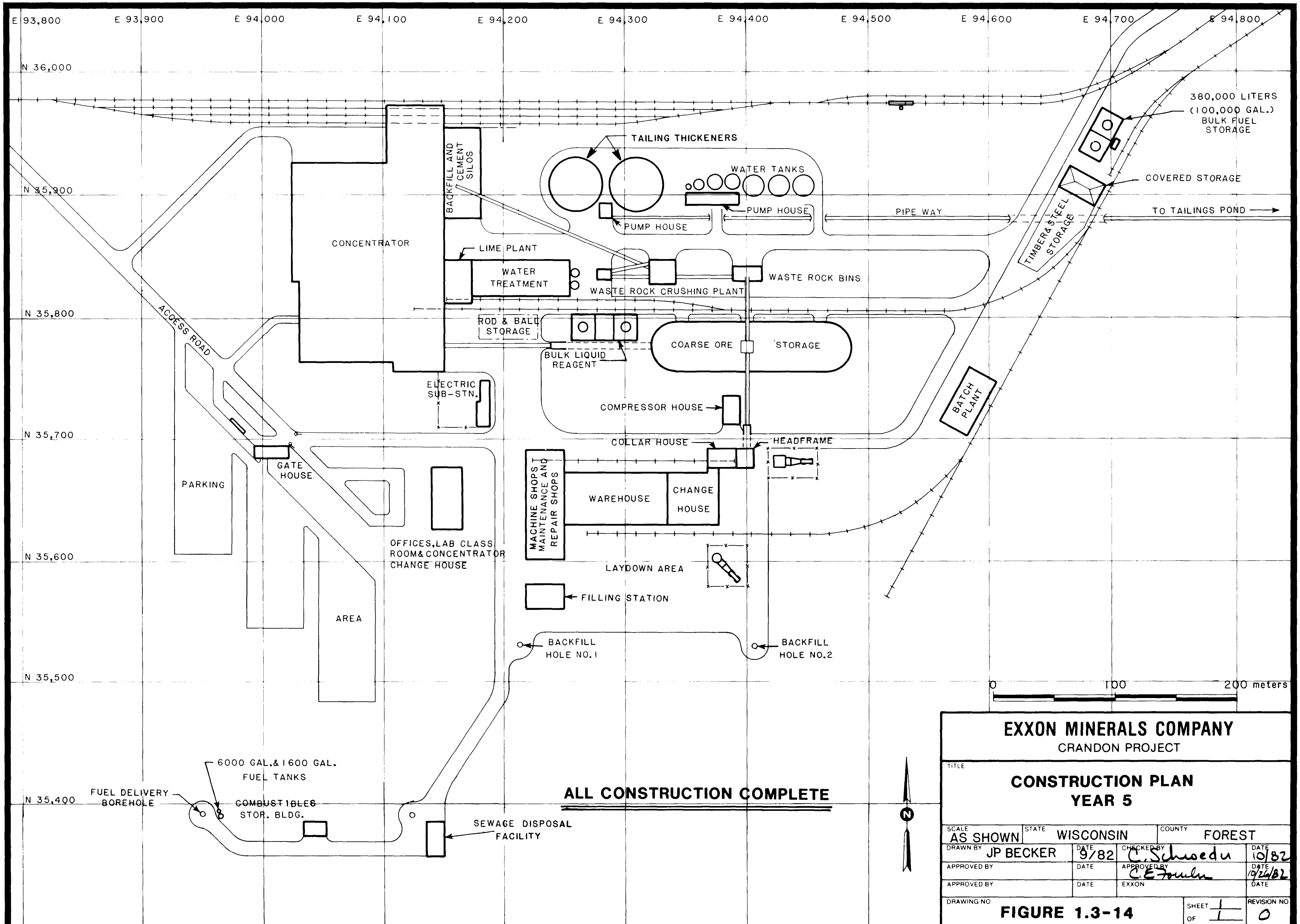
100
200 meters
6000 GAL. & 1600 GAL.
FUEL TANKS
FUEL DELIVERY
BOREHOLE
COMBUSTIBLES
STOR. BLDG.
SEWAGE DISPOSAL
FACILITY
N
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
CONSTRUCTION PLAN
YEAR 3
SCALE AS SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY JP BECKER
DATE 9/82
CHECKED BY C Schroeder
DATE 10/82
APPROVED BY
DATE
APPROVED BY
DATE 10/26/82
APPROVED BY
DATE
EXXON
DATE
DRAWING NO
FIGURE 1.3-12
SHEET 1 OF 1
REVISION NO. 0



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CONSTRUCTION PLAN
YEAR 4

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY JP BECKER	DATE 9/82	CHECKED BY C Schroeder	DATE 10/82
APPROVED BY	DATE	APPROVED BY C E Fowler	DATE 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO **FIGURE 1.3-13**		SHEET 1 OF 1	REVISION NO 0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E 94,800
N 36,000
N 35,900
N 35,800
N 35,700
N 35,600
N 35,500
N 35,400
380,000 LITERS (100,000 GAL.) BULK FUEL STORAGE
TAILING THICKENERS
WATER TANKS
BACKFILL AND CEMENT SILOS
COVERED STORAGE
PUMP HOUSE
PUMP HOUSE
PIPE WAY
TO TAILINGS POND
TIMBER & STEEL STORAGE
CONCENTRATOR
LIME PLANT
WATER TREATMENT
WASTE ROCK CRUSHING PLANT
WASTE ROCK BINS
ROD & BALL STORAGE
COARSE ORE STORAGE
BULK LIQUID REAGENT
ACCESS ROAD
ELECTRIC SUB-STN.
BATCH PLANT
COMPRESSOR HOUSE
COLLAR HOUSE
HEADFRAME
GATE HOUSE
PARKING
MACHINE SHOPS MAINTENANCE AND REPAIR SHOPS
WAREHOUSE
CHANGE HOUSE
OFFICES, LAB CLASS ROOM & CONCENTRATOR CHANGE HOUSE
LAYDOWN AREA
FILLING STATION
AREA
BACKFILL HOLE NO. 1
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6000 GAL. & 1600 GAL. FUEL TANKS
FUEL DELIVERY BOREHOLE
COMBUSTIBLES STOR. BLDG.
SEWAGE DISPOSAL FACILITY
ALL CONSTRUCTION COMPLETE
N
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
CONSTRUCTION PLAN
YEAR 5
SCALE AS SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY JP BECKER
DATE 9/82
CHECKED BY C. Schroeder
DATE 10/82
APPROVED BY
DATE
APPROVED BY C.E. Fowler
DATE 10/26/82
APPROVED BY
DATE
EXXON
DATE
DRAWING NO
FIGURE 1.3-14
SHEET 1 OF 1
REVISION NO 0

During the first year of construction clearing, grubbing, and rough-grading will be performed in a continuous operation. Approximately 160 ha (395 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 stormwater 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 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 the sewage and water treatment facilities, reclaim pond No. R1, a perimeter fence, and the fire protection and water storage system.

During Year 2 the headframe will be completed and equipment installation started. Sinking of the main shaft will be initiated immediately upon completion of the required portion of the headframe and will be completed in Year 3. Underground mine development will commence during the second quarter of Year 2. Also during Year 2, foundations will be started for the concentrator, fine crushing facilities, fine ore storage bins, the lime plant, and the coarse ore storage facilities.

Installation of permanent hoisting, ventilation, and switchgear will continue in the headframe during Year 3 and be completed in Year 4. Mechanical, electrical, and instrumentation work will increase during Year 4 as the civil and structural work decreases. The principal above ground structures will be completed during Year 4. Reclaim pond No. R2 will be constructed during Year 4 and excavation of tailing pond No. Tl will be started.

During Year 5, the final year of construction activities, underground development will be completed so that operational and production activities can be initiated on a limited scale. Construction of reclaim pond No. R2 and tailing pond No. Tl will be completed during Year 5 and the tailings and recirculation water lines will be installed. Clean up and landscaping activities, which have been ongoing throughout the construction plase, will be completed.

1.3.3 Construction Operations

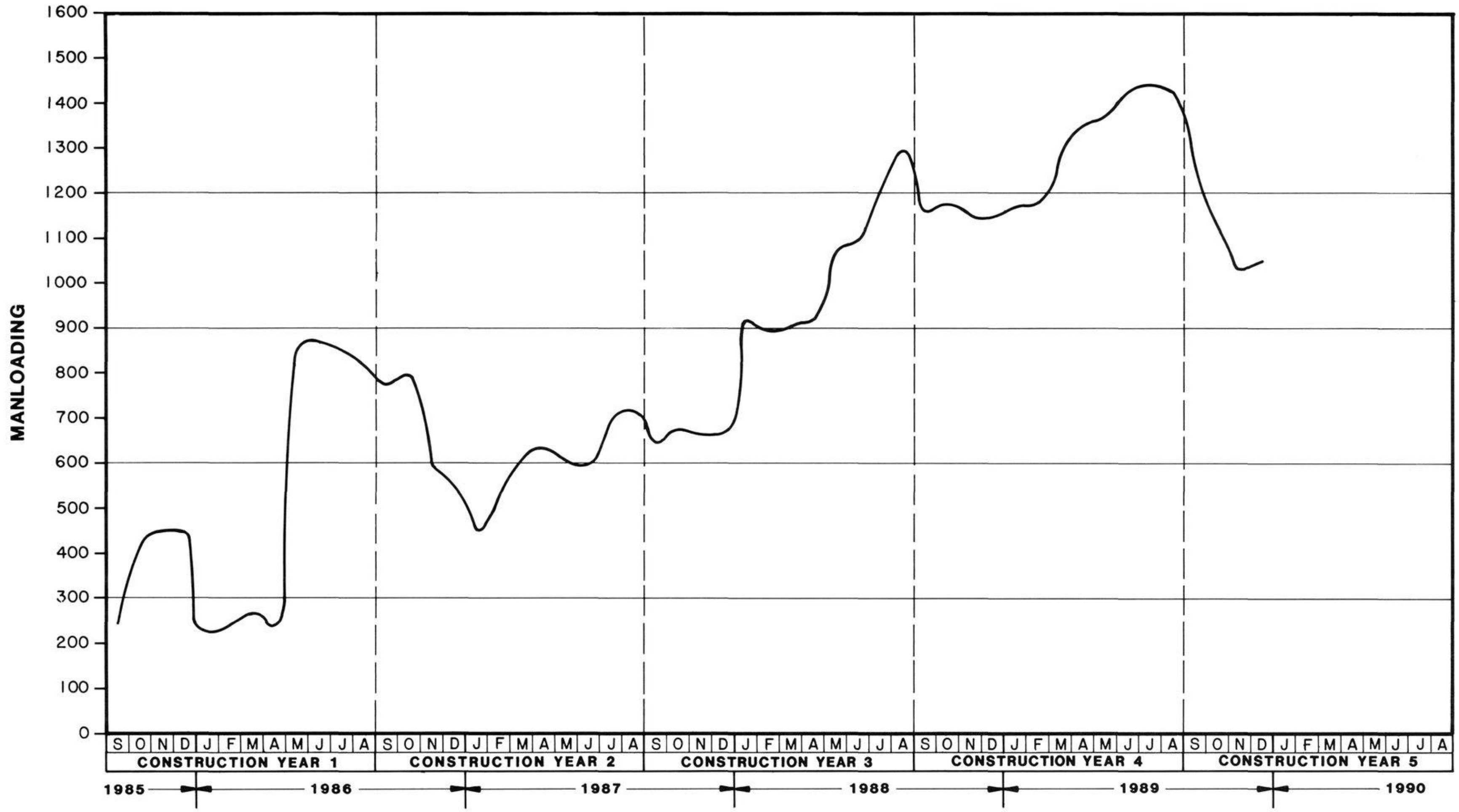
1.3.3.1 Manpower

The estimated manpower required during the various phases of construction are shown on Figure 1.3-15. Sequencing of construction activities will provide a smooth build-up of personnel, thereby minimizing peaks and valleys in manning levels. Seasonal fluctuations, however, cannot be entirely eliminated and this is particularly true during the first 2 years when much of the work must be performed outside.

During the course of the surface facilities construction there will be a progressive change in craft skills requirements. For approximately the first 2 years, the work will emphasize site preparation, excavation, construction of building foundations, and constuction 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 third year of construction, emphasis will shift toward the need for iron workers and carpenters, with a continuing need for concrete forming and pouring skills. The emphasis during the final 2 years of construction will be toward the need for millwrights 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 later part of Year 3. Where feasible, constructin employees will be drawn from the local area.

During the first year, site preparation earthwork will be conducted throughout the daylight hours. This is required to maximize progress to the



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE **CONSTRUCTION PHASE MANPOWER COMPOSITE CURVE ESTIMATED LOADING**

SCALE NONE	STATE WISCONSIN		COUNTY FOREST	
DRAWN BY S. J. Harvey	DATE 7/20/82	CHECKED BY S.E.		DATE 8/17/82
APPROVED BY	DATE	APPROVED BY C.E. Fowler		DATE 10/26/82
APPROVED BY	DATE	EXXON		DATE
DRAWING NO. FIGURE 1.3-15			SHEET 1 OF 1	REVISION NO. 0

point where buildings can be erected to provide work areas during periods of severe weather.

Construction of the headframe will be done on three shifts, 24 hours per day, 7 days per week. By the second year most of the construction activities, with the exception of the headframe construction, 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 make-up.

1.3.3.2 Equipment

The types of equipment which will be used for the construction of the surface facilities are described in Tables 1.3-2 and 1.3-3. 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 to the construction schedule is presented in Table 1.3-4. 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, fuels will be obtained from a commercial source. 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

Table 1.3-2

CONSTRUCTION EQUIPMENT SURFACE FACILITIES*

DESCRIPTION	MODEL	ENGINE	HORSE-POWER
Chain Saws	CS400 EVL	40cc	--
Feller Buncher	PM 850	GMC 6V53	180
Hydro Mower	PM 800	GMC 6V53	180
Front End Loader	CAT 988B	D333 6 CYL	--
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	FORD 5600	4 CYL	--
Motor Grader	CAT 16G	D3406	325
Gradall	G1000	(2) GM4-71N	136 ea.
Compactor	I.R. SP-48	D3-53	--
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
Compactor	I.R. DA50	D4-53	--
Compactor V30	Essick V30-WR	Diesel	12
Motor Scraper 21/30 Yd.	--	--	--
Crane 150T	American 8450	(2) GM8V-71N	318 ea.
Crane 90T	American 7460	(2) GM6-71N	--

Table 1.3-2 (continued)

DESCRIPTION	MODEL	ENGINE	HORSE-POWER
Crane 65T	Link Belt TM650	GM8V-71N GM6V-53N	304 178
Crane 50T	Lorain MC540	NHC 250 C 160	250 160
Crane 30T	Grove RT635	V5046	210
Crane 18T	P&H T180	V8-210	202
Super Lift	Pettibone PC200	6-354	--
Forklift	Pettibone PC150	6-354	--
Forklift	Pettibone GS 60	F-227	--
Slash Master	900	GMC 671	261
Front End Loader	CAT 977L	--	--
Dump Trucks 5Y	F 700	351 CID	250
Front End Loader	992C	--	--
Concrete Pumpers	--	--	--
Crane	4100 Manitowac	--	--
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
Concrete Pumper	--	--	--
Water Truck (3000 Gal)	6773	0333	200
Fuel Truck (4000 Diesel/1000 Gas)	International	185Y	185Y

Table 1.3-2 (continued)

DESCRIPTION	MODEL	ENGINE	HORSE-POWER
Transit Mix Trucks 9 1/2 yd^3	--	--	--
Tractor/Low Boy 60T	GMC 6000	D3406	326
Generator	250 kW	Diesel	385
Generator	30 kW	Diesel	61
Generator	2,000 kW	Diesel	2,500
Generator	2,000 kW	Diesel	2,500
Diesel Compressor	150 CFM	Diesel	65
Diesel Compressor	300 CFM	Diesel	97

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

Table 1.3-3

CONSTRUCTION EQUIPMENT LIST 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 75 T	AMER 5530 TM	GM DD 4-71N Diesel GM DD 6171N Diesel	115 Upper 238 Carrier
Crane 25 T	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	CAT 3208 Diesel	125
Off Road Truck	TEREX 33-07	GM DD 12V-71T Diesel	493
Belly Dump Truck and Trailer	Ford LT-9000 Tractor	240 Cummins Diesel	240
Dump Truck Tandems	Ford LT-9000	240 Cummins Diesel	240
PD Trailer and Tractor	Ford LT-9000 Tractor	240 Cummins Diesel	240
Flatbed Truck	International	185T	185

Table 1.3-3 (continued)

DESCRIPTION	MODEL	ENGINE	HORSE-POWER
Pickup Truck	Chev 13/4 Ton	GM 305 V8 Gas JD 6 CYL Diesel	180 110 (Hydro-seeder)
Hydroseeder CAT Powered 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 and Trailer 60T	GMC 6000	CAT D3406 Diesel	326
Processing Plant	-	-	-
Batch Plant	-	-	-
Bentonite Unloading System	-	-	-
42" Conveyor	Universal	Electric	-
Generator	335 KW	CAT D346	-
Generator	250 KW	CAT 3408 Diesel	385
Generator	90 KW	CAT 3304 Diesel	-
Generator	30 KW	Homelite Diesel	61
15 HP Sump Pump	-	-	-
Flowmaster Pump	-	-	-
Power Ram Packer	Kelly 10KR7	-	-
Power Auger	-	-	-
Chain Saws	Homelite 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.

TABLE 1.3-4

REPRESENTATIVE CONSTRUCTION EQUIPMENT LOADING SCHEDULE PAGE 1 OF 4

DESCRIPTION	1985				1986												1987							
	YEAR 1												YEAR 2											
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
Lumbering Equipment (Mine/Mill Site)																								
Chain Saws	20	20	20	20	5	5	5																	
Feller Buncher	3	3	3	3																				
Hydro Mower	3	3	3	3																				
Construction Equipment - Earth Moving (Mine/Mill Site)																								
Front End Loader 988B	1	2	4	4	2	1	1	1	3	2	3	3	2	2	2	2						2	2	2
Bulldozer D9		1	1	1	1				1	1	1	1												
Bulldozer D8																								
Bulldozer D7	2	10	10	10	10				8	8	6	4												
Bulldozer D6		3	3	3	3	1	1	1	1	2	2	2	1	1										
Backhoe 235									1	1	1	1											1	1
Backhoe 245		1	1	1			1	1	1									2	2	1	1			
Backhoe Combo FD5600		1	2	4	1	1	1	2	4	2	1		1					3	3	2	1	1	2	3
Motor Grader 16G		2	2	3	2	2	2	2					1	2	2	1	1	1	1	1	1			
Gradall G1000									3	3	4	4	2									2	2	1
Compactor SP48									3	3	3	2	2	2										
Wacker BPG24		2	2	3		1	1	3	10	8	6	4	2	2				3	3	2	2	2	3	3
Compactor BPG 9									4	4	3	3	2	2							1	3	4	3
Compactor 815		2	2	2	2				2	2	2	2	1											
Compactor Sheepfoot W/D6		3	4	4	4		2	2	2	1	1	1												
Compactor VIB DA50		4	4	5	3	1	2	5	6	7	5	3	1	1								1	1	1
Compactor V30									1	1														
Motor Scraper 21/304		7	9	11	11				13	13	7													
Construction Equipment - Lifting (Mine/Mill Site)																								
Crane 150T																								
Crane 90T									1	1	1	1												
Crane 65T																								
Crane 50T											2	2	2	2	2									
Crane 30T							1	2	4	3	5	6	3	2	1	1			1	1	1	3	1	1
Crane 18T			1	1	1	1	1	1	2	2	2	2	2	3	3	3	1	1	1	1	2	2	2	2
Super Lift PC200			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Forklift 15000#			1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
Forklift 6000#		1	1	1	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
Headframe Equipment																								
Crane 30T	1	1	1	1	1	1																		
Concrete Pumpers	1	2	2	1																				
Crane 4100 Manitoc			1	1	1																			
Automotive Equipment																								
Sedans, 4-door	1	1	2	2	2	2	2	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	4	4
Pickups	4	6	8	10	10	10	10	10	10	10	10	10	10	10	12	12	12	14	14	14	14	14	14	14

DESCRIPTION	1987				1988												1989											
	YEAR 3												YEAR 4												YEAR 5			
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Lumbering Equipment (Mine/Mill Site)																												
Chain Saws																												
Feller Buncher																												
Hydro Mower																												
Construction Equipment - Earth Moving (Mine/Mill Site)																												
Front End Loader 988B	2	2	2	2	2	1	1	2		4	4	4	5	5	3	4	2		2	2	1							
Bulldozer D9																												
Bulldozer D8											1	1	1	1	1				1	1								
Bulldozer D7																												
Bulldozer D6																												
Backhoe 235	2	2	2	2	2	1	1	4	4	4	4	4	5	5	3	3	1		2	2	1							
Backhoe 245																												
Backhoe Combo FD5600	2	1	2	1		1	1	1	2	2	2	1	2	2	3	3	3	1	2	2	1				2	2	2	2
Motor Grader 16G	1	1	1	1	1	1	1	1					1	1	1	1	1	1	1	1					1	1	1	1
Gradall G1000																1	1											
Compactor SP48	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1	1							
Wacker BPG24	2	1	2	1	1	3	3	4	4	3	3	3	5	5	4	4	4	1	4	4	1				2	2	2	2
Compactor BPG 9	2	4	4	5	5	2	2	3	5	3	3	2	2	2	2	1	1		1	1								
Compactor 815																									1	1	1	1
Compactor Sheepfoot W/D6												1	1	1					1	1								
Compactor VIB DA50									1	1																		
Compactor V30																												
Motor Scraper 21/304																												
Construction Equipment - Lifting (Mine/Mill Site)																												
Crane 150T								1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Crane 90T										1	1						1	2	2	2	2	2	1	1	1			
Crane 65T		1	1	1		2	2	2	2	2	2	2	3	1	2	2	2	2	1	2	2	2	1		1	1		
Crane 50T		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	1	1	1	1
Crane 30T	1	2	2	1	1	4	4	4	3	3	4	4	6	5	5	5	6	5	5	5	6	5	5	5	5	4	4	3
Crane 18T	2	2	2	4	5	5	4	4	4	4	4	3	3	4	2	2	4	5	6	7	7	7	6	5	5	4	3	3
Super Lift PC200	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
Forklift 15000#	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	1	1
Forklift 6000#	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	2	2	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	4	4	4	4	4	4	4	2	1	1
Pickups	14	14	14	14	14	14	14	14	14	14	12	12	12	12	12	12	12	12	12	12	10	10	8	8	8	6	2	1

Note: Equipment based on 8-hr. day.

Note: Support equipment is included with automotive equipment.

TABLE 1.3-4 (CONTINUED)

DESCRIPTION	1985				1986												1987												1988												1989											
	YEAR 1												YEAR 2												YEAR 3												YEAR 4												YEAR 5			
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Flatbed 10T	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	1	1	1	1	1
Flatbed 8T	1	1	1	1	1	1	1	2	1	1	1	1	2	2	1	1	1	2	2	2	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
Mobile Lub. Units	1	2	2	2	2	2	2	2					2	2	2	2	2	2	2	2					2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
Vacuum Trucks	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	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Pump Trucks 5Y	2	6	10	1	1	1	12	15	15	12	12	12	12	12	4	4	4	6	5	2	2	2	2	2	6	8	8	8	5	5	4	4	3	3	3	3	6	5	3	3	3	3	3	2	1							
Concrete Pumper			1	1	1	1	1	1	3	3	3	3	3	3	1	1	1	1	3	3	2	2	2	2	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2				1	1	1	
Water Truck (3000 Gal.)	1	2	2	1	1	1	1	2	2	2	2	2	2	2	1	1	1	1	2	2	1	1	1	1	2	2	2	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1				1	1	1	1
Fuel Truck (4000 Diesel 1000 Gas)	1	1	2	1	1	1	1	2	2	2	2	2	2	2	1	1	1	1	2	2	2	2	1	1	2	2	2	1	1	1	2	2	2	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
Tran-Mix Trucks 9-1/2 Y		2	4	2	2	2	4	4	8	6	6	4	4	5	4	4	4	4	8	4	4	4	4	4	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	6	6	6				4	4	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	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																																			
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	1																																													
Backhoe (Comb.) FD 5600		1	1	2	2	2	1																																													
Motor Grader 16G		1	1	2	2	2	2																																													
Gradall G1200		1	1	1	1	1	1																																													
Dump Trucks 5Y		5	8	12	12	8	5																																													
Compactors 815		2	2	2	2	2	2																																													
Compactors W/D6 Sheepfoot		2	2	2	2	2	2																																													
Compactor DA 50		1	1	1	1	1	1																																													
Wacker BPG 24		2	2	2	2	2	2																																													
Crane 65T				1	1	1	1																																													
Crane 30T			1	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	1																																
Dump Trucks 5Y							2	4	6	8	8	6	4	2	2	2	2	2	2	2																																
Compactor 815								2	2	2	2	2	1	1	1	1	1	1	1	1																																
Compactor W/D6 Sheepfoot								2	2	2	2	2	1	1	1	1																																				

TABLE 1.3-4 (CONTINUED)

DESCRIPTION	1985				1986												1987												1988												1989											
	YEAR 1												YEAR 2												YEAR 3												YEAR 4												YEAR 5			
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Compactor DA 50								1	1	1	1	1	1	1																																						
Crane 30T								1	1	1	1	1	1	1																																						
Note: Support equipment included with automobile equipment																																																				
Construction Support Equipment																																																				
Generators 385 HP 250 kW	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1																															
Generators 61 HP 30kW	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3																															
Diesel Compressor 65 HP 150 CFM				2	2	2	2	2	2				2	2	2	2	2	2	2	2	2				4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	1	1
Diesel Compressor 97 HP 300 CFM															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	1				
Mine Waste Disposal & Reclaim Pond Area Equipment																																																				
CAT 631 Scraper									8	11	10	10	10	7	5	5																					12	12	14					9	12	12	8	10	8	8	8	8
CAT 631 W Water Wagon									2	3	2	6		1																							3	3	4					3	2	2	2	1				
CAT D9 Dozer									2	3	2	2	2	1																							3	3	3					2	2	2	2					
CAT D8 Dozer									9	3	4	5	4	4	2	4						2				2											9	3	5					3	4	6	2	6	4	4	4	
CAT D6 Dozer											1	5	2																										3					3				2	2	2		
Rake (D8)									5																												5															
Disc (D8)												1																											1									1				
CAT 988 Loader										2		1	2	2		1						1				1												2	3					4	2	3	2	2	1	1		
CAT 966 Loader									3					2	1																						2							1	1							
CAT 235 Excavator									2	1			1	1	1																						1		1					1	1							
CAT 16G Motor Grader											1	1																											1									1				
CAT 14G Motor Grader									2	3	3	9	6	6	2	2																					3	3	6					6	4	4	2	6	6	6	4	
CA 25 Compactor									2	3	2	6	2	2																							3	3	6					4	2	2	2	2	2	2		
Tandem Dump Truck									3			9	9	9		4						4				4											3		8					8		4		8	8	8		
Flatbed Truck									1	3	1	1	1	1	1																													1				2				
Pickup Truck									5	5	5	8	6	7	3	2						1				1											6	4	7					9	4	4	2	6	4	4	3	
PD Trailer & Tractor												2	2	2																									2					2				2	2	2		
Batch Plant & Pug Mill												1	1	1																									1					1				1	1	1		
Processing Plant										1	1	1	1	1																								1	1					1	1	1	1	1				
Bentonite Unloading System												1	1	1																									1					1				1	1	1		
Lowboy Trailer & Tractor									34	11	2	24	1																								39	5	17					3	1						3	
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	1																																				
Generator 30 kW												1	1	1	1	1																					3	3						3	3							
42" Belt Conveyor												1	1	1	1	1																												1	1		2	2	2	2		
Pump 15 HP												1	1	1	1	1																					7	7						7	7							
Truck Crane 25 Ton									1	1		1																									1															
J D Hydroseeder												1																																						1		
J D Tractor with Disc												1																																						1		
J D Diesel Mulcher												1																																						1		
Flowmaster Pump									1	1	1	1		1																					1	1	1	1						1	1	1	1					
Chainsaw									2																										2																	
Portable Ram Packer												2	2	2																							2	2									2	2	2			
Belly Dump Trailer & Tractor													13	13																																		13				

TABLE 1.3-4 (CONTINUED)

DESCRIPTION	1985				1986												1987												1988												1989											
	YEAR 1												YEAR 2												YEAR 3												YEAR 4												YEAR 5			
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
CAT 824 Wheel Tractor													I	I																								I														
Compressor 1200 CFM																																						I														
J D 410 Backhoe									I	I																												I														
Truck Crane 75 Ton									I	I																																										
Power Auger									I	I	I	I	I	I	I																																					
Water Discharge Pipeline																																																				
Bull Dozer D7																	I	I																																		
Backhoe CAT 235																						I	I																													
Front End Loader 988B																						I	I																													
Dump Trucks 5Y																						I	I																													
Flatbed 8T																						I	I																													
Trencher																						I	I																													

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 5 years of construction activities are presented in Table 1.3-5.

1.3.3.4 Traffic Control

The flow of vehicles and equipment into and out of the construction site will be controlled for reasons of safety 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.

Anticipated truck and car traffic associated with construction phase activities is presented below:

	Construction Year				
Vehicles	1	2	3	4	5
Workmen Private Automobiles	270	250	400	450	390
Service Truck	12	12	10	10	10
Equipment Delivery Truck	3	5	5	5	5
Staff Automobiles	30	30	100	100	100

Note: All estimated traffic loads are based on the yearly peaks; yearly averages would be considerably less.

TABLE 1.3-5

ESTIMATED FUEL/ENERGY USES DURING PROJECT CONSTRUCTION[a]

Construction Year	Average Daily Use[a]								Average Yearly Use[a]						
	Diesel Fuel		Gasoline		Natural Gas		Electrical		Disel Fuel		Gasoline		Natural Gas		Electrical
	Liters	Gallons	Liters	Gallons	M^3	SCF	KWH Thousands		Liters	Gallons	Liters	Gallons	M^3	SCF	KWH Thousands
1985 (4 months)	9,308	2,460	235	62	--	--	2.2[b]		3,257.8	861.0	82.3	21.7	--	--	777.6
1986	22,108	5,840	475	125	--	--	21.6[b]		7,737.8	2,044.0	166.3	43.8	--	--	7,776.0
1987	4,475	1,182	465	123	137	4850	118.8[c]		1,566.3	413.7	162.8	43.1	47.9	1,697.5	42,768.0
1988	12,205	3,225	400	105	150	5335	252.0[d]		4,271.8	1,128.8	140.0	36.8	52.5	1,867.3	90,720.0
1989	15,130	3,997	435	115	165	5835	424.8[d]		5,295.5	1,399.0	152.3	40.3	57.8	2,042.3	152,928.0
1990	3,284	870	195	52	174	6170	486.0[d]		384.3 (4 months)	101.8	22.8 (4 months)	6.1	20.4 (4 months)	721.9	56,862.0

[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 these years of construction.

[c]Electrical power supplied from on-site generation during the early part of this year and from the utility company power system in the latter part of the year.

[d]All electrical power supplied from utility company starting in these years.

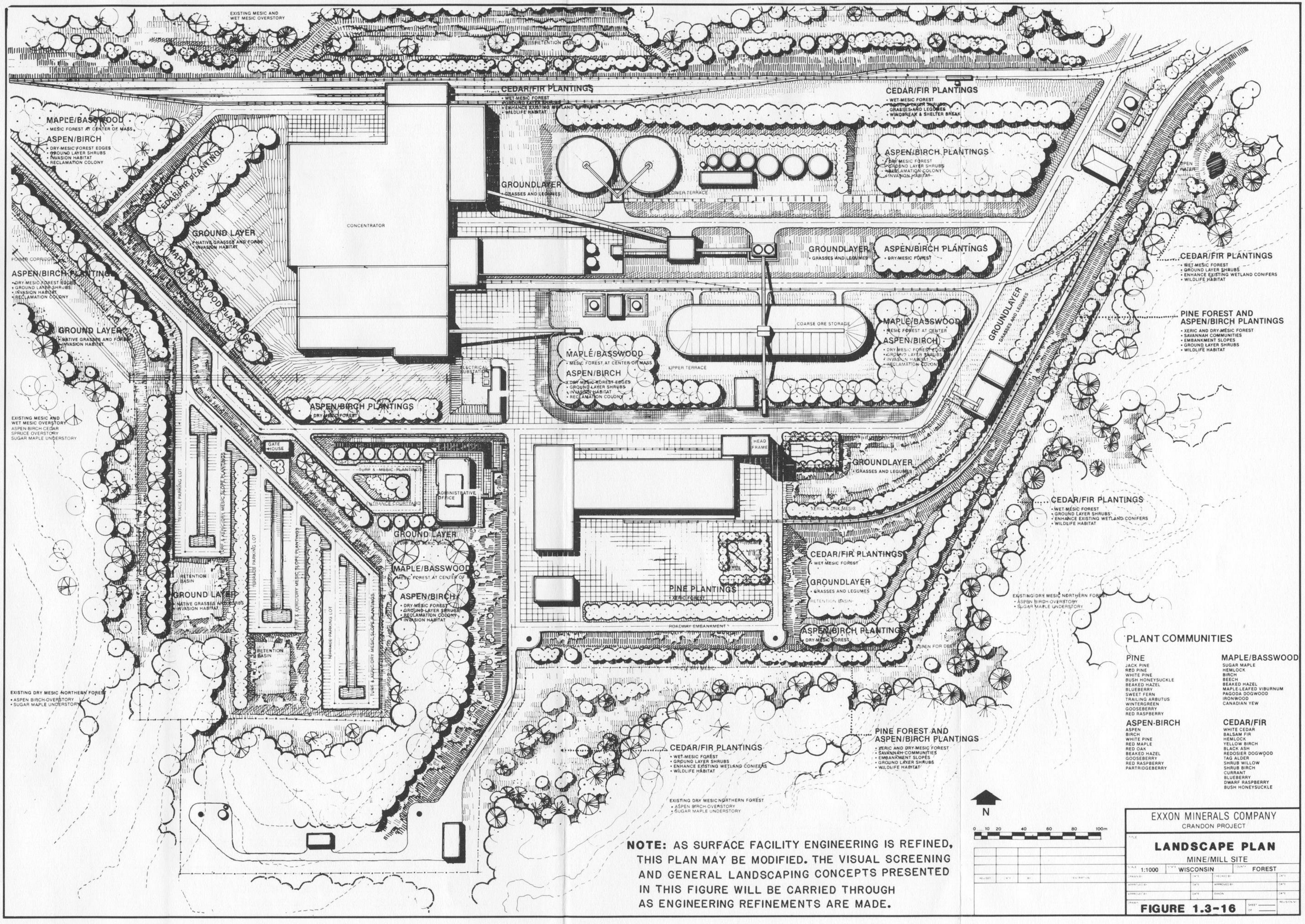
1.3.4 Landscape Plan

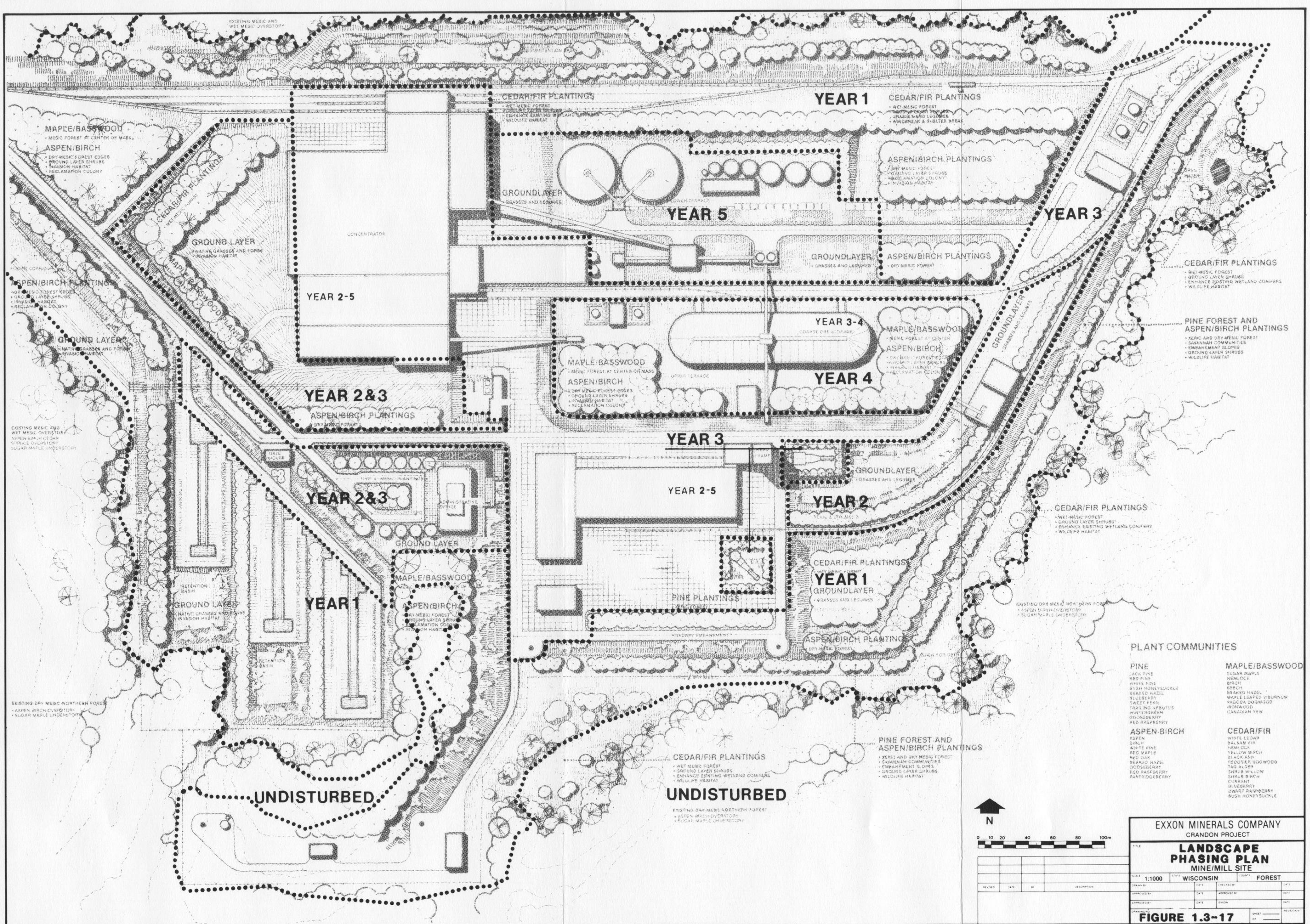
Site landscaping will occur throughout the construction period and will be primarily concentrated in the mine/mill site area. The purpose of the landscape plan is to revegetate the mine/mill site in a manner compatible with the functional, aesthetic, and environmental character of the surrounding landscape. 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 stablizing soils, improving soil fertility, and providing habitat for natural invasion of native woody and herbaceous species.

Plant species will be selected that are compatible with specific soil conditions. A representative landscape plan for the mine/mill area is presented in Figure 1.3-16. 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 plan for landscaping the mine/mill site is shown in Figure 1.3-17.

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 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 1.3-16). Plant associations will be selected and located to conform with soil moisture


EXISTING MESIC AND WET MESIC OVERSTORY
RETENTION BASIN
CEDAR/FIR PLANTINGS
• WET MESIC FOREST
• GROUND LAYER SHRUBS
• ENHANCE EXISTING WETLAND CONIFERS
• WILDLIFE HABITAT
CEDAR/FIR PLANTINGS
• WET MESIC FOREST
• GRASSES AND LEGUMES
• WINDBREAK & SHELTER BREAK
MAPLE/BASSWOOD
• MESIC FOREST AT CENTER OF MASS
ASPEN/BIRCH
• DRY MESIC FOREST EDGES
• GROUND LAYER SHRUBS
• INVASION HABITAT
• RECLAMATION COLONY
CEDAR/FIR PLANTINGS
• WET MESIC FOREST
GROUNDLAYER
• GRASSES AND LEGUMES
CONCENTRATOR
ASPEN/BIRCH PLANTINGS
• DRY MESIC FOREST
• GROUND LAYER SHRUBS
• RECLAMATION COLONY
• INVASION HABITAT
LOWER TERRACE
GROUND LAYER
• NATIVE GRASSES AND FORBS
• INVASION HABITAT
GROUNDLAYER
• GRASSES AND LEGUMES
ASPEN/BIRCH PLANTINGS
• DRY MESIC FOREST
MAPLE/BASSWOOD PLANTINGS
ASPEN/BIRCH PLANTINGS
• DRY MESIC FOREST EDGES
• GROUND LAYER SHRUBS
• INVASION HABITAT
• RECLAMATION COLONY
GROUND LAYER
• NATIVE GRASSES AND FORBS
• INVASION HABITAT
COARSE ORE STORAGE
MAPLE/BASSWOOD
• MESIC FOREST AT CENTER
ASPEN/BIRCH
• DRY MESIC FOREST EDGES
• GROUND LAYER SHRUBS
• INVASION HABITAT
• RECLAMATION COLONY
GROUNDLAYER
• GRASSES AND LEGUMES
CEDAR/FIR PLANTINGS
• WET MESIC FOREST
• GROUND LAYER SHRUBS
• ENHANCE EXISTING WETLAND CONIFERS
• WILDLIFE HABITAT
PINE FOREST AND ASPEN/BIRCH PLANTINGS
• XERIC AND DRY MESIC FOREST
• SAVANNAH COMMUNITIES
• EMBANKMENT SLOPES
• GROUND LAYER SHRUBS
• WILDLIFE HABITAT
MAPLE/BASSWOOD
• MESIC FOREST AT CENTER OF MASS
ASPEN/BIRCH
• DRY MESIC FOREST EDGES
• GROUND LAYER SHRUBS
• INVASION HABITAT
• RECLAMATION COLONY
UPPER TERRACE
ELECTRICAL SUBSTATION
ASPEN/BIRCH PLANTINGS
• DRY MESIC FOREST
EXISTING MESIC AND WET MESIC OVERSTORY
ASPEN BIRCH CEDAR
SPRUCE OVERSTORY
SUGAR MAPLE UNDERSTORY
GATE HOUSE
TURF & MESIC PLANTINGS
ENTRANCE COURTYARD
ADMINISTRATIVE OFFICE
HEAD FRAME
GROUNDLAYER
• GRASSES AND LEGUMES
XERIC & DRY MESIC
CEDAR/FIR PLANTINGS
• WET MESIC FOREST
• GROUND LAYER SHRUBS
• ENHANCE EXISTING WETLAND CONIFERS
• WILDLIFE HABITAT
TERRACE PARKING LOT
GROUND LAYER
• TURF AND XERIC SHRUBS
MAPLE/BASSWOOD
• MESIC FOREST AT CENTER OF MASS
ASPEN/BIRCH
• DRY MESIC FOREST
• GROUND LAYER SHRUBS
• RECLAMATION COLONY
• INVASION HABITAT
RETENTION BASIN
GROUND LAYER
• NATIVE GRASSES AND FORBS
• INVASION HABITAT
CEDAR/FIR PLANTINGS
• WET MESIC FOREST
GROUNDLAYER
• GRASSES AND LEGUMES
RETENTION BASIN
PINE PLANTINGS
ROADWAY EMBANKMENT
ASPEN/BIRCH PLANTINGS
• DRY MESIC FOREST
EXISTING DRY MESIC NORTHERN FOREST
• ASPEN BIRCH OVERSTORY
• SUGAR MAPLE UNDERSTORY
EXISTING DRY MESIC NORTHERN FOREST
• ASPEN BIRCH OVERSTORY
• SUGAR MAPLE UNDERSTORY
CEDAR/FIR PLANTINGS
• WET MESIC FOREST
• GROUND LAYER SHRUBS
• ENHANCE EXISTING WETLAND CONIFERS
• WILDLIFE HABITAT
PINE FOREST AND ASPEN/BIRCH PLANTINGS
• XERIC AND DRY MESIC FOREST
• SAVANNAH COMMUNITIES
• EMBANKMENT SLOPES
• GROUND LAYER SHRUBS
• WILDLIFE HABITAT
EXISTING DRY MESIC NORTHERN FOREST
• ASPEN BIRCH OVERSTORY
• SUGAR MAPLE UNDERSTORY
PLANT COMMUNITIES
PINE
JACK PINE
RED PINE
WHITE PINE
BUSH HONEYSUCKLE
BEAKED HAZEL
BLUEBERRY
SWEET FERN
TRAILING ARBUTUS
WINTERGREEN
GOOSEBERRY
RED RASPBERRY
MAPLE/BASSWOOD
SUGAR MAPLE
HEMLOCK
BIRCH
BEECH
BEAKED HAZEL
MAPLE-LEAFED VIBURNUM
PAGODA DOGWOOD
IRONWOOD
CANADIAN YEW
ASPEN-BIRCH
ASPEN
BIRCH
WHITE PINE
RED MAPLE
RED OAK
BEAKED HAZEL
GOOSEBERRY
RED RASPBERRY
PARTRIDGEBERRY
CEDAR/FIR
WHITE CEDAR
BALSAM FIR
HEMLOCK
YELLOW BIRCH
BLACK ASH
REDOSIER DOGWOOD
TAG ALDER
SHRUB WILLOW
SHRUB BIRCH
CURRANT
BLUEBERRY
DWARF RASPBERRY
BUSH HONEYSUCKLE
N
0 10 20 40 60 80 100m
NOTE: AS SURFACE FACILITY ENGINEERING IS REFINED, THIS PLAN MAY BE MODIFIED. THE VISUAL SCREENING AND GENERAL LANDSCAPING CONCEPTS PRESENTED IN THIS FIGURE WILL BE CARRIED THROUGH AS ENGINEERING REFINEMENTS ARE MADE.
EXXON MINERALS COMPANY
CRANDON PROJECT
LANDSCAPE PLAN
MINE/MILL SITE
1:1000
WISCONSIN
FOREST
FIGURE 1.3-16



YEAR 1
CEDAR/FIR PLANTINGS
CEDAR/FIR PLANTINGS
MAPLE/BASSWOOD
ASPEN/BIRCH
ASPEN/BIRCH PLANTINGS
GROUNDLAYER
YEAR 5
YEAR 3
GROUND LAYER
ASPEN/BIRCH PLANTINGS
GROUNDLAYER
ASPEN/BIRCH PLANTINGS
CEDAR/FIR PLANTINGS
YEAR 2-5
YEAR 3-4
MAPLE/BASSWOOD
ASPEN/BIRCH
PINE FOREST AND
ASPEN/BIRCH PLANTINGS
GROUND LAYER
MAPLE/BASSWOOD
ASPEN/BIRCH
YEAR 4
YEAR 2&3
ASPEN/BIRCH PLANTINGS
YEAR 3
GROUNDLAYER
YEAR 2-5
YEAR 2&3
YEAR 2
CEDAR/FIR PLANTINGS
GROUND LAYER
MAPLE/BASSWOOD
CEDAR/FIR PLANTINGS
YEAR 1
GROUNDLAYER
ASPEN/BIRCH
YEAR 1
GROUND LAYER
PINE PLANTINGS
ASPEN/BIRCH PLANTINGS
PLANT COMMUNITIES
PINE
MAPLE/BASSWOOD
ASPEN-BIRCH
CEDAR/FIR
PINE FOREST AND
ASPEN/BIRCH PLANTINGS
CEDAR/FIR PLANTINGS
UNDISTURBED
UNDISTURBED
N
0 10 20 40 60 80 100m
EXXON MINERALS COMPANY
CRANDON PROJECT
LANDSCAPE
PHASING PLAN
MINE/MILL SITE
1:1000
WISCONSIN
FOREST
FIGURE 1.3-17

conditions, drainage patterns, and exposure. Turf grasses will be maintained around the gate house and the administration 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 1.3-16).

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 scrubbers to control air emissions; and treatment of contaminated water.

1.3.5.1 Mine/Mill Site, Reclaim Ponds and Mine Waste Disposal Facility Development

Air Emissions - Tables 1.3-6 and 1.3-7 present the estimated air contaminant emission rates for construction of the mine/mill surface facilities and the reclaim ponds, and the mine waste disposal facility, 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. Minor emissions 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 applicable state and federal regulations.

The main access road will be constructed and paved during the first year, thus eliminating fugitive dust from this source. Certain high use in-plant roads will also be paved early in the construction program to reduce fugitive dust emissions. All on-site roadways and excavation sites will be watered as required to control fugitive dust emissions. To suppress blowing dust from vehicles hauling soil or muck over long distances, such vehicles will be covered, if required. Speed controls will reduce emissions

TABLE 1.3-6

ESTIMATED AIR CONTAMINANT EMISSION RATES BY SPECIFIC SOURCES DURING CONSTRUCTION OF THE MINE/MILL SURFACE FACILITIES

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL CONTROLLED COMPONENT EMISSION RATES kg/h (pounds per hour)		kg/h (pounds per day)		t/y (short tons per year)	
MINE/MILL SURFACE CONSTRUCTION								
Fugitive Sources								
Mine/Mill Surface Facilities	TSP	Water sprays, if necessary	N/A*		214.0	(470.0)	20.6	(22.8)
Railroad Bed	TSP	Water sprays, if necessary	N/A		174.0	(382.0)	28.0	(30.8)
Access Road	TSP	Water sprays, if necessary	N/A		144.0	(318.0)	21.8	(24.0)
Waste Rock Area	TSP	Water sprays, if necessary	N/A		104.0	(228.0)	8.8	(9.8)
Reclaim Pond	TSP	Water sprays, if necessary	N/A		110.0	(242.0)	16.6	(18.2)
Temporary Sources								
Fuel Transfer and Storage	HC		N/A		1.7	(3.7)	0.4	(0.4)
Stationary Sources								
Concrete Batch Plant	TSP	Baghouse on mix truck loading hopper and silo filter vents - 90%	0.7	(1.5)	16.0	(36.0)	2.5	(2.7)
Mobile Sources**								
Tailpipe Emissions	TSP		4.0	(8.0)	48.0	(106.0)	7.3	(8.0)
Diesel Vehicles	SO_2		3.0	(6.0)	38.0	(84.0)	5.7	(6.3)
	NO_x		34.0	(76.0)	460.0	(1016.0)	68.9	(76.0)
	CO		10.0	(23.0)	37.0	(303.0)	20.7	(22.8)
	HC		5.0	(11.0)	69.0	(152.0)	10.3	(11.4)

* Not Applicable
** Diesel fuel sources only

TABLE 1.3-7

ESTIMATED AIR CONTAMINANT EMISSION RATES BY SPECIFIC SOURCES DURING CONSTRUCTION OF THE MINE WASTE DISPOSAL FACILITY

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL CONTROLLED COMPONENT EMISSION RATES kg/h (pounds per hour)	kg/d (pounds per day)	t/y (short tons per year)
MINE WASTE DISPOSAL FACILITY AND RECLAIM PONDS					
Fugitive Sources					
Windblown					
Haul Road	TSP	Speed control and chemical stabilization if necessary - 85%	N/A*	N/A	0.729 (0.804)
Disposal Area	TSP		N/A	N/A	5.062 (5.58)
Support Area	TSP	Speed control and chemical stabilization if necessary - 85%	N/A	N/A	0.128 (0.141)
Truck Hauling	TSP				
Till to Dike and Storage	TSP	Speed control	N/A	N/A	21.709 (23.93)
Waste Rock to Tailings Area	TSP	Speed control and chemical stabilization if necessary - 85%	N/A	N/A	2.195 (2.42)
Bentonite to Batch Plant	TSP	Speed control and chemical stabilization if necessary - 85%	N/A	N/A	1.388 (1.53)
Bentonite Modified Soil Mixture from Batch Plant to Pond	TSP	Watering	N/A	N/A	7.022 (7.74)
Underdrain Material from Support Area to Pond	TSP	Watering	N/A	N/A	6.967 (7.68)
Filter Material from Support Area to Pond	TSP	Watering	N/A	N/A	8.110 (8.94)
Rip-Rap from Support Area to Pond	TSP	Watering	N/A	N/A	8.963 (9.88)

Table 1.3-7 (continued)

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL CONTROLLED COMPONENT EMISSION RATES kg/h (pounds per hour)	kg/d (pounds per day)	t/y (short tons per year)
Loading					
Pond Excavation with Scraper	TSP		N/A	N/A	252.53 (278.37)
Loading Till into Batch Plant and Processing Plant	TSP	Minimize drop height	N/A	N/A	4.87 (5.37)
Loading Underdrain Filter Material and Rip Rap	TSP	Minimize drop height	N/A	N/A	8.72 (9.61)
Dumping					
Bentonite Modified Soil Mixture in Pond	TSP		N/A	N/A	1.89 (2.08)
Waste Rock at Stockpile Stockpile	TSP		N/A	N/A	1.12 (1.23)
Underdrain, Filter Material and Rip-Rap	TSP		N/A	N/A	6.48 (7.14)
Mobile Sources					
Tailpipe Emissions					
Diesel	TSP		8.93 (19.69)	116.02 (255.78)	12.52 (13.80)
	SO_2		7.03 (15.50)	91.40 (201.50)	9.86 (10.87)
	NO_x		85.33 (188.11)	1,109.20 (2445.37)	119.66 (131.90)
	CO		25.47 (56.15)	331.10 (729.95)	35.72 (39.37)
	HC		12.79 (28.20)	166.29 (366.60)	17.94 (19.77)
Gasoline	TSP	Catalytic converter (on trucks)	0.068(0.149)	0.86 (1.9)	0.094 (0.104)
	SO_2		0.009(0.020)	0.12 (0.258)	0.013 (0.014)
	NO_x		0.180(0.397)	2.34 (5.158)	0.252 (0.278)
	CO		0.827(1.823)	10.75 (23.70)	1.159 (1.278)
	HC		0.132(0.292)	1.72 (3.797)	0.186 (0.205)

Table 1.3-7 (continued)

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL CONTROLLED COMPONENT EMISSION RATES kg/h (pounds per hour)	kg/d (pounds per day)	t/y (short tons per year)
MINE WASTE DISPOSAL FACILITY					
Stationary Sources					
Liner Batch Plant	TSP	Enclosed dumping areas and vent to filters - 90%	N/A	N/A	0.925 (1.02)
Soil Processing Plant	TSP	Emissions vented to baghouse - 99.6%	N/A	N/A	0.025 (0.028)

*Not applicable.

from haulage vehicles, and minimizing drop distances will reduce 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. Exposed slopes will be watered as needed to control wind blown dust until vegetation is established. 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 passive filter vents. Pre-washed concrete aggregate will be used by the batch plant to minimize dust emissions. The aggregate loading and discharge points may be vented to a baghouse or wet scrubber. 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 mine waste disposal facility.

During construction, vehicles and equipment will be refueled directly from trucks. Equipment refueling and temporary gasoline storage, tank loading or filling constitute the major hydrocarbon losses associated with the transfer and storage of fuel.

Noise Emissions - The worst-case noise levels estimated to occur during construction of the mine/mill surface facilities, the reclaim ponds, and mine waste disposal facility are summarized in Table 1.3-8.

TABLE 1.3-8

NOISE LEVELS ASSOCIATED WITH CONSTRUCTION OF THE MINE/MILL SITE, RECLAIM PONDS AND MINE WASTE DISPOSAL FACILITY*

	Year									
	1		2		3		4		5	
L_{DN}	Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet
65	426.7	1400	396.2	1300	91.4	300	609.6	2000	335.3	1100
60	762.0	2500	670.6	2200	152.4	500	1066.8	3500	609.6	2000
55	1371.6	4500	1219.2	4000	274.3	900	1910.3	6300	1066.8	3500

*Based on distance from center of the mine waste disposal facility.

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 the mine shaft sinking and headframe construction and any overtime work involved in mine/mill site preparation. Most of this noise will be from temporary fans, air compressors and refrigeration systems. During sinking of the mine shafts, only blasting for breakage of large boulders will be required in the top 46 m (150 feet) of soil. Blasting will be conducted to minimize noise emanations from shaft sinking activites below the collar section, and surface noise emissions from these sources will decrease as the shafts are deepened.

Subsequent years are estimated to have noise levels of 50-55 dBA at the Project boundary. Estimated noise levels during the winter months will be only 45-50 dBA because of reduced construction activity.

Average noise levels (24 hour period) should not exceed the EPA Guideline Value of 55dBA (L_{dn}) at the Project boundary during any phase of construction.

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 2.7 to 4.5 t (3 to 5 short tons) per week during the summer months, May through September, of the first 2 years. Waste material will be reduced to 0.9 to 1.8 t (1 or 2 short tons) every 2 weeks during the winter months of the first 2 years. During Years 3 and 4, when most of the building material and equipment will be delivered and installed, waste materials will increase to an estimated 7.3 to 9.1 t (8 to 10 short tons) per week during the summer, and decrease to 1.8 to 2.7 t (2 or 3 short tons) in the winter. In Year 5, when almost all of the equipment has been received, waste material will decrease to 0.9 to 1.8 t (1 to 2 short tons) per week.

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 of at a recycle center. Scrap metal will be stored in bins and sold for salvage. Waste products that cannot be recycled will be disposed of at an approved landfill in the Town of Nashville.

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.

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 ponds and mine waste disposal facility. 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 59 ha (146 acres) of ground in the mine/mill site area. Construction of the access road and railroad spur corridors will disturb a total of approximately 33 ha (82 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 bridges will be constructed with culverts to maintain water continuity within the wetlands. For those areas where bridges cross streams, temporary retaining walls will be constructed of sheet piling. The techniques to be used for erosion control are described in the Mining Permit Application Section D, Reclamation Plan.

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 mine waste disposal facility will be continuous and 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 from an 18 ha (44 acre) waste rock and ore storage embankment located in the mine waste disposal area (Figure 1.2-9) and a 2 ha (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 0.003 m^3/s (50 gallons per minute) during the first year of development and peak at an estimated maximum rate of up to 0.126 m^3/s (2,000 gallons per minute) during the third year of construction. This maximum rate may be mitigated. The water treatment facility required for the construction period will be built in Years 1 and 2 and be in operation during the remainder of the 5 year construction period. Only the equipment required during the construction period will be installed; the remaining process equipment will be installed as required to meet operating requirement. Contaminated mine water and contaminated surface water runoff will be pumped to an influent surge system with a total volume of 10,410 m^3 (2.75 million gallons) and at a constant rate from there into the water treatment system. During approximately the first 15 months of construction contaminated surface water runoff and any water generated during the first stages of sinking the initial portion of the shaft will be impounded in a temporary lined holding pond adjacent to the shaft contractor's laydown area. By the second year of construction the reclaim pond will be available to provide additional emergency surge volume.

Total effluent flow rate, if unmitigated during construction will peak at approximately 0.126 m^3/s (2,000 gallons per minute) during the third year of construction. Treated effluent will be discharged to Swamp Creek below County Road M.

There will be six phases of construction for the mine waste disposal facility over a 26 year period with the length of each varying from 2 to 4 years and with several years when no major work occurs between phases. During each phase of construction, control of uncontaminated surface water runoff will be accomplished by constructing a series of ditches, dikes, and retention ponds. Surface water drainage with the potential for high suspended solids content will be directed through sedimentation ponds. These sedimentation ponds will allow settling of the suspended solids. Bales of hay will also be used as needed to provide small dikes for control of drainage in localized areas.

Contaminated surface water runoff from the waste rock embankment area will be collected and stored in a lined pond. The waste rock embankment will be sloped to drain to the west side of the area. A toe ditch and berm will be constructed around the perimeter of the area to contain the water and direct the drainage to the pond. A temporary pond to store the surface water runoff from the waste rock embankment will be located such that water will be gravity fed into the pond at two points. A 20 mil PVC liner will be installed on the pond bottom to prevent seepage and it will be covered by a 0.6 m (2 foot) layer of protective fill. This pond will have a storage capacity of approximately 38,200 m^3 (31 acre-feet) which is the equivalent of one year's net annual precipitation gain (rainfall and snowmelt minus evaporation) of approximately 178 mm (7 inches) plus the 10-year, 24-hour storm which is approximately 91 mm (3.6 inches).

This pond will be used for approximately 3 years, until tailings pond No. T1 is constructed. If the temporary pond approaches its storage capacity during this time, the water will be pumped to reclaim pond No. R1. When the temporary pond is removed, the water will also be emptied into reclaim pond No. R1. Once pond No. T1 is completed, all surface water from the waste rock embankment will drain into T1.

Another potential source of contaminated water is sanitary wastes. Although a permanent sanitary waste treatment facility will be constructed as soon as possible, 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.

1.4 Operations Sequence

Operation of the mine/mill complex will include mining and processing of two ore types (massive and stringer) concurrently. Average capacity for the total operation will be generally as indicated in the operation schedule (Table 1.4-1).

1.4.1 Schedule

The mine/mill schedule establishes the rates and storage requirements that will be used for the day to day operations of the facility. The schedule provides the basis for determining facilities requirements, manpower requirements, mine/mill facilities water requirements, tailings disposal, and facilities inventory. The mine/mill operating schedule and capacities listed in Tables 1.4-1 and 1.4-2, respectively, were based upon an operational life of 26 years for the mine/mill facility, which includes an iritial period of approximately 3 years production build up. Production will commence upon installation of the underground crusher facilities. The backfilling operation will start approximately 9 months after start of production.

TABLE 1.4-1

OPERATING SCHEDULE FOR THE MINE/MILL FACILITIES
BASED ON AVERAGE ANNUAL PRODUCTION RATE

FACILITY	Production Rate t/d	Production Rate short tons/day	Operating Schedule Days per Year	Operating Schedule Shifts per day	Operating Schedule Hours per Shift
Mine Production	13,100	14,400	250*	3	8
Mine Ore Hoisting and Coarse Ore Conveying	13,100	14,400	250*	2	8
Fine Crushing	9,100	10,033	360	3	8
Concentrator	9,100	10,033	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, as needed.

TABLE 1.4-2

ESTIMATED STORAGE REQUIREMENTS

FACILITY	ORE TYPE	LIVE TONNAGE	DAYS' SUPPLY
Coarse ore storage	Massive ore (Cu-Pb-Zn)	22,000 t (24,255 short tons)	4
	Stringer ore (Cu-Zn)	18,000 t (19,845 short tons)	4
Fine ore storage	Massive ore (Cu-Pb-Zn)	13,000 t (14,333 short tons)	2
	Stringer ore (Cu-Zn)	11,000 t (12,128 short tons)	2
Concentrate storage	Copper	4,490 t (4,950 short tons)	10
	Lead	690 t (761 short tons)	10
	Zinc	9,760 t (10,760 short tons)	10

1.4.2 Mine Operations

1.4.2.1 Mining Method and Equipment

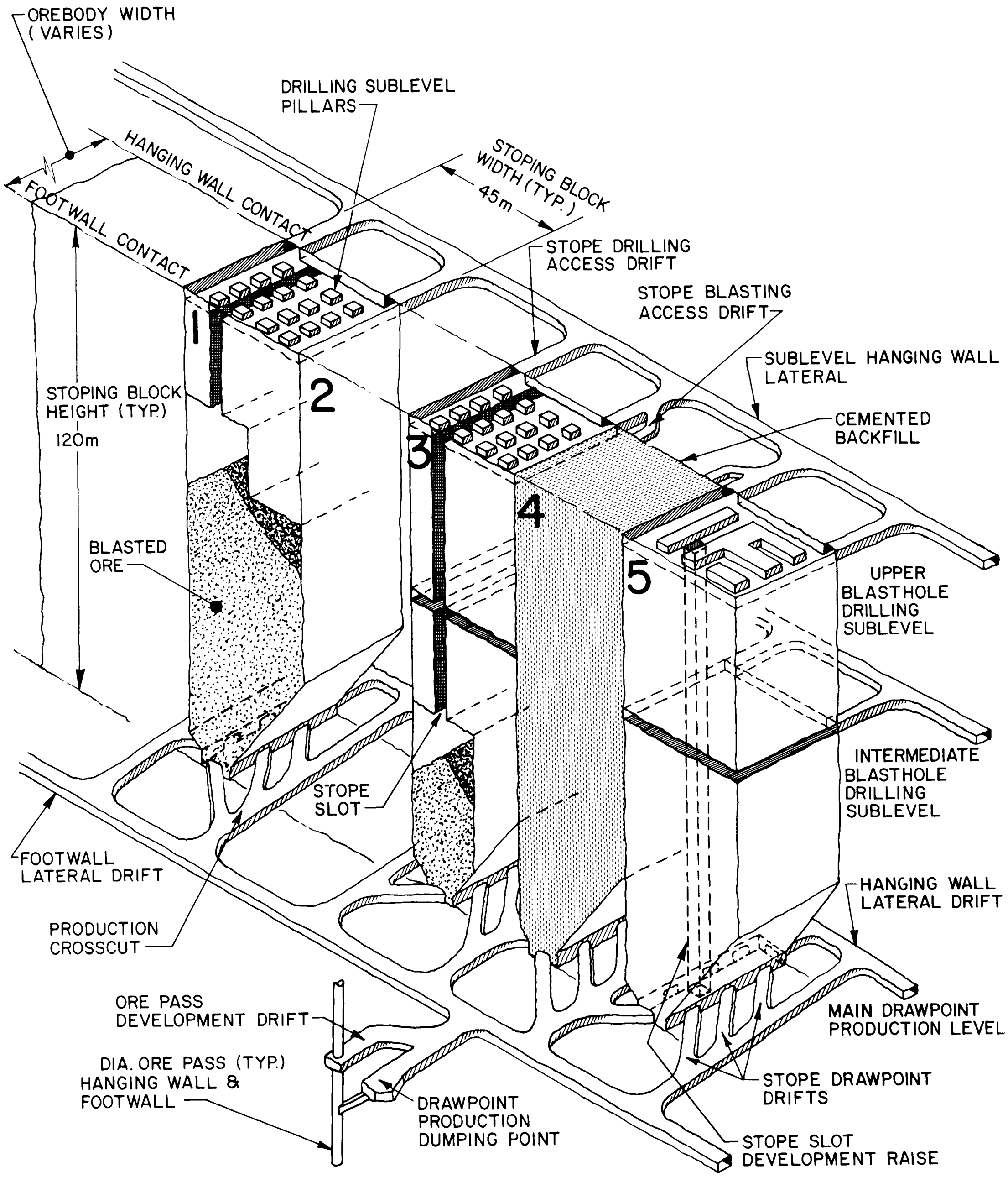
The primary mining method will be sublevel blasthole open stoping with delayed backfilling; however, a cut-and-fill stoping method may also be used.

The orebody will be divided into stoping blocks (Figure 1.4-1). 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" in Figure 1.4-1). 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 methods initiated by a single 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 690 kPa (100 pounds per square inch) and increase the pressure to about 1,725 kPa (250 pounds per square inch).



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
UNDERGROUND MINE
TYPICAL STOPE BLOCKS

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY S.J. HARVEY	DATE 7/82	CHECKED BY J. E. GRIMES		DATE 8/24/82	
APPROVED BY D. E. Moe	DATE 10/26/82	APPROVED BY C. E. Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 1.4-1**			SHEET 1 OF 1	REVISION NO. 0	

Production blasting will be done at intervals during the week and normally at the end of a shift. An average of about 3,175 kg (7,000 pounds) of explosives will be used daily.

Broken ore will be removed from the drawpoints by load/haul/dump (LHD) vehicles and hauled to dump points at vertical ore passes. At rated capacity, five or more stopes will be operating in the mine simultaneously to produce 13,100 t (14,400 short tons) of ore per day. This may require approximately eight LHD's in operation at one time.

The LHD's will be equipped with exhaust gas scrubbers. Ventilating air will be provided to dilute the exhaust to concentrations as specified by applicable codes and removed from the mine. Points where dust may be produced by handling of the 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 mine openings 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 are conducted under the easily accessible roofs of drifts where frequent inspections can detect any loose rock, and where rock bolts or other means will be used, where required, to improve strength of mine workings.

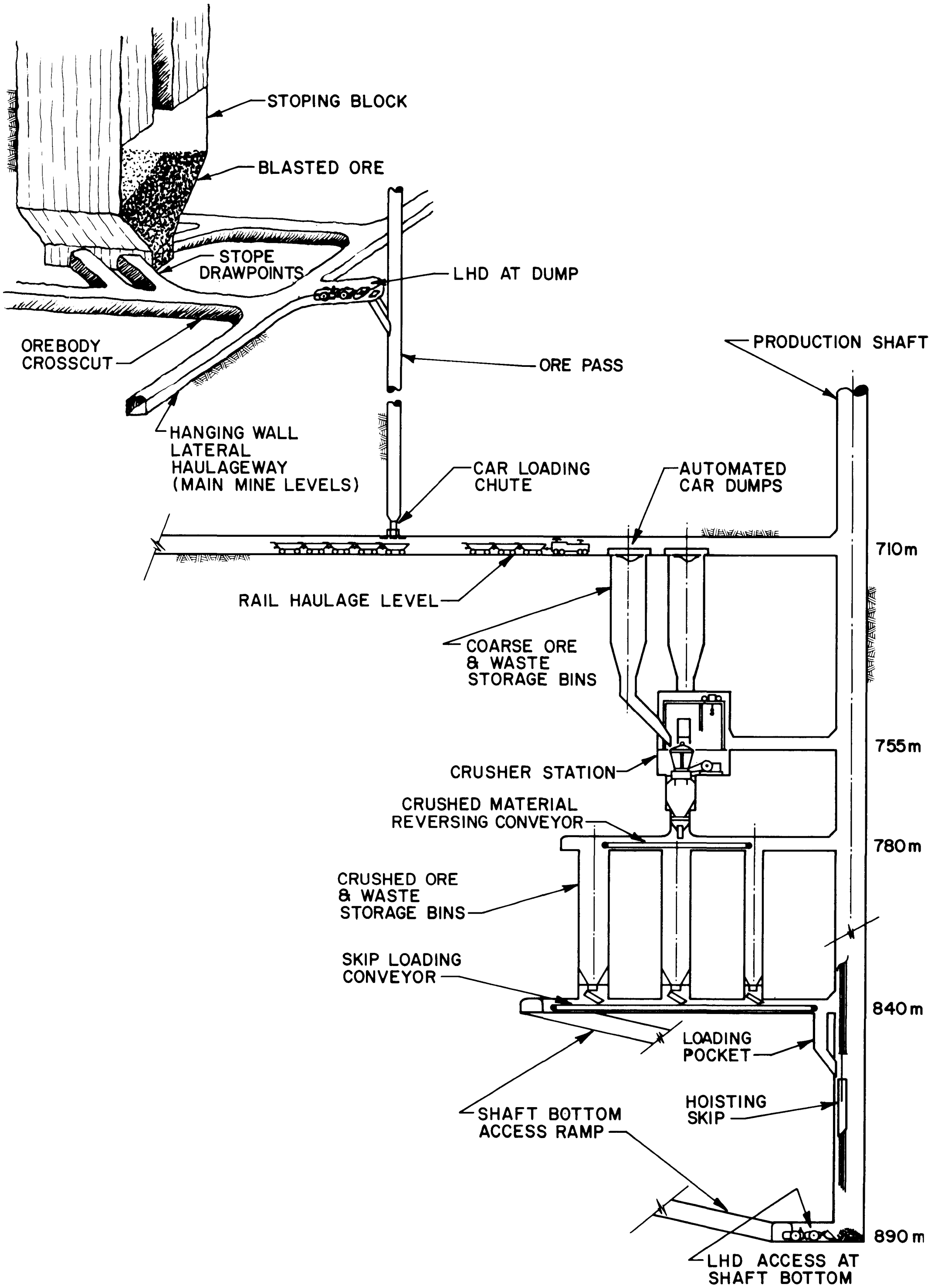
On the uppermost mine levels where the ore and country rocks have been somewhat weakened by surficial weathering, mechanized cut and fill mining methods may be employed. These methods involve removal of horizontal lifts of ore approximately 4 - 5 m (13 - 16 feet) thick. The void created by each horizontal mining pass is then backfilled prior to mining the next lift above. This approach limits the spans of unsupported stope walls and roofs, and thereby ensures safe working conditions. Less than 10 percent of the orebody will require use of this conventional but non-standard 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 LHD's 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, which are nearly vertical openings leading down to the rail haulage system on the lower level (Figure 1.4-2). Chutes at the bottom of each of the ore passes will allow the loading of rail cars. A train of these cars will be hauled by a trolley locomotive to storage areas ahead of the crusher.

Feeders will control the flow of ore from each of these bins into the top of a crusher, which will reduce the material size to minus 152 mm



EXXON MINERALS COMPANY CRANDON PROJECT			
TITLE: TYPICAL ORE TRANSPORT SYSTEM			
SCALE: NONE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: S.J. HARVEY	DATE: 7/82	CHECKED BY: J.E. GRIMES	DATE: 8/24/82
APPROVED BY: D.E. Moe	DATE: 10/26/82	APPROVED BY: C.E. Fowler	DATE: 10/26/82
APPROVED BY:	DATE:	EXXON	DATE:
DRAWING NO: FIGURE 1.4-2	SHEET 1 OF 1	REVISION NO. 0	

(6 inches). Below the crusher, the crushed ore or waste rock will be conveyed to one of two fine ore bins or one fine waste bin. Below these bins, another belt conveyor will transport the ore to the loading pocket at the shaft. This pocket will measure the proper load for a hoisting conveyance, or skip, which will then transport the ore or waste rock to the surface. At the surface, the skips will discharge into a bin incorporated as part of the headframe structure. From there, the rock will be fed onto a belt conveyor for transport to the surface ore storage facilities, or to the waste rock handling system.

Dust suppression and/or collection systems will be used to control dust generated by the handling of the broken 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 baghouse. In still other areas, the flow of fresh air will dilute and remove dust through 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 and the fresh air intake shaft. Controlled amounts will be drawn from these shafts on each operating level, passed through the various working places, and collected in an exhaust air system which ultimately conducts the air back to surface through two exhaust air shafts, one located at each end of the orebody. Main fans installed on the surface near the top of the exhaust air shafts will be used to move air through the mine. Fans with a total capacity of approximately 873 m^3/s (1,850,000 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 distribution and control of the air flow through 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 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 the winter months, air entering the two downcast shafts will require heating to approximately 3°C (37°F). This will be accomplished by a system of direct-fired, natural gas-fueled heaters installed near the top of each shaft. The ambient air temperature in the underground mine workings will average approximately 18°C (65°F) year round.

1.4.2.4 Mine and Backfill Dewatering

It is projected that water coming into the mine from ground water seepage will range from a potential controlled inflow rate of approximately 0.063 m^3/s (1,000 gallons per minute) up to an estimated maximum unmitigated inflow rate of approximately 0.126 m^3/s (2,000 gallons per minute). Mine backfill transport water is estimated to be approximately 0.03 m^3/s (465 gallons per minute) and a minor amount of potable water. Some water will be retained in the backfill. These water streams will ultimately be pumped to the surface for treatment as necessary.

Ground water will be collected in drainage galleries or holes drilled into the rock above the active mine workings, to provide for separate handling to surface. The water which is not collected in this interceptor system and which flows into mine workings will be collected in ditches and small sumps. Here, solids will be settled, and the water will then be conducted via pipelines and boreholes to one of the main mine sumps. Backfill water will be collected at the backfilled stope and will flow through boreholes to the main sumps. The main sump installations will be near the main production shaft -- one on the 350 m Level and one on the 840 m 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 840 m Level. A pumping system will lift the water collected in that sump to the 350 m Level, where another system of pumps will lift it to surface. A separate sump/pumping system on the uppermost mine level will lift the segregated uncontaminated ground water inflow to surface.

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, 12.4 M t (13.6 million short tons) of waste rock will be produced. Some waste rock will be utilized in the backfill cycle. However, because of the position of the waste-producing headings relative to stopes prepared to take waste rock, approximately 60 percent will be hoisted to the surface rather than utilized directly in the mine as 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 (Figure 1.4-2).

A crushing schedule for waste will be developed to accommodate the need during a particular period of time, and the waste rock will be handled in a similar manner to ore. Of the waste reaching the surface, some will be passed through a crushing plant and introduced to the tailings backfill slurry for transport back to the mine. The balance of the waste rock hoisted to the surface will be trucked to the waste disposal area.

1.4.2.6 Backfill Handling Underground

The backfilling operation will begin approximately 9 months after the start of mine production. The backfill will consist primarily of the coarse fraction of the mill tailings, although it may be supplemented by mine waste rock, and if required, glacial sand. Except for waste rock transported directly from development headings to stopes for use as fill, the backfill material will be transported underground in a slurry consisting of approximately 70 percent solids by weight. This slurry will travel through a system of boreholes and pipes and will be distributed as necessary throughout the mine. The backfill operation will generally be conducted 3 shifts per day, 7 days per week.

That portion of the backfill transport system which passes through the glacial overburden and into the top of bedrock will consist of steel pipe installed within a larger diameter steel casing cemented into competent bedrock. Backfill will be delivered to the top of this pipe via a pipeline from the backfill preparation facility.

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

1.4.2.7 Water Balance

Water will enter the mine from three sources. Ground water may account for up to approximately 0.126 m^3/s (2,000 gallons per minute), backfilling will introduce approximately 0.03 m^3/s (465 gallons per minute), and potable water will constitute a minor amount. Approximately 0.01 m^3/s (200 gallons per minute) of the ground water seepage will be collected and used in closed circuit for mining process uses such as drill water or dust suppression. These are estimated values and are calculated to represent operation of the mine at full rated capacity which is not expected until approximately 7 years from start of construction. Not all of the water entering the mine will be returned to surface, since the backfill will retain about 13 percent moisture. Approximately 0.02 m^3/s (325 gallons per minute) of backfill water will be pumped to the surface, together with all of the mine drainage and process water. The total maximum mine pumping rate is estimated to be 0.143 m^3/s (2,335 gallons per minute), including up to 0.063 m^3/s (1,000 gallons per minute) of segregated ground water seepage, representing the maximum potential for unmitigated seepage flow into the mine.

1.4.3 Mill Operations

The massive and stringer ores will be processed at an average rate of 5,005 t/d (5,518 short tons per day) and 4,095 t/d (4,515 short tons per day), respectively. Valuable minerals will be recovered as concentrates of copper, lead, and zinc.

The following subsections provide descriptions of the processes that will be used to crush, grind, and recover the minerals from each ore type and produce backfill materials for the mine. Table 1.4-3 gives the estimated design capacity and average quantity of ore handled and processed during a full production year.

1.4.3.1 Coarse Ore Transport and Fine Crushing

Two types of coarse ore, crushed in the mine to minus 152 mm (6 inches), will be transported to the coarse ore stockpile, reclaimed as needed, and transported to the fine crushing facility (Figure 1.4-3). The function of the coarse ore stockpile is to provide surge capacity between the mine and the concentrator, and to provide a supply of ore to operate the concentrator for those times when the mine is not in production. The coarse ore stockpile will consist of a stringer ore stockpile with 18,000 t (19,845 short ton) live storage, and a massive ore stockpile with 22,000 t (24,255 short ton) live storage.

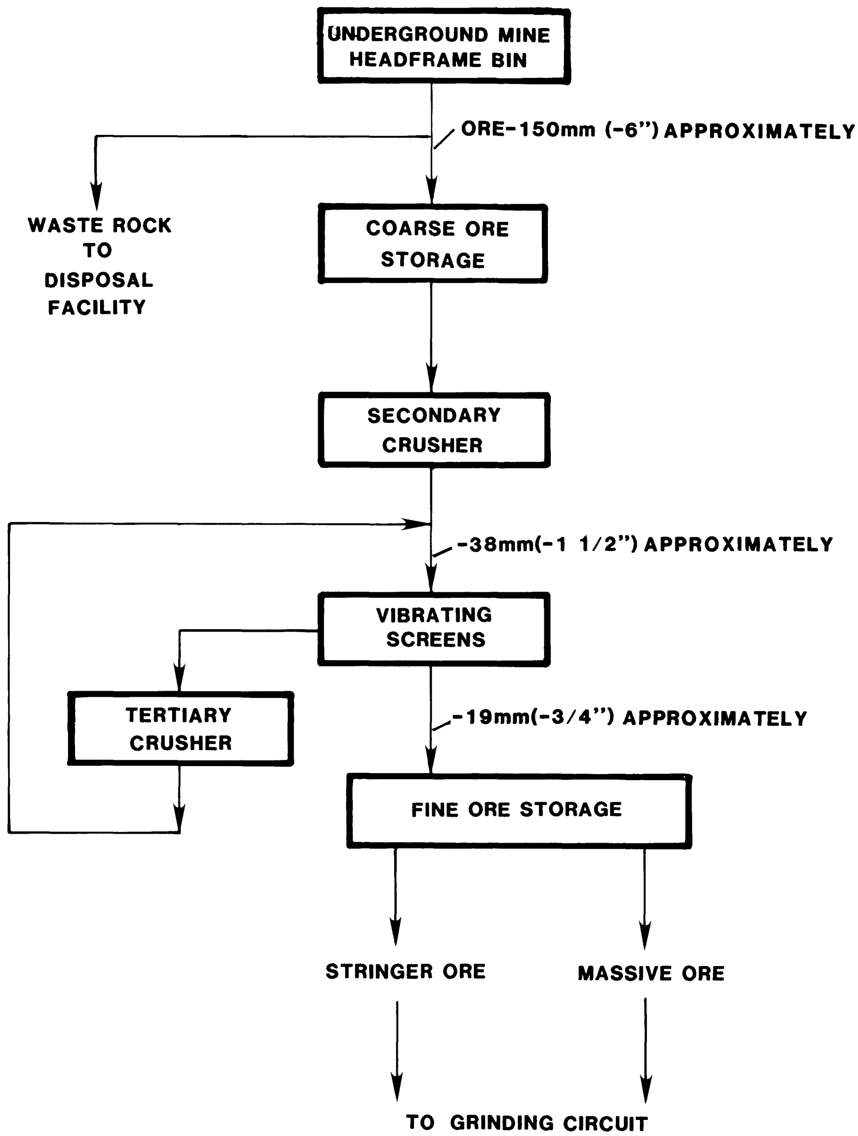
Coarse ore will be transported from the stringer and massive ore storage piles by belt feeders. One type of coarse ore at a time will be reclaimed. These feeders will discharge to a collecting belt conveyor which will transport the ore to the fine crushing facility. The ore will be fed directly to the secondary crusher.

TABLE 1.4-3

ESTIMATED DESIGN CAPACITY AND AVERAGE QUANTITY OF ORE HANDLED AND PROCESSED DURING A FULL PRODUCTION YEAR

	Design Capacities		Average Quantities			
	t/d	short tons per day	t/d	short tons per day	t/y*	short tons per year*
Massive Ore	5,255	5,794	5,005	5,518	1,801,800	1,986,485
Stringer Ore	4,300	4,741	4,095	4,515	1,474,200	1,625,305
Total	9,555	10,535	9,100	10,033	3,276,000	3,611,791
Copper Concentrate	471	519	449	495	161,640	178,208
Lead Concentrate	72	79	69	76	24,840	27,386
Zinc Concentrate	1,025	1,130	976	1,076	351,360	387,375
Flotation Tailing	7,987	8,807	7,606	8,386	2,738,160	3,018,822

*Yearly values based on 360 operating days per year.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
COARSE ORE TRANSPORT
AND FINE CRUSHING

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY JP BECKER	DATE 8/82	CHECKED BY J. E. Wlmsn		DATE 10/24/82	
APPROVED BY	DATE	APPROVED BY C E Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 1.4 - 3**		SHEET OF		REVISION NO 0	

The secondary crusher product will be conveyed to sizing screens where material larger than about 19 mm (0.75 inch) will be separated and fed to the tertiary crusher and crushed to minus 19 mm (0.75 inch). The crushed material will be returned to a surge bin and then recycled over the same screens. Fine ore passing through the screens will be collected by a belt conveyor and transferred to a travelling tripper belt conveyor to fine ore bins. One set of bins will store stringer ore and the other massive ore.

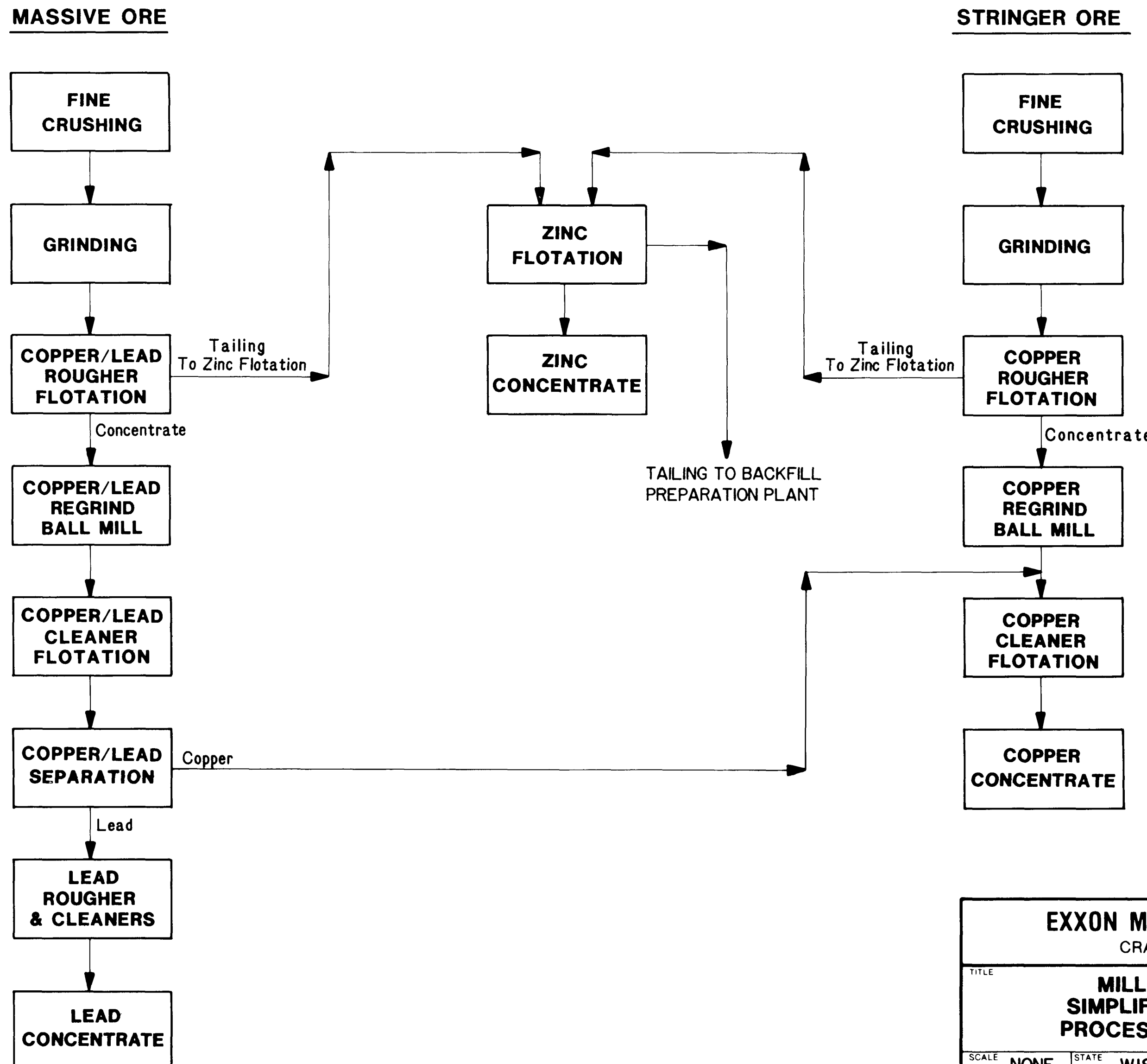
The fine ore crushing plant will be designed to crush up to 620 t/h (684 short tons per hour) of coarse ore, and to deliver the crushed ore at the same rate to the fine ore bins.

All conveyors in the crushing facility will be contained within the building or conveyor galleries. Major material transfer points will be vented to a dust collection system.

1.4.3.2 Grinding and Flotation

The processes for grinding the ores for mineral liberation and for concentrating the ore minerals by flotation are discussed in the following subsections. The overall process flowsheet is presented in Figure 1.4-4.

The design quantities and normal operating quantities of ore that will be processed by grinding and flotation are presented in Table 1.4-3. The design quantities are values used to determine material and water balances and to determine the size of major processing equipment. The total design quantity is 5 percent greater than the normal operating quantity. The normal operating values represent average quantities of ore processed and average quantities of concentrates produced.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
SIMPLIFIED OVERALL
PROCESS FLOWSHEET

SCALE NONE	STATE WISCONSIN	COUNTY FOREST

DRAWN BY S. J. Harvey	DATE 7/15/82	CHECKED BY	DATE 8/24/82
APPROVED BY	DATE	APPROVED BY	DATE 10/20/82
APPROVED BY	DATE	EXXON	DATE

DRAWING NO **FIGURE 1.4-4** SHEET 1 OF 1 REVISION NO. 0

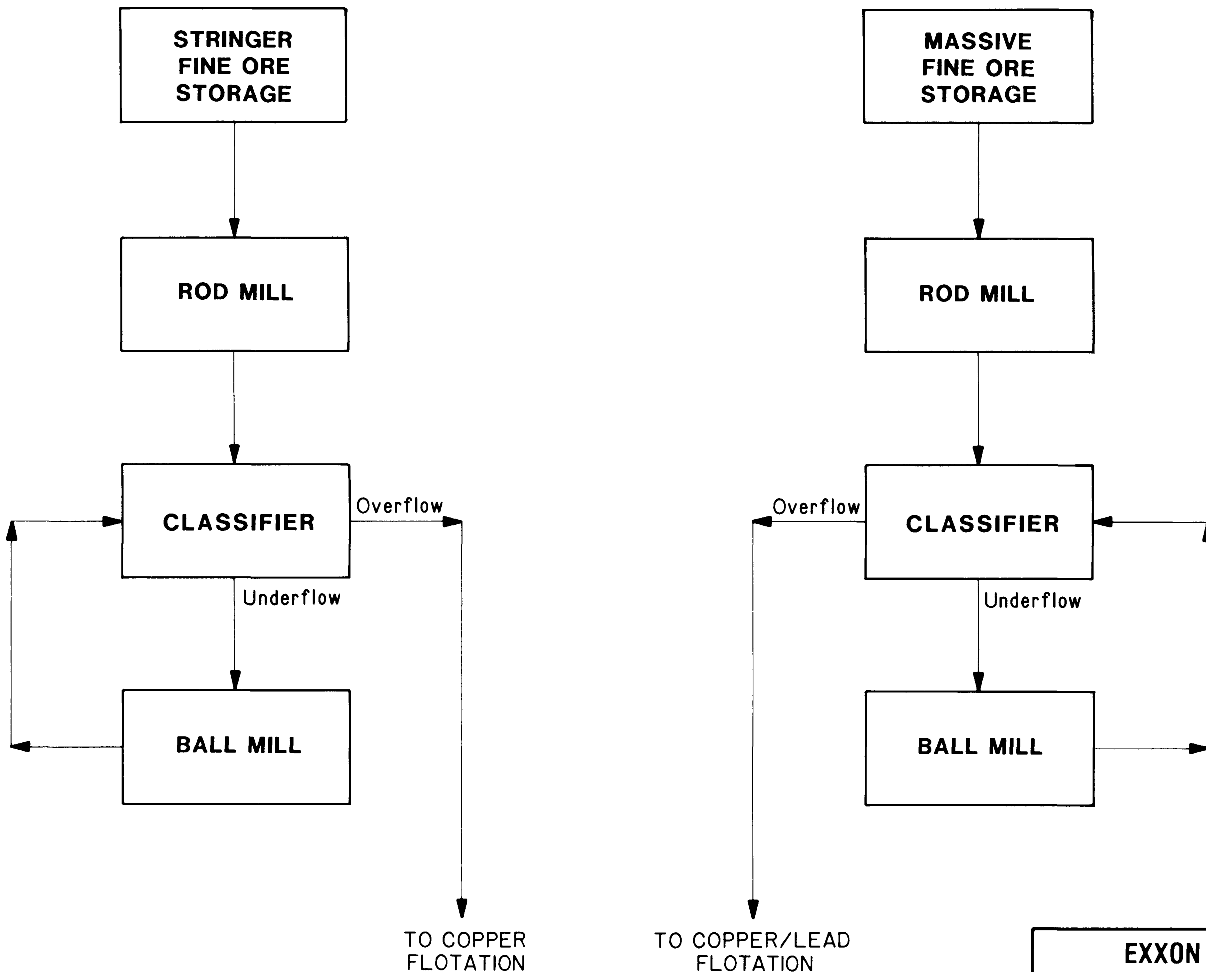
1.4.3.2.1 Grinding

To liberate the minerals effectively, a two-stage grinding circuit will be installed for each ore type. The first stage of grinding will be performed by rod mills. In the second stage, ball mills will grind the ore to the required particle size for rougher flotation. The grinding circuits are presented in Figure 1.4-5.

The two finely crushed ores (massive and stringer) will be removed from their respective fine ore bins by a system of feeders and conveyor belts and transported to one of two identical grinding circuits where each ore will be ground separately. Each ore type will be conveyed into a rod mill at a controlled rate where water will be added to form a slurry, and the ore will be ground. The feed rate will be monitored by a belt scale on the rod mill feed conveyor. As the slurry passes through the rotating mill, ore pieces will be broken between tumbling rods to a particle size similar to coarse sand. The rod mill product will discharge into a sump and be pumped to a classifier which will separate particles based on their size. The slurry containing the coarse particles from the classifier will be fed to a ball mill. As the mill rotates and the slurry passes through the mill, tumbling steel balls will break the ore particles resulting in size reduction and liberation of the minerals. Discharge from the ball mill will flow to the same sump in which the rod mill discharge is collected and be pumped to the classifier.

The overflow from the classifier will be aerated and conditioned for feed to flotation. The purpose is to make the minerals amenable to flotation.

The rotating rod and ball mills will generate noise in the 95 dBA range. However, outside the concentrator building, these noise levels will



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
ORE GRINDING FLOWSHEET

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY S. J. Harvey	DATE 8/82	CHECKED BY		DATE 8/24/82	
APPROVED BY	DATE	APPROVED BY		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 1.4-5**			SHEET 1 OF 1	REVISION NO. 0	

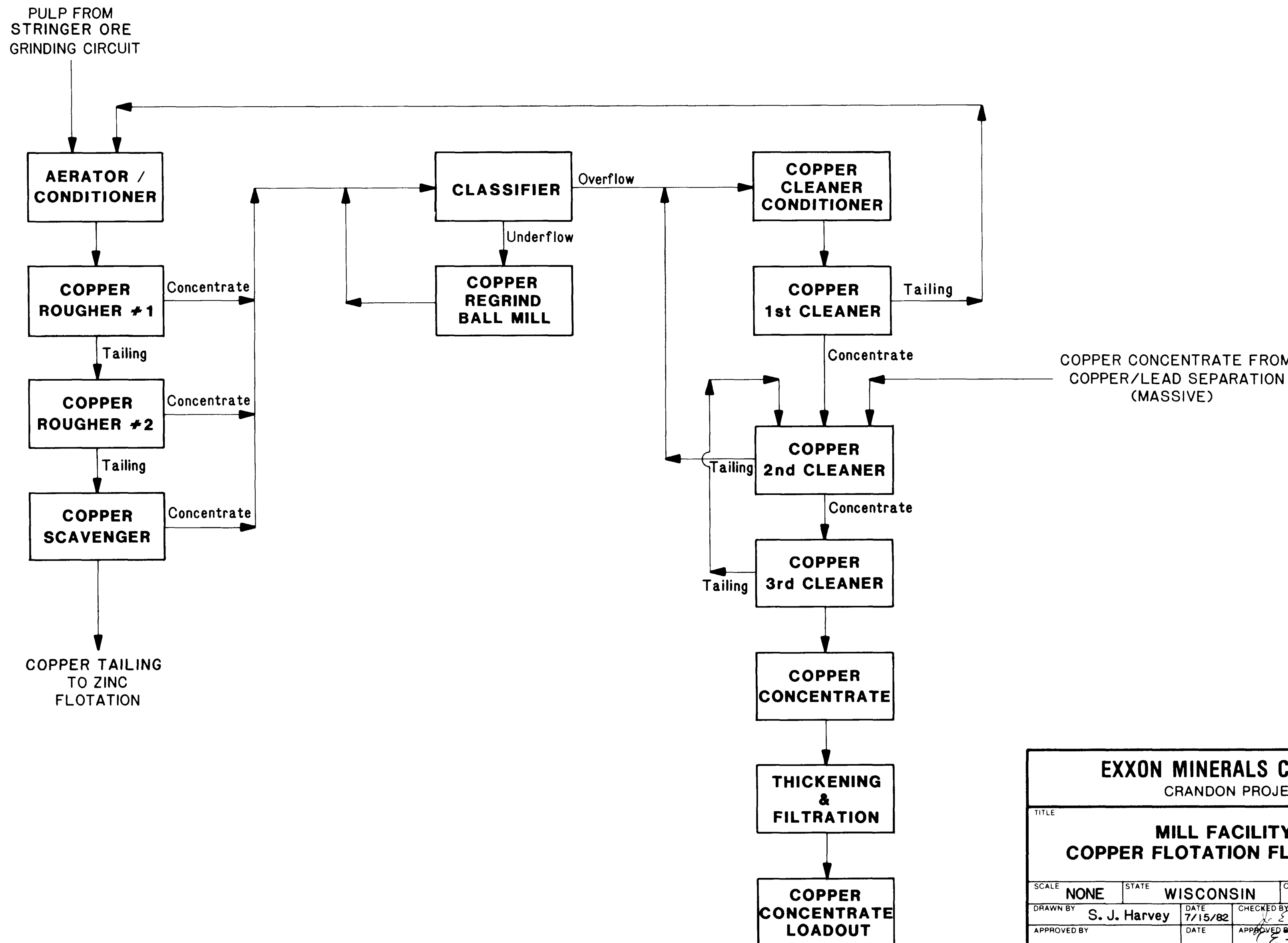
be 65 dBA. Dust generated by the grinding system feed conveyors will be collected, where necessary, in dust collectors and returned to the process. All noise and air emissions are discussed in subsection 1.4.9.

1.4.3.2.2 Flotation

Flotation is the process used to physically separate the zinc, copper, and lead minerals from the gangue to produce concentrates.

Copper Flotation - The stringer (copper-zinc) ore after grinding, aeration, and conditioning with reagents, will be subjected to flotation to selectively recover a copper concentrate and produce an intermediate tailing that contains the zinc minerals. The slurry from the conditioner will pass through the copper rougher and scavenger flotation machines. The rougher and scavenger concentrates will be pumped to a regrind circuit consisting of a ball mill and classifier. The classifier overflow will be refloated in three successive cleaning stages to produce a high-grade copper concentrate. The classifier underflow (over-size material) will be recycled to the regrind mill. As discussed in the next subsection, copper concentrates from the copper-lead (massive ore) circuit will be added to the second stage of this cleaning process. Tailing from the copper first cleaner flotation stage will be returned to the process for additional conditioning and flotation. The copper flotation flowsheet is shown in Figure 1.4-6.

Copper-Lead and Lead Flotation Circuits - After grinding, aeration, and conditioning, the massive (copper-lead-zinc) ore slurry will be distributed to conditioners feeding the copper-lead rougher and scavenger flotation machines. This flotation step will produce a combined copper-lead



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 8/24/82	
APPROVED BY	DATE	APPROVED BY		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO	**FIGURE 1.4- 6**		SHEET 1 OF 1	REVISION NO. 0	

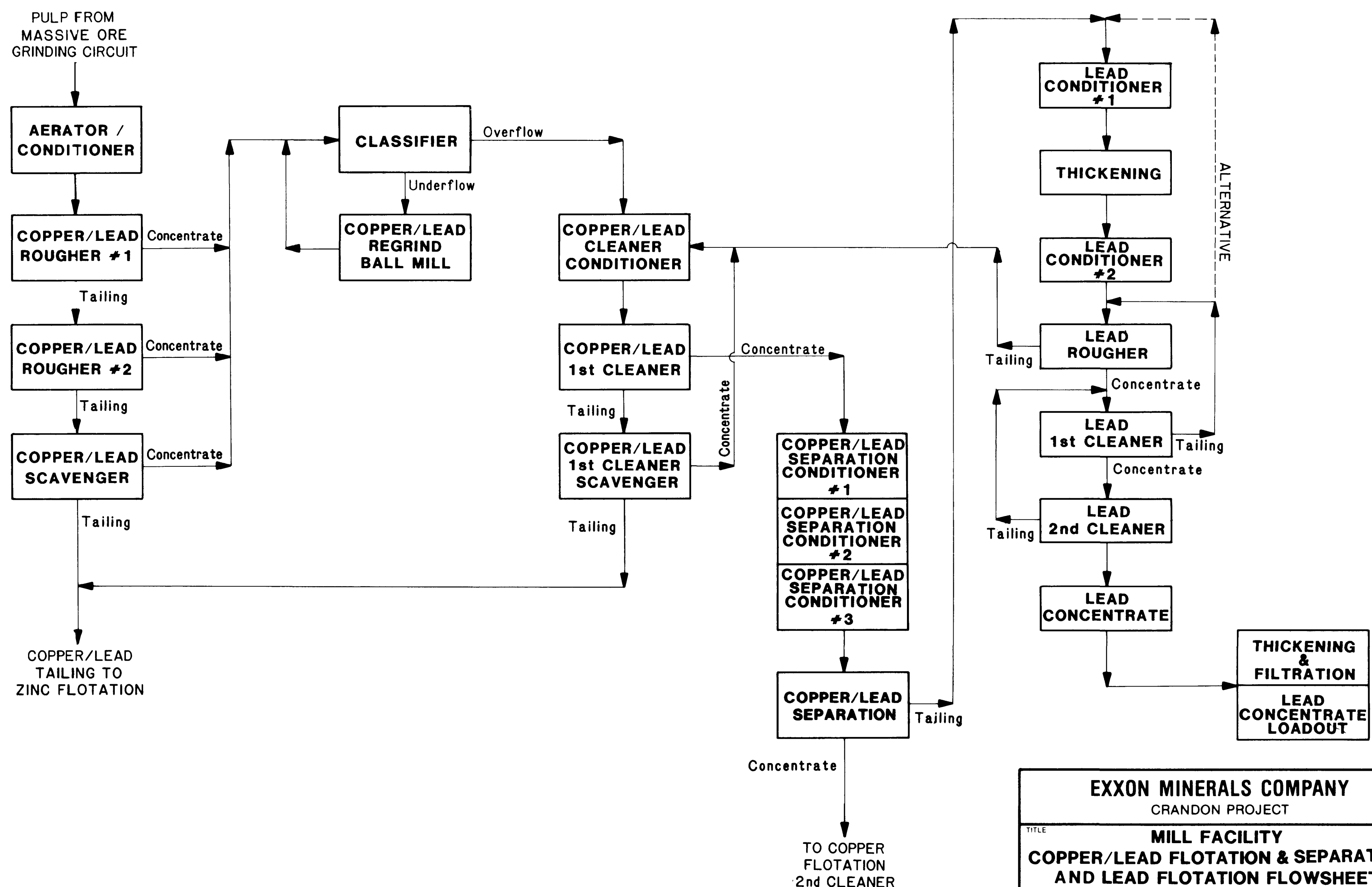
rougher-scavenger concentrate that requires further processing. The tailing from the copper-lead scavenger circuit contains zinc minerals and will be pumped to the zinc flotation circuit.

The copper-lead rougher and scavenger concentrates will be pumped to a regrind circuit consisting of a ball mill and cyclone classifier. The classifier overflow will be refloated in one cleaning stage to make a higher grade copper-lead concentrate. The classifier underflow will be returned to the regrind mill. The copper-lead cleaner concentrate will be subjected to copper-lead separation with the copper concentrate being pumped to the second stage of the copper cleaning circuit. The tailing, depleted of copper but containing lead, will be treated in the lead flotation circuit.

The lead minerals will be concentrated in a bank of flotation cells as a lead-rougher concentrate. This rougher concentrate will be upgraded in a cleaner flotation circuit to produce a final lead concentrate. Figure 1.4-7 illustrates the copper-lead and lead flotation circuits.

Zinc Flotation - The feed to the zinc flotation circuit will consist of the following three process streams: (1) stringer ore copper scavenger tailing; (2) massive ore copper-lead scavenger tailing; and (3) copper-lead first cleaner scavenger tailing.

The total zinc flotation circuit feed will be conditioned with reagents prior to zinc flotation. Zinc rougher and scavenger concentrates will be classified. The coarse material (underflow) will be sent to a regrind ball mill for further size reduction. The fine material (overflow) will be passed through cleaner stages of flotation to produce a final zinc concentrate. The final mill tailing comprised of zinc scavenger tailing and



EXXON MINERALS COMPANY
CRANDON PROJECT

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

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY S. J. Harvey	DATE 7/15/82	CHECKED BY		DATE 8/24/82	
APPROVED BY	DATE	APPROVED BY		DATE 8/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO FIGURE 1.4 - 7		SHEET OF		REVISION NO. 0	

first cleaner-scavenger tailing will be directed to the mine backfill preparation circuit. The zinc flotation circuit is presented in Figure 1.4-8.

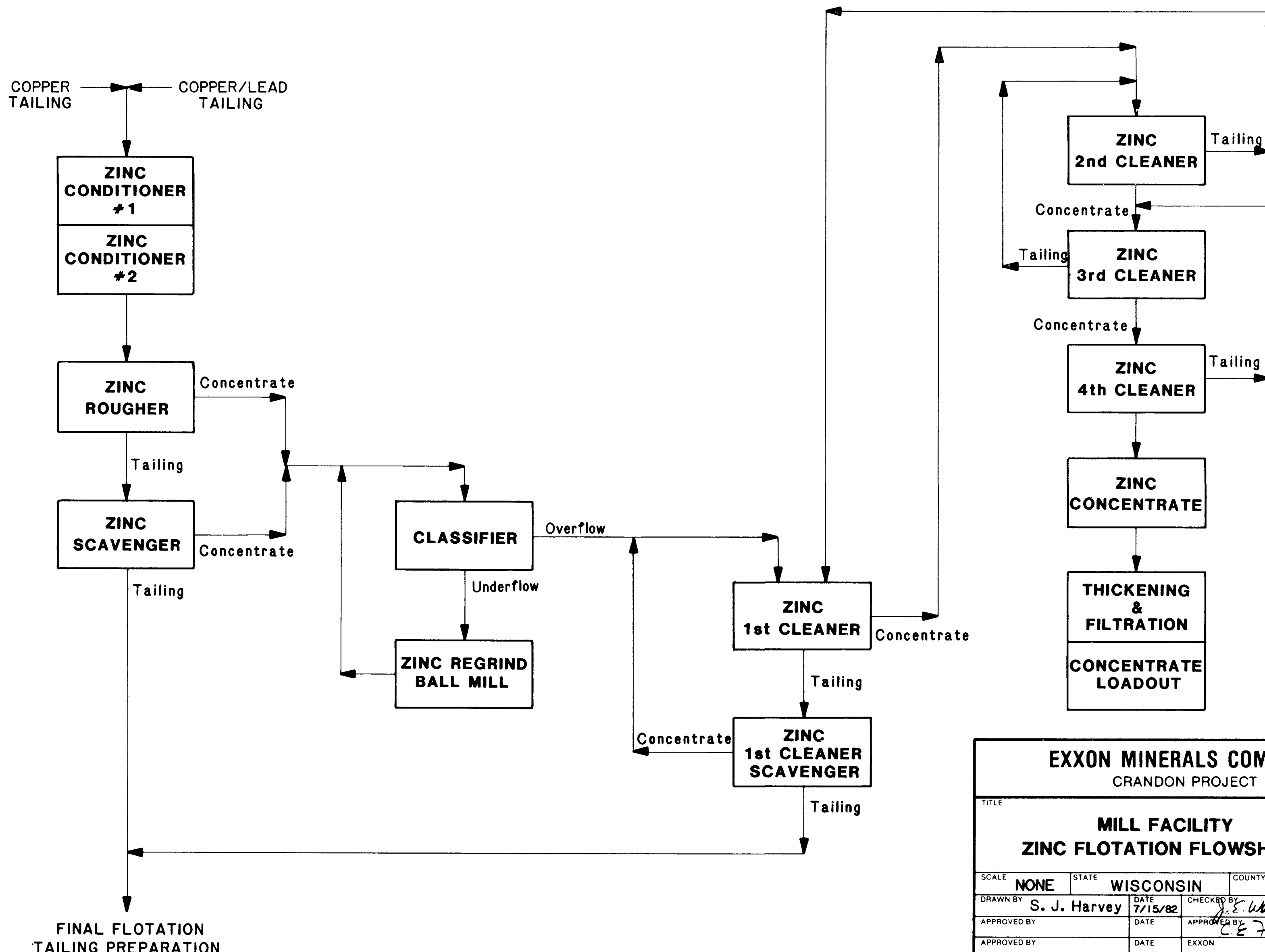
Sampling - Selected process streams will be analyzed using a low level X-ray analyzer which will semi-continuously monitor the appropriate metal levels in the process streams. Data from the analyzer along with mass flow rate data will be used to control the addition of reagents to the flotation process. 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. Later, as 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 type of concentrate from the flotation area will be pumped to a thickener in the dewatering area. Each thickened concentrate will be pumped to a filter for final dewatering to produce filter cakes with lower moisture content. The dewatered copper, lead, and zinc concentrates will normally be conveyed into railcars.

When railcars are not available, storage space will be able to hold 10 days production of copper, lead, and zinc concentrates. The primary sources of noise here will be the equipment used to reclaim copper and zinc concentrate from the excess storage area. Noise and air emissions are discussed in subsection 1.4.9.



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 J. E. Wiener		DATE 8/24/82	
APPROVED BY	DATE	APPROVED BY C. E. Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 1.4 - 8**			SHEET 1 OF 1		REVISION NO. 0

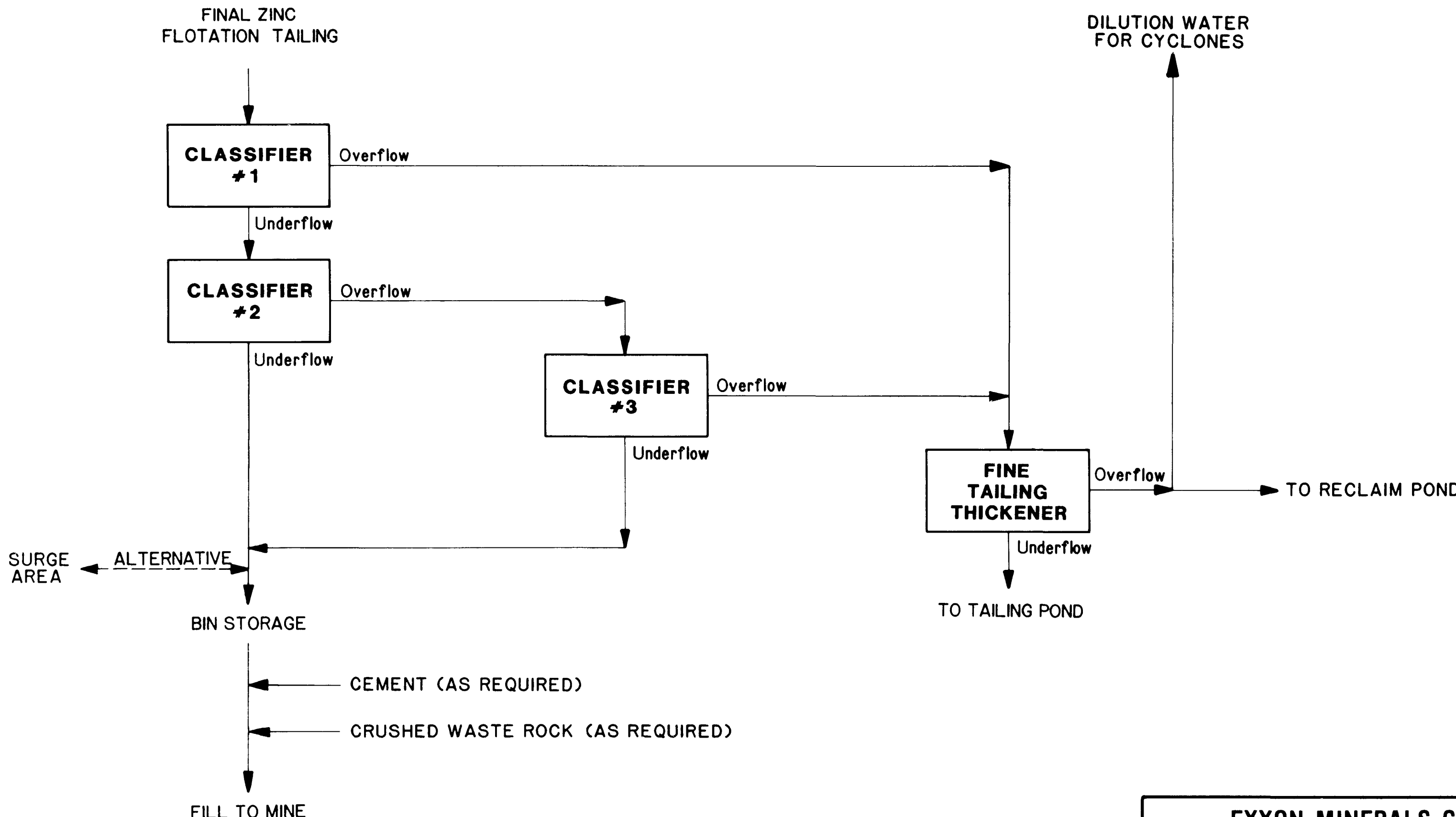
Concentrates will normally be shipped from the Project site in 100-ton capacity railcars at an estimated rate of 20 to 25 cars per day, 5 days per week. Delivery requirements, empty car availability, and weather will cause variances from normal shipping frequency and in the number of cars per shipment. Shipping could vary from 5 to 45 or more cars per shipment.

1.4.3.4 Surface Backfill System

A classifier will be used to recover the coarse fraction of the mill tailing for backfill (Figure 1.4-9). The mine backfill will use all the coarse fractions of the mill tailing and prepared waste rock as needed. The coarse tailing and waste rock will be mixed with cement (as required) and water and pumped to the mine. The fine fraction of the mill tailing cannot be used as mine backfill and will be disposed of at the tailing pond.

Normally, backfill will not be stored on the surface. Once backfilling in the mine has started, the demand for fill is expected to be continuous and fill will be required on a 7-day-per-week basis. However, for those short periods of time when fill cannot be accepted underground, it will be temporarily stored in a lined 2.0 ha (5 acre) area north of the concentrator. Up to 150,000 t (165,375 short tons) can be temporarily stored in this area. Material will be delivered to this temporary storage area as a slurry and be reclaimed as a slurry. Any excess water from this storage area will be sent to the reclaim water pond and, therefore, remain in the process water system.

Backfill preparation on the surface will begin when required by the mine. This is currently projected to be the ninth month of mine production.



EXXON MINERALS COMPANY

CRANDON PROJECT

TITLE

MILL FACILITY
ZINC TAILING BACKFILL FLOWSHEET

SCALE NONE		STATE WISCONSIN		COUNTY FOREST	
DRAWN BY S. J. Harvey	DATE 7/15/82	CHECKED BY J. E. Wenner		DATE 8/24/82	
APPROVED BY	DATE	APPROVED BY C E Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 1.4- 9**		SHEET OF		REVISION NO.	

1.4.3.5 Fine Tailing Thickening

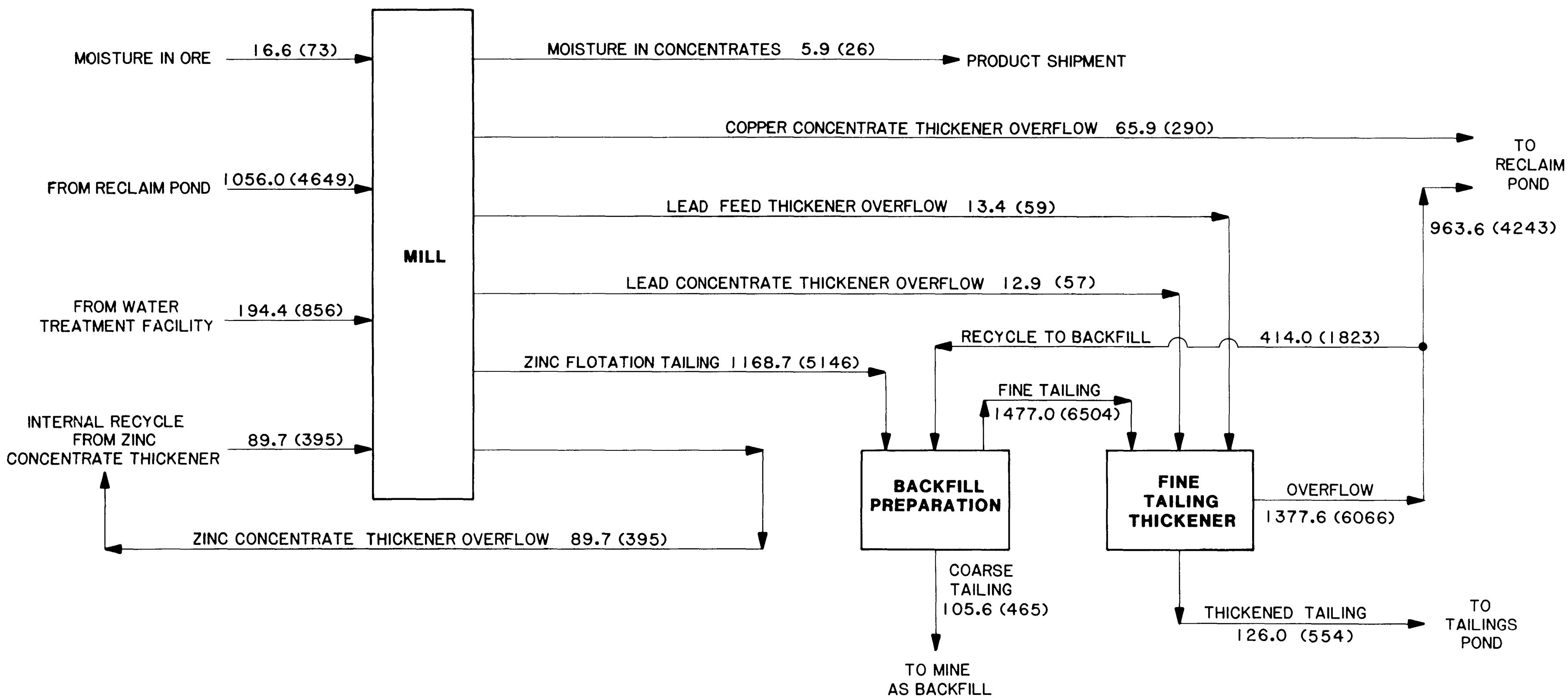
The fine fraction of the final mill tailing will be pumped to tailing thickeners located outside the concentrator building. The thickened underflow will be pumped to the tailings pond. A portion of the clarified thickener overflow water will be recycled back to the backfill preparation facility, while the remainder will be pumped directly to the reclaim pond.

Because the solids are in slurry form, no dust will be generated in this area. Noise levels associated with fine tailing thickening and transport are tabulated in subsection 1.4.9.

1.4.3.6 Water Balance

A block flow diagram showing a typical water balance for the mill and related processing facilities is presented in Figure 1.4-10. This balance is based on a design ore throughput of 9,555 t/d (10,535 short tons per day) rather than on an average throughput of 9,100 t/d (10,033 short tons per day). The flow rates shown in Figure 1.4-10 and discussed below are estimates based on a water use model. Actual flow rates may vary from the values shown.

The design quantity of water required for the mill process will be 0.372 m^3/s (5,901 gallons per minute) which includes all process and reagent preparation requirements. Also required is 0.115 m^3/s (1,823 gallons per minute) as dilution water for the backfill preparation cyclone. These total requirements are exclusive of the moisture contained in the ore, 0.005 m^3/s (73 gallons per minute). Approximately 0.025 m^3/s (395 gallons per minute) of water will overflow the zinc concentrate thickener;



NOTE: BALANCE IS BASED ON GALLONS PER MINUTE.
VALUES IN m^3/hr. ARE CALCULATED.
TO CONVERT m^3/h TO m^3/s DIVIDE BY 3600.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WATER BALANCE
MILL & RELATED FACILITIES
ALL FLOWS AS m3/h (GPM)

SCALE NONE		STATE WISCONSIN		COUNTY FOREST	
DRAWN BY S. J. Harvey	DATE 7/15/82	CHECKED BY		DATE 9/24/82	
APPROVED BY	DATE	APPROVED BY		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 1.4- 10**		SHEET 1 OF 1		REVISION NO 0	

this quantity will be recycled directly back to the zinc flotation circuit without leaving the mill facility. The balance indicates that 0.293 m^3/s (4,649 gallons per minute) of water will be recycled to the mill from the water reclaim pond. The balance of the water requirements will be made up with treated water from the water treatment facility, 0.054 m^3/s (856 gallons per minute).

The water balance during full production of the concentrator is shown in Figure 1.4-10. No fresh water requirement for processing is shown because of the intention to use all recycled water for the milling process. However, during mill start-up, it is expected that varying quantities (up to 0.372 m^3/s [5,900 gallons per minute]) of fresh water will be required. Further, fresh water for process requirements will be available on a standby basis for use if recycling cannot meet the total water needs for the mill; however, this should be only on a temporary basis.

Water overflowing the copper concentrate thickener, 0.018 m^3/s (290 gallons per minute), will be sent to the reclaim pond. Overflows from the lead circuit feed thickener and the lead concentrate thickener are low-volume flows and will be routed to the fine tailing thickener so that any heavy metals in these two streams can be precipitated (precipitate then becomes part of the solid tailing product).

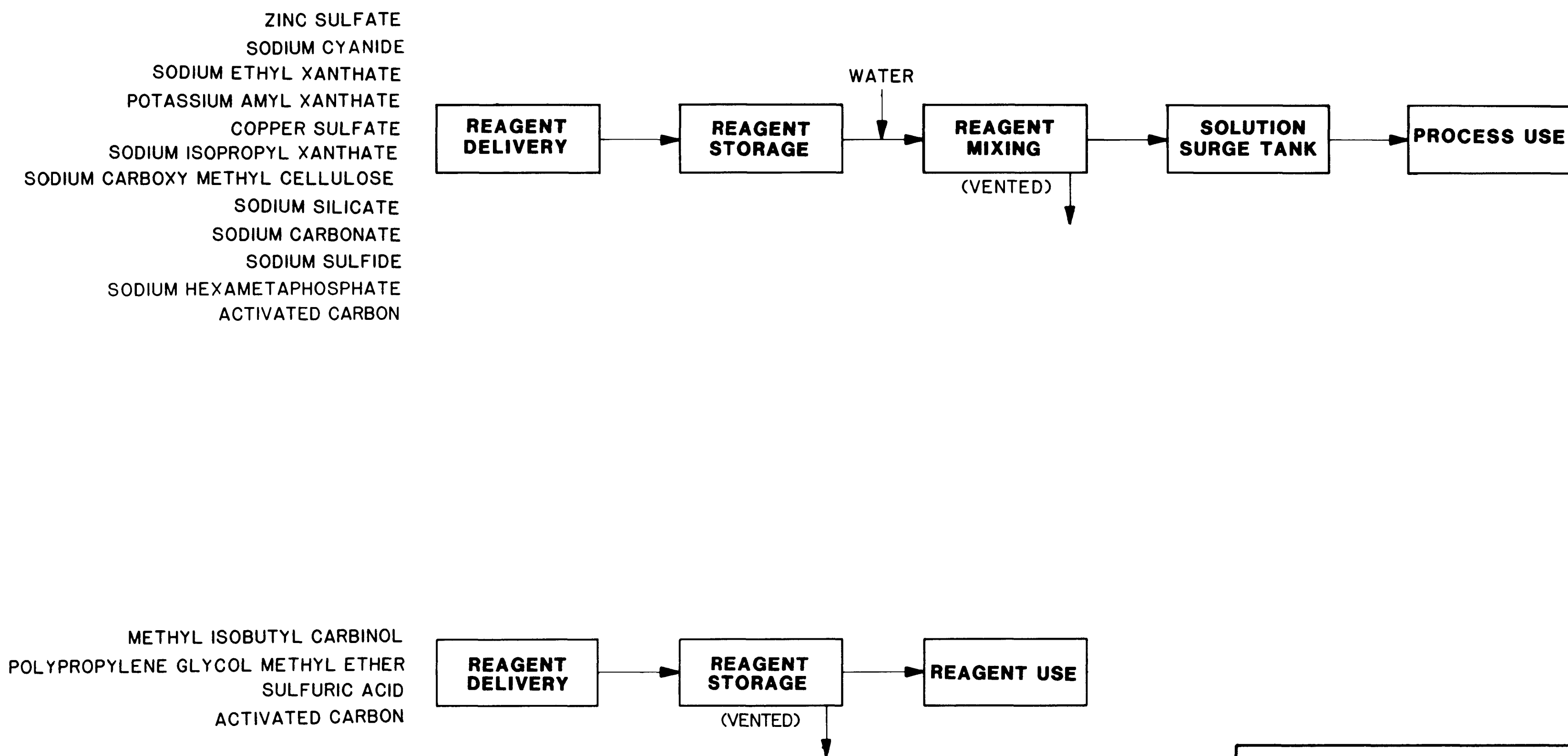
The zinc flotation tailing stream will have 0.325 m^3/s (5,146 gallons per minute) of water and 7,987 t/d (8,806 short tons per day) of solids. This stream will go to the backfill classifiers where the coarse tailing particles will be separated from the fine tailing particles. As stated previously, an additional 0.115 m^3/s (1,823 gallons per minute) of water will be required in this operation; this water will be recovered from the fine tailing thickener overflow. The coarse material, along with 0.029 m^3/s (465 gallons per minute) of water, will go to the mine as backfill or be temporarily stored on the surface until required as backfill. The fine material (fine tailing) is a very dilute suspension of water and fine solids. This stream will be thickened to about 55 percent solids by weight in the fine tailing thickener. The thickened tailing stream flow rate of approximately 0.035 m^3/s (554 gallons per minute) will be pumped to the tailings pond. The thickener overflow stream will be 0.383 m^3/s (6,066 gallons per minute) of which 0.115 m^3/s (1,823 gallons per minute) can be directly recycled to the backfill cyclone as dilution water; the balance of the tailing thickener overflow (0.267 m^3/s [4,244 gallons per minute]) will be pumped to the reclaim water pond. It is possible that once operating experience is gained in the mill, more water can be recycled from the fine tailing thickener overflow stream without going to the reclaim pond.

A small amount of water, 0.0016 m^3/s (26 gallons per minute), will leave the facility as moisture contained in the copper, lead, and zinc concentrates.

1.4.3.7 Reagent Receiving, Storage, and Use

Chemical reagents will be used in the flotation process and the water treatment process. The reagent preparation and handling facilities are presented schematically in Figures 1.4-11 and 1.4-12. Summary data regarding reagent use are provided in Table 1.4-4.

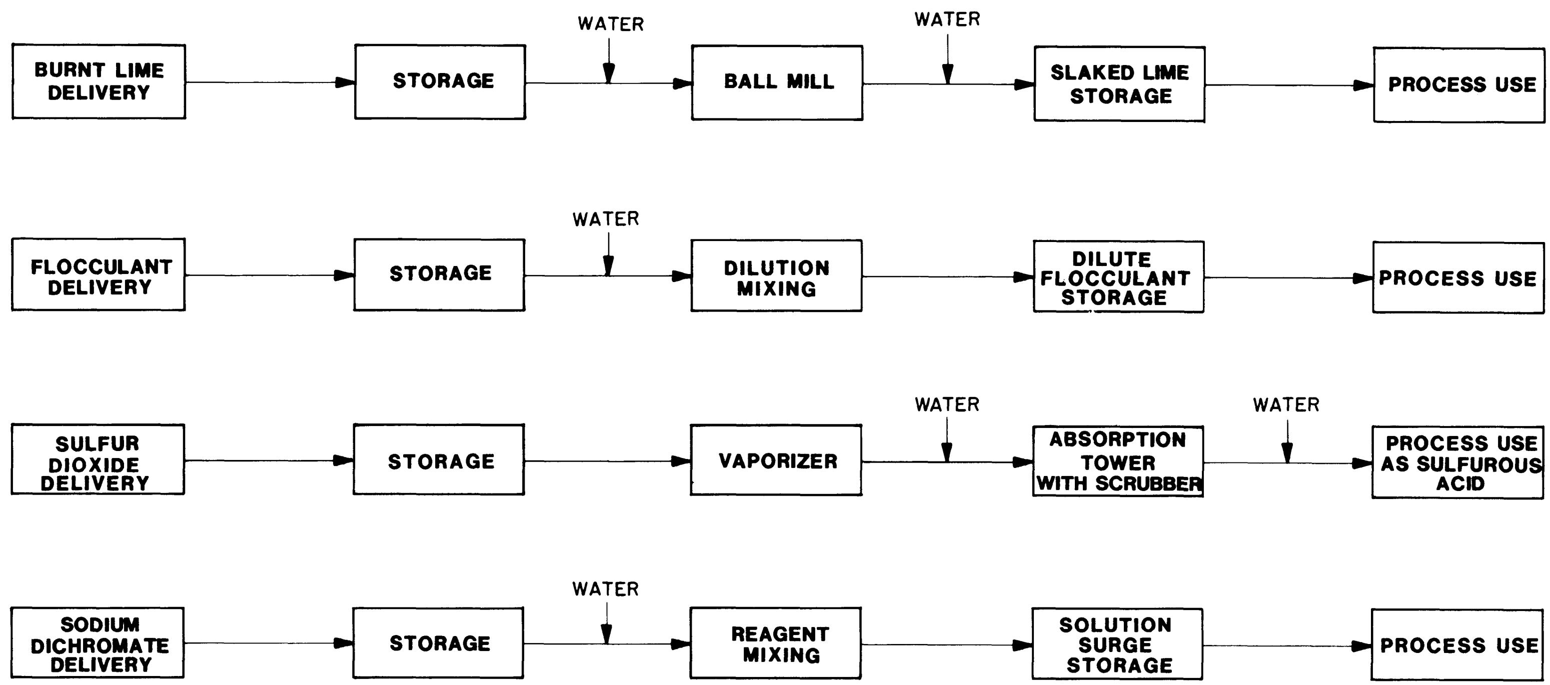
The reagents can be classified generally into two physical forms, solid and liquid. The reagent handling and storage area will be designed to



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
REAGENT HANDLING & PREPARATION

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY R. C. Dietz	DATE 8/82	CHECKED BY	DATE 8/24/82
APPROVED BY	DATE	APPROVED BY	DATE 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO **FIGURE 1.4-11**		SHEET 1 OF 1	REVISION NO 0



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
REAGENT HANDLING & PREPARATION

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY R C DIETZ	DATE 8/82	CHECKED BY	DATE 8/24/82
APPROVED BY	DATE	APPROVED BY	DATE 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO FIGURE 1.4-12		SHEET 1 OF 1	REVISION NO. 0

TABLE 1.4-4

TYPICAL REAGENT USE, CONSUMPTION RATE, AND STORAGE

Chemical	Primary Use	Receive By	Estimated Monthly Consumption kg	Estimated Monthly Consumption pounds		Storage Capacity kg	Storage Capacity pounds
Mill							
Sulfur Dioxide SO_2	Depressant	Tank Car	93,000	205,000	Liquid	68,000	150,000
Copper Sulfate $CuSO_4 \cdot 5H_2O$	Activator	Railcar	98,100	216,300	Granular	136,100	300,000
Sodium Cyanide NaCN	Depressant	Truck	6,000	13,200	Briquette	16,300	36,000
Polypropylene Glycol Methyl Ether	Frother	Truck	8,200	18,100	Liquid	22,700	50,000
Sodium Sulfide $Na_2S \cdot 9H_2O$	Activator and Precipitant	Railcar	68,100	150,200	60% Flake	104,300	230,000
Xanthates	Collectors	Truck	19,100	42,100	Pellet	28,600	63,000
Zinc Sulfate $ZnSO_4 \cdot 7H_2O$	Depressant	Truck	16,300	36,000	Granular	24,500	54,000
Starch	Depressant	Truck	7,700	16,900	Powder	13,600	30,000
Sodium Dichromate	Depressant	Truck	13,700	30,100	Liquid	53,100	117,000

TABLE 1.4-4 (continued)

Chemical	Primary Use	Receive By	Estimated Monthly Consumption kg	Estimated Monthly Consumption pounds		Storage Capacity kg	Storage Capacity pounds
Mill							
Sodium Silicate Na_2SiO_3	Dispersant	Tank Car	40,900	90,100	Liquid	79,600	175,500
Carbon	Adsorbent	Railcar	21,900	48,100	Powder	34,000	75,000
Methyl Isobutyl Carbinol	Frother	Tank Car	10,900	24,100	Liquid	36,300	80,000
Lime CaO	pH Modifier	Rail	500,000	1,100,000	pebble	1,200,000	2,640,000
Water Treatment							
Soda Ash Na_2CO_3	Precipitant	Railcar	237,200	523,000	Powder	340,100	750,000
Sulfuric Acid H_2SO_4	pH Modifier	Truck	34,600	76,300	Liquid	30,600	67,500
HMP*	Anti-scalant	Truck	3,000	6,500	Granular	3,200	7,000
Flocculant	Flocculant	Truck	14,200	31,200	Liquid	18,200	40,000

*Sodium Hexametaphosphate

properly segregate the reagents. Reagents received in solid form will be stored in their containers and transferred to the mixing tanks as required. Each area will have curbs or dikes around the tanks to eliminate mixing of incompatible materials and contain spills.

All reagent mixing and handling will occur within the mill building. Drums and bags of reagents will be emptied directly into mixing tanks. Bulk liquid reagents will be pumped from storage tanks into mixing tanks. Prepared and mixed reagents will be transferred to reagent storage tanks and from there to reagent day tanks located in the flotation area. Durable reagent containers (drums) will be returned to the respective suppliers to be refilled.

Reagents will be delivered in several ways. Lime will be delivered in the form of burnt lime (CaO) by either truck or covered railcar, and will be transferred to covered bins. The burnt lime will be hydrated to $Ca(OH)_2$ to prepare milk of lime (MOL) as a reagent for distribution throughout the facility.

Sulfur dioxide will be transferred directly to three liquid SO_2 storage tanks. Vented SO_2 vapors will be compressed to liquid SO_2 and recycled to the liquid storage tanks. The liquid SO_2 will be metered to an SO_2 vaporizer and the vapor dissolved in water to a 10 percent SO_2 solution (sulfurous acid) for storage as needed. The solution is further diluted for reagent distribution. The reagent mixing area will be closely monitored for SO_2 vapors. Adequate venting will be designed to control the vapors in the working area.

Sodium silicate (Na_2SiO_3) will be received as a liquid at approximately 25 percent concentration. Unloading will be simplified by using heating coils for cold weather operations.

Sodium dichromate will be received in solution form, diluted with water to the desired concentration and mixed with sodium silicate for use as a reagent. Sodium dichromate could also be received in solid form if necessary.

Sodium cyanide and sodium sulfide will be stored separately in a controlled storage location and will be removed only when needed. No drums or bags of these materials will be stored in other areas.

Fresh or treated water will be used in the mixing and dilution of reagents. Treatment of potential spills and odors in the reagent storage and preparation areas is discussed in subsection 1.4.3.11.

1.4.3.8 Ventilation

Buildings will have permanently installed heating and ventilating equipment with the exception of the coarse ore storage building and the waste rock crushing building. Portable heaters will be provided in these areas when emergency repairs are required during periods of extremely cold weather. A description of heating and ventilation equipment is presented in subsection 1.2.2.7, Mechanical Equipment.

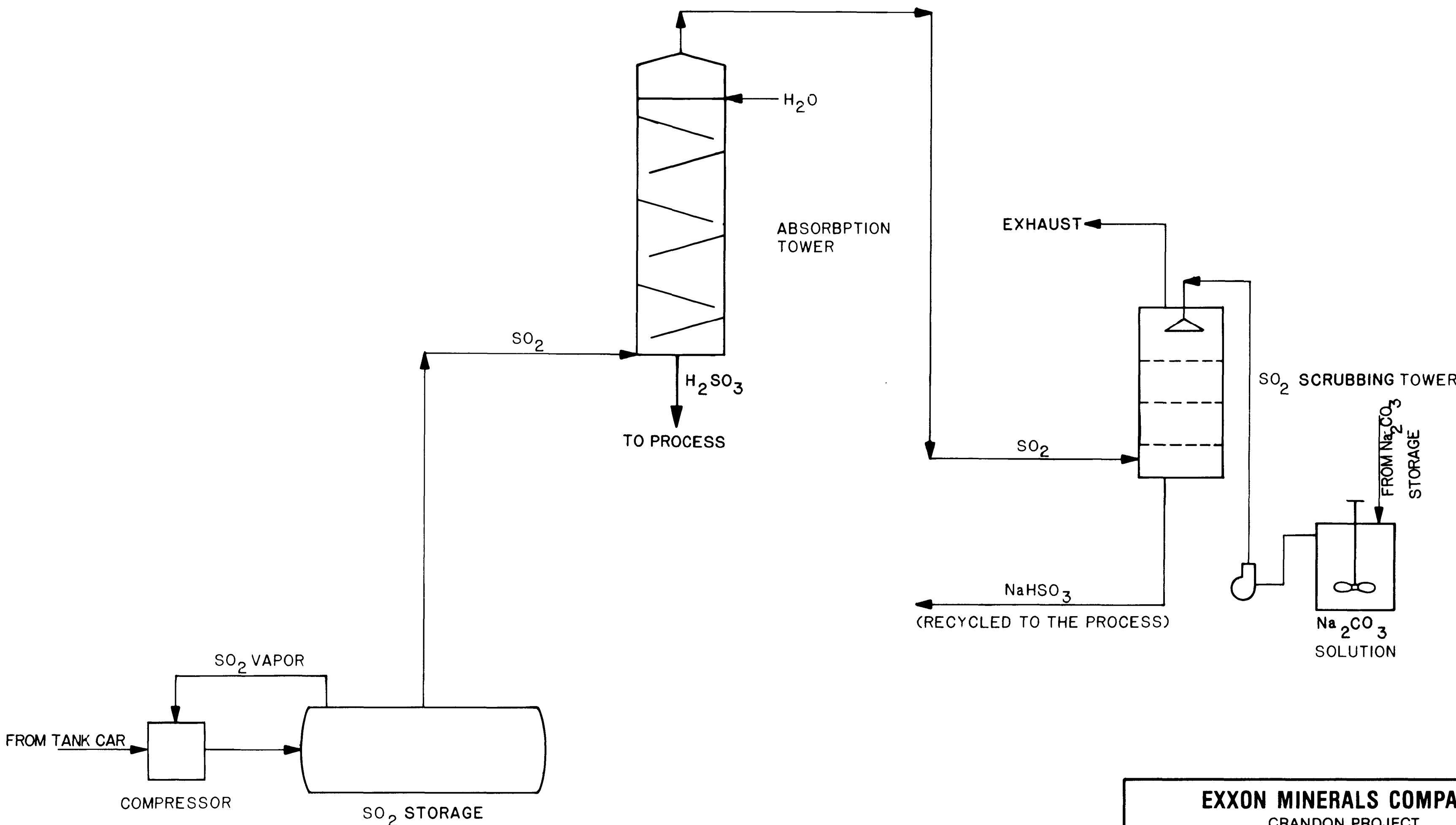
1.4.3.9 Lubrication

Lubricants for the mechanical equipment will include greases and oils as specified by the equipment manufacturers. Waste oil and grease from all equipment will be collected in appropriate containers and returned to the supplier for reprocessing or disposal.

TABLE 1.4-5

TYPICAL PROCEDURES FOR HANDLING SPILLS AND EMISSIONS

REAGENT	TYPE OF SPILL COLLECTION	TYPE OF EMISSION COLLECTION
Lime (calcium oxide)	Curbed area w/sump	Wet scrubber
Copper sulfate	Curbed area w/sump	Wet scrubber
Zinc sulfate	Curbed area w/sump	Wet scrubber
Sodium cyanide	Curbed area w/sump	Filter vent
Activated carbon	Curbed area w/sump	Not applicable
Sodium ethyl xanthate	Curbed area w/sump	Filter vent
Potassium amyl xanthate	Curbed area w/sump	Filter vent
Sodium isopropyl xanthate	Curbed area w/sump	Filter vent
Sodium carboxy methyl cellulose	Curbed area w/sump	Wet scrubber
Sodium sulfide	Curbed area w/sump	Wet scrubber
Flocculants	Curbed area w/sump	Not applicable
Sodium carbonate	Curbed area w/sump	Wet scrubber
Sulfur dioxide	Curbed area w/sump	Caustic scrubber
Sodium dichromate	Curbed area w/sump	Wet scrubber
Sodium silicate	Curbed area w/sump	Wet scrubber
Methyl isobutyl carbinol	Curbed area w/sump	Not applicable
Polypropylene glycol methyl ether	Curbed area w/sump	Not applicable



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
SULFUR DIOXIDE SYSTEM

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY R. C. Dietz	DATE 7/82	CHECKED BY [signature]		DATE 8/24/82	
APPROVED BY	DATE	APPROVED BY [signature]		DATE [handwritten]	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO. FIGURE 1.4-13		SHEET 1 OF 1		REVISION NO. 0	

1.4.3.10 Spills and Odors

Occasionally, spills can occur in the grinding and concentration process areas and in the reagent storage and preparation areas. To avoid circuit contamination, spills in the grinding and flotation areas will be collected in floor sumps and pumped back to a process stream in the circuit where the spill occurred. The concentrate loadout area will be designed with curbing such that spilled material can be transferred to the appropriate concentrate thickeners.

Spills in the reagent storage and preparation areas will be collected in sumps and pumped to a spill control tank for recycling or disposal as necessary. Typical procedures for handling spills and emissions are presented in Table 1.4-5. These areas will have curbed impervious pads and sumps equipped with float-activated alarms which will signal the control room to take appropriate action. Any spills of solid material will be collected and returned to their source area.

The major source for reagent odors will be the reagent mixing and storage area in the concentrator building. Where necessary, the tanks in this area will be equipped with special hoods and vapor-collecting equipment, to exhaust these odors to the atmosphere where ambient dilution will dissipate the odors. Vapors from the liquid SO_2 storage tank will be captured and recompressed to liquid SO_2 as indicated in Figure 1.4-13. Dust from handling and process transfer of bagged or drummed dry materials will be vented to a wet scrubber or controlled with filter vents.

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 waste rock embankment area in the mine waste disposal facility, a one-way haul distance of approximately 3.6 km (2.2 miles).

Permanent waste rock handling facilities at the mine/mill area will employ waste rock bins. Haul trucks will be loaded directly from the bins.

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.

1.4.4.2 Tailing Slurry and Water Transport Systems

The transport systems for transferring the tailing slurry to the disposal area and the reclaim water to and from the reclaim ponds will consist of pumps and pipelines. The operations discussed in this subsection cover only that part of the transport systems between the tailings thickener and water tanks in the mine/mill site and the interface point at reclaim pond No. R1 in the mine waste disposal facility area. 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 1.4-6.

All pumps will be located at either the tailings 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 anticipated 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.

1.4.4.3 Mine Waste Disposal Ponds

Operation of the mine waste disposal facilities will include the deposition of tailing in the ponds, maintenance of the equipment associated with the tailing transport system, and the water recovery systems from the tailing ponds. A detailed description of the mine waste disposal ponds is presented in the Mine Waste Disposal Feasibility Report (Appendix 1.2A).

Pond Sequencing - The mine waste disposal facility will consist of four ponds constructed, operated, and reclaimed in the sequence as shown in Figure 1.4-14. 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 tailing, only one tailing pond will be in operation at any time.

Tailing Discharge - At full production approximately 3,500 t/d (3,858 short tons per day) of tailing will be produced and will be disposed of at the mine waste disposal facility. Tailing will be transported to the mine waste disposal facility in a water based slurry at approximately 55 percent solids by weight. Slurry flow will be at an approximate rate of 0.051 m^3/s

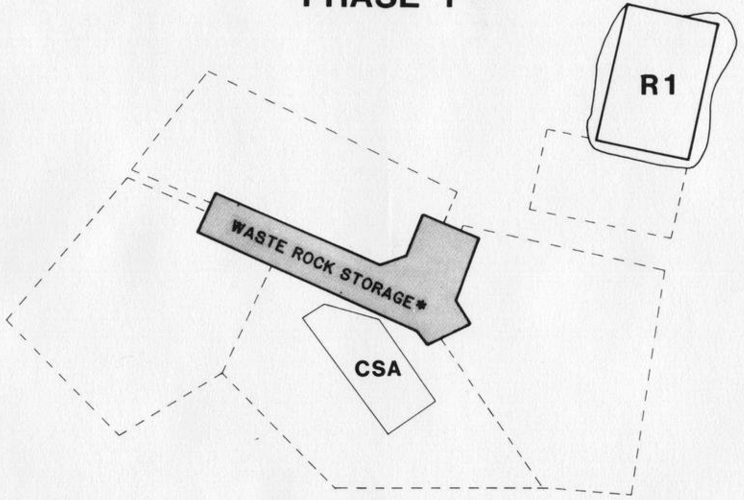
TABLE 1.4-6

TAILING SLURRY/RECLAIM WATER TRANSPORT SYSTEMS DATA

	Flow		Velocity		Pressure	
	m^3/h	gpm	mps	fps	kpa	psi
Tailing Slurry (Thickener Underflow)	185*	814*	1.64	5.35	683	99
Thickener Overflow Water to Reclaim Pond	1030	4533	0.76	2.50	200	29
Reclaimed Water to Mine/Mill	1153	5074	0.86	2.80	255	37

*Values are higher than calculated flow rate to accommodate normal fluctuations in tailing volume. To convert m^3/h to m^3/s, divide by 3600.

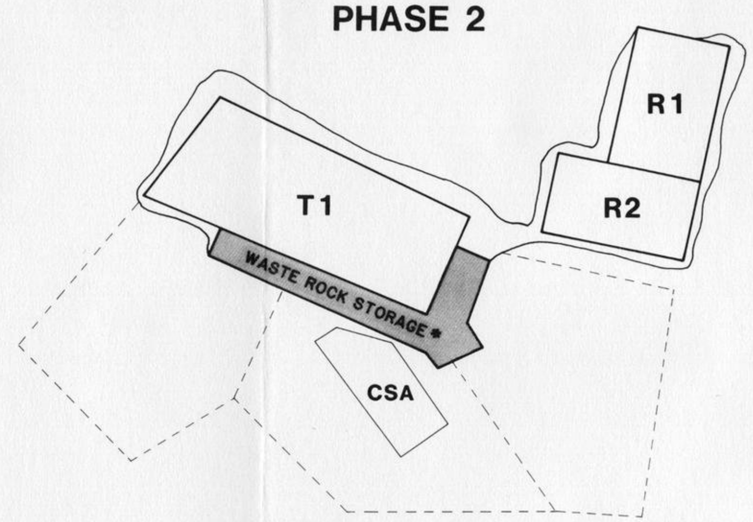
PHASE 1



PRE-PRODUCTION

** INCLUDES AREA FOR TEMPORARY PRE-PRODUCTION ORE STORAGE*

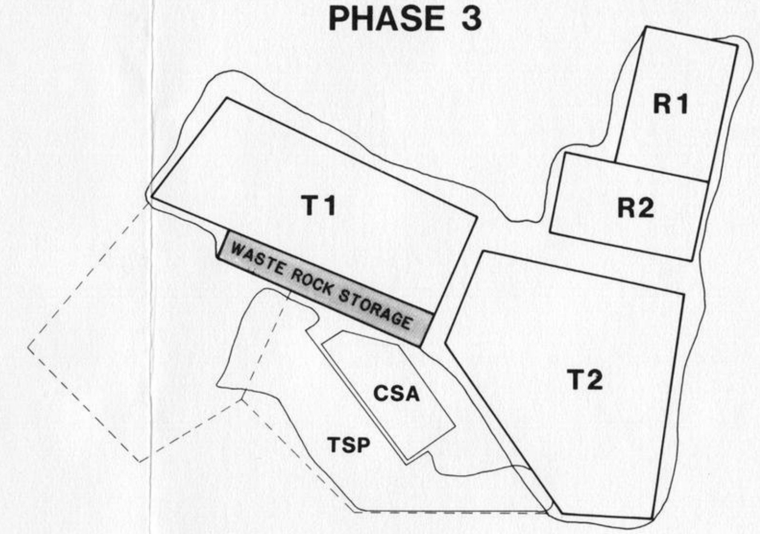
PHASE 2



PRODUCTION USING TAILINGS POND NO. T1

** INCLUDES AREA FOR TEMPORARY PRE-PRODUCTION ORE STORAGE*

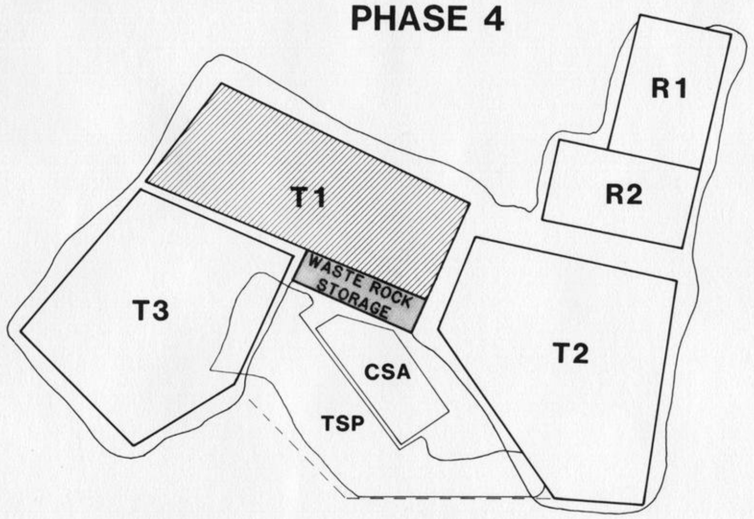
PHASE 3



TAILINGS POND NO. T1 - FILLED

TAILINGS POND NO. T2 - OPERATIONAL

PHASE 4

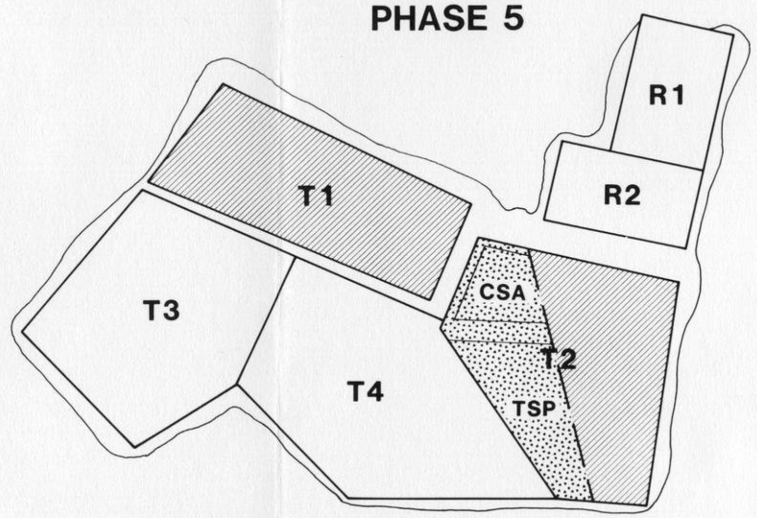


TAILINGS POND NO. T1 - RECLAIMED

TAILINGS POND NO. T2 - FILLED

TAILINGS POND NO. T3 - OPERATIONAL

PHASE 5



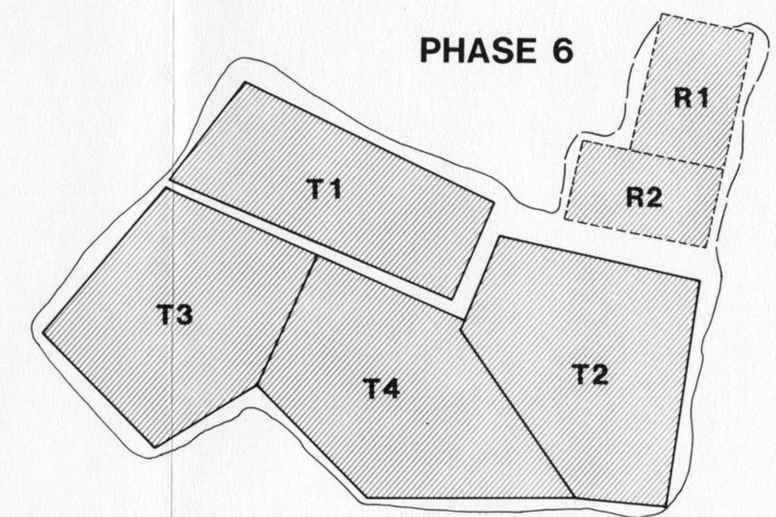
TAILINGS POND NO. T1 - RECLAIMED

TAILINGS POND NO. T2 - PARTIALLY RECLAIMED

TAILINGS POND NO. T3 - FILLED

TAILINGS POND NO. T4 - OPERATIONAL

PHASE 6



RECLAIM PONDS NO. R1 & R2 - REMOVED & REVEGETATED

TAILINGS PONDS NO. T1, T2, T3 & T4 - RECLAIMED

LEGEND

CSA - CONSTRUCTION SUPPORT AREA

TSP - TILL STOCKPILE

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY

CRANDON PROJECT

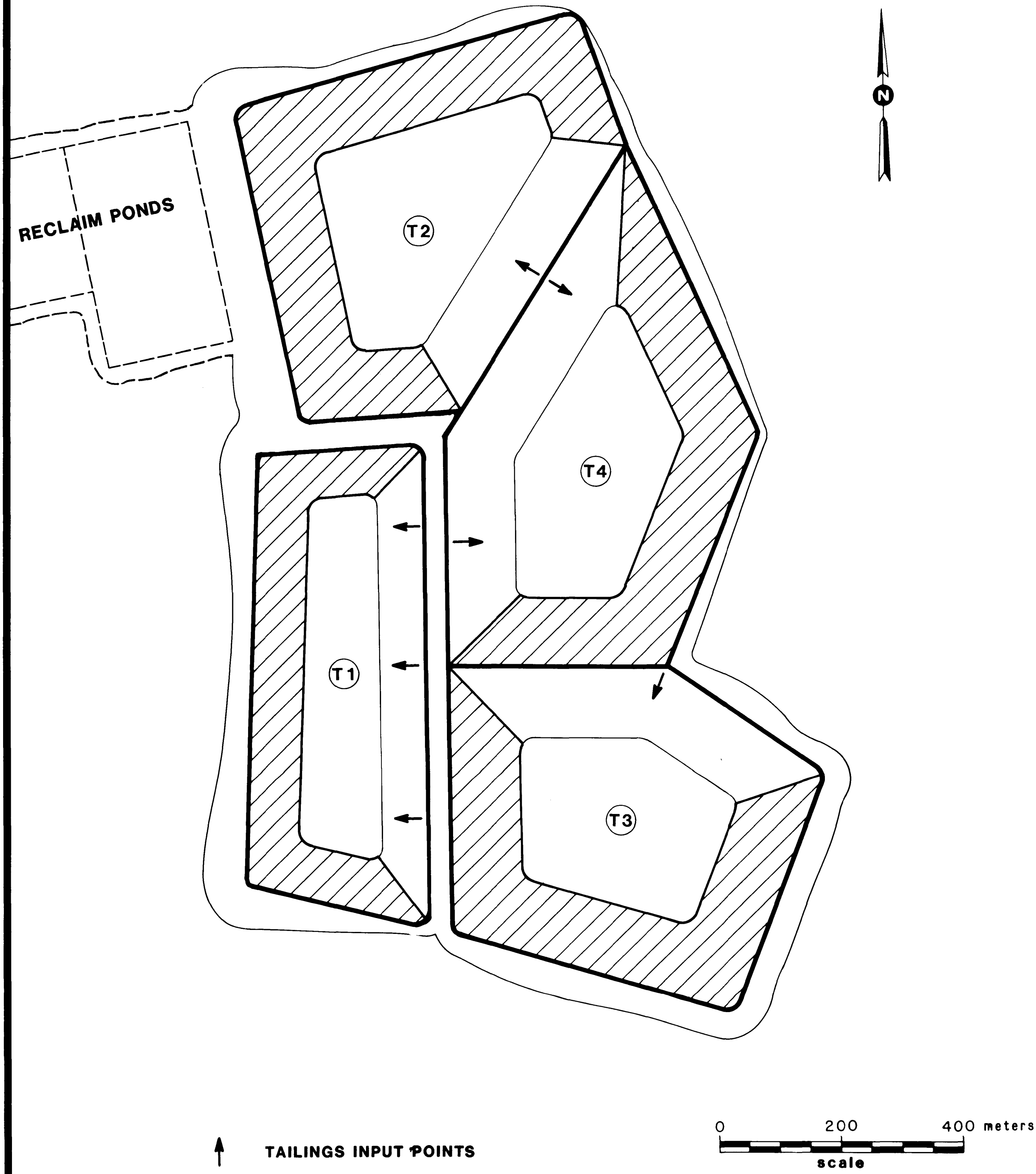
TITLE: **WASTE DISPOSAL FACILITY RECLAIM/TAILINGS PONDS DEVELOPMENT PHASES**

SCALE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: C.A. HACKER	DATE: 8/82	CHECKED BY:	DATE: 11/29/82
APPROVED BY:	DATE:	APPROVED BY:	DATE:
APPROVED BY:	DATE:	EXXON:	DATE: 11/29/82
DRAWING NO.: FIGURE 1.4 - 14		SHEET ___ OF ___	REVISION NO.: 0

solids by weight. Slurry flow will be at an approximate rate of 0.051 m^3/s (791 gallons per minute). The tailing slurry will be deposited from either one or two sides of each pond (Figure 1.4-15). Protective rock will be provided at the end of the discharge pipe to protect the embankment face at the discharge point. As each pond fills with tailings, the discharge points will be moved to develop the most favorable final tailings surface. The tailings will establish a beach in the ponds as it deposits 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 it is estimated that water could pond to a depth of 6.1 m (20 feet).

Decant and Seepage Control Systems - Water will enter the tailing ponds with the tailing slurry and as rain and snow throughout the year. Water is 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 1.4-16 shows the approximate balanced flows for a typical pond during a normal year.

The decant water system and the seepage control system are illustrated in Figure 1.2-16. 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 suitable water depth in the ponded water area. At the crest of the pond the two streams will be joined for transfer to reclaim water pond No. R2 (Figure 1.2-16). Except for the trucks and other equipment associated with the construction of the various



↑ TAILINGS INPUT POINTS

ROCK FACING FOR SLOPE PROTECTION

EXXON MINERALS COMPANY

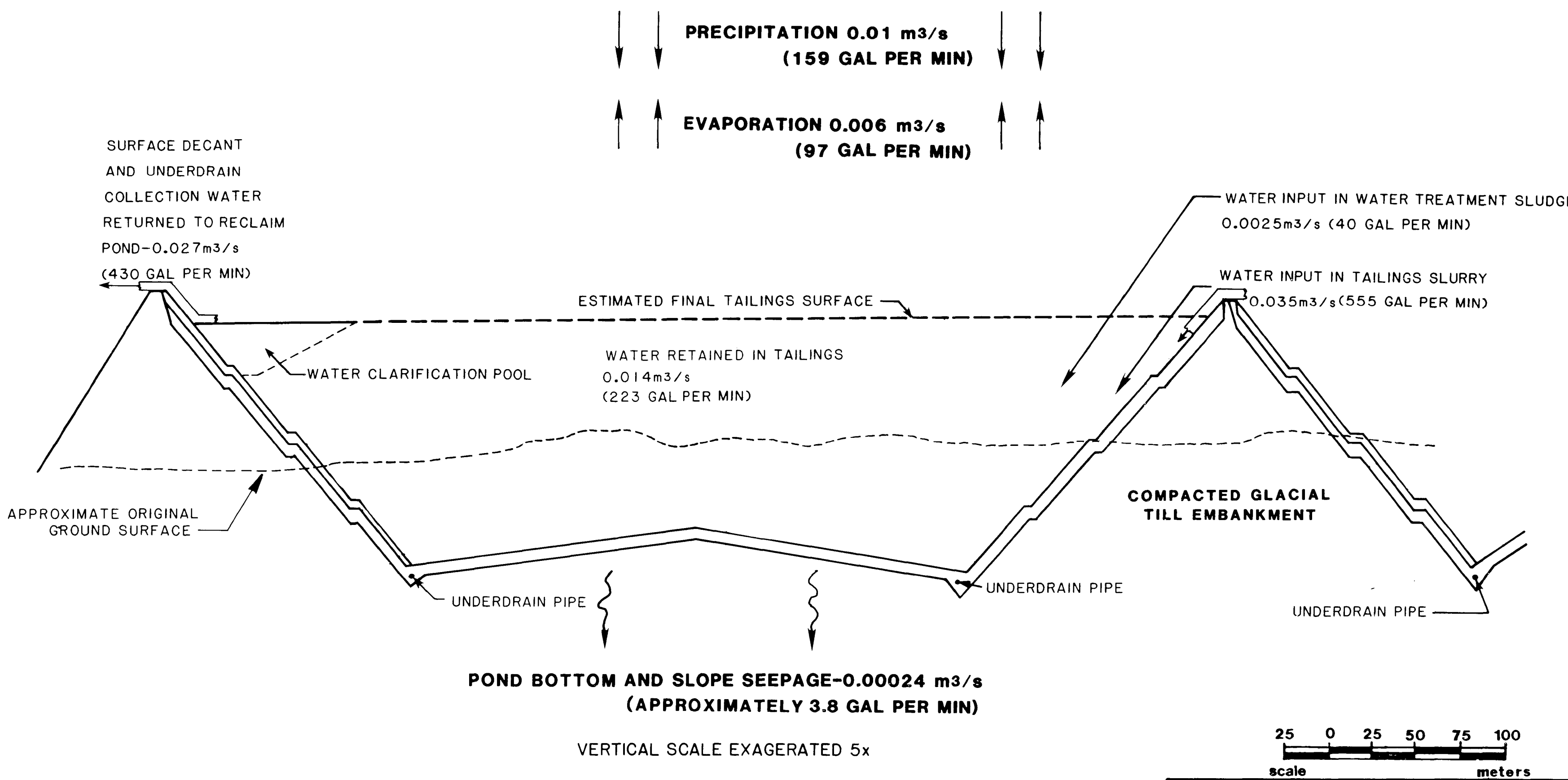
CRANDON PROJECT

TITLE

WASTE DISPOSAL FACILITY
TAILINGS PONDS
DEPOSITION POINTS

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY R.C. DIETZ	DATE 7/82	CHECKED BY C.C. Schroeder	DATE 8-17-82
APPROVED BY	DATE	APPROVED BY C E Fowler	DATE 10/26/82
APPROVED BY	DATE	EXXON	DATE
DRAWING NO **FIGURE 1.4-15**		SHEET 1 OF 1	REVISION NO. 0

TYPICAL POND WATER BALANCE DURING OPERATION
(COMPUTATIONS BASED ON POND T3 AREA WITH AVERAGE PRECIPITATION)



NOTE:

2) PRECIPATATION 0.78m/YEAR
(30.77 IN PER YEAR)

3) EVAPORATION 0.59m/YEAR
(22.36 IN PER YEAR)
OVER 80% OF POND AREA

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY TYPICAL TAILINGS POND WATER BALANCE

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY J.P. BECKER	DATE 8/82	CHECKED BY C.C. Schroeder		DATE 8-17-82	
APPROVED BY	DATE	APPROVED BY C.E. Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO FIGURE 1.4-16			SHEET 1 OF 1		REVISION NO. 0

phases of the entire waste disposal facility, the pumps in the decant and underdrain system represent the only operating equipment at the mine waste disposal facility. These pumps will be electric, in the 25-50 horsepower range, and will have very low noise levels.

A ground water monitoring program for the mine waste disposal facility is presented in the Mine Waste Disposal Feasibility Report (Appendix 1.2A).

1.4.5 Water Treatment

1.4.5.1 Water Reclaim System

An important feature of the Project will be the recycle and reuse of water for ore processing. The use of a reclaim water pond ensures the ability to successfully recycle water to the mill. The primary functions of the reclaim ponds are as follows:

1) Provide 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 evaporative, oxidative and biological processes to occur and thereby control the concentrations of certain chemical constituents in the water.

The volume of the reclaim ponds (as well as the 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.

Small amounts of fine particulate matter will be in the water that flows from the tailing pond to the reclaim pond, and in other streams going to the pond. The long residence time in the pond will allow most fine suspended particles to settle to the bottom.

Retention of water within the pond will promote the oxidation of thiosulfate and other polythionate compounds to sulfate. During warm weather thiosulfate oxidation will take place rapidly. This oxidation also will occur in colder months, but at a slower rate. Lime will be added to the water where it flows from reclaim pond R2 to reclaim pond R1 to neutralize acid generated as a result of thiosulfate oxidation.

The trace concentrations of organic compounds in the water will be reduced in the reclaim pond by evaporation and oxidation. This is important so that water can be recycled to the mill. The residual cyanide concentration in the water will also be reduced by either partial oxidation to cyanate or complete oxidation to carbon dioxide (CO_2) and nitrogen (N_2).

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 a storage tank for distribution to the grinding and flotation operations and to the water treatment facility.

1.4.5.2 Water Treatment System

A water treatment system will be necessary to treat water pumped from the mine as required and to treat sufficient water from the reclaim pond to control scaling in the mill water circuit. Treated water from the system will be used as mill process make up water to the maximum extent possible, and excess treated water will be transported to the surface water discharge point.

The proposed water treatment system will be designed 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.

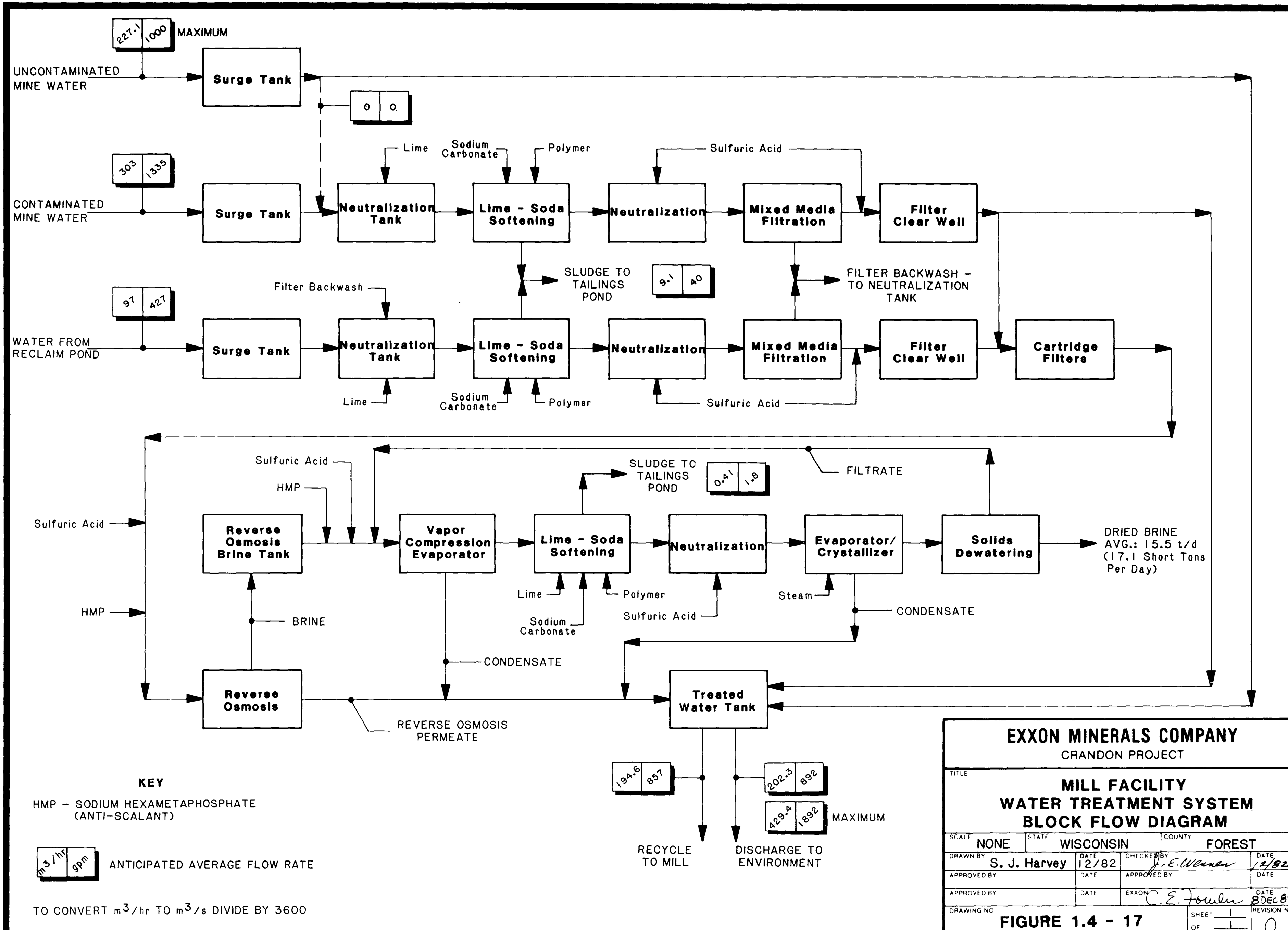
3) Be flexible with respect to influent water quality.

4) Be compatible with various stages of mine/mill development.

The planned water treatment system will consist of the following unit processes which will be operated as required in the proper combination on the varying influent water streams.

Unit Process	Primary Functions
Surge and Equalization	Permit steady state flow rate to treatment processes. Provide tankage for pH adjustment.
Carbonate Precipitation	Remove suspended material in raw influent water. Precipitate metal hydroxides. Precipitate calcium as $CaCO_3$, thereby permitting higher water recovery in the reverse osmosis system.
pH Adjustment	Neutralize effluent from the carbonate precipitation system.
Mixed Media Filtration	Remove suspended solids from water. (This is a necessary process to protect reverse osmosis membranes against fouling.)
Reverse Osmosis	Concentrate dissolved inorganic constituents into a smaller brine stream.
Vapor Compression Evaporation	Further concentrate dissolved constituents into a highly concentrated brine stream
Evaporator/Crystallizer	Dry inorganic solids residue for ultimate disposal.

A block flow diagram of the water treatment system is presented in Figure 1.4-17. In addition to the treatment equipment, there will be a surge tank to accept uncontaminated mine water for monitoring and treatment, if necessary, prior to discharge.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MILL FACILITY
WATER TREATMENT SYSTEM
BLOCK FLOW DIAGRAM

SCALE NONE		STATE WISCONSIN		COUNTY FOREST	
DRAWN BY S. J. Harvey	DATE 12/82	CHECKED BY J. E. Werner		DATE 12/82	
APPROVED BY	DATE	APPROVED BY		DATE	
APPROVED BY	DATE	EXXON C. E. Fowler		DATE 8 DEC 82	
DRAWING NO **FIGURE 1.4 - 17**		SHEET 1 OF 1		REVISION NO 0	

Analysis of the water management system for the Project indicates a need to treat approximately 0.111 m^3/s (1,762 gallons per minute) of contaminated water for discharge and recycle. Uncontaminated water pumped from the mine will be monitored and treated, if necessary. Anticipated influent to the water treatment system will consist of the following:

	Design Flow Rate	
Source	m^3/s	(gallons per minute)
Contaminated Water Pumped from Mine		
Mine Seepage Water	0.063	(1,000)
Backfill Drainage	0.020	(325)
Excess Potable Water	0.0006	(10)
Reclaim Pond Water	0.027	(427)
Subtotal	0.1106	(1,762)
Uncontaminated Mine Water	0.063	(1,000)
TOTAL	0.1736	(2,762)

Water from the mine and the reclaim pond will be pumped to surge tanks and then be metered into the treatment system. In the event of short-term shutdowns of the treatment system due to equipment failure or other reasons, the amount of water pumped from the reclaim pond will be reduced and the mine water would be diverted to the reclaim pond. During this shut down period, discharge water will be diverted to the reclaim and tailings ponds. The mine and mill can continue in operation for a substantial period of time under these conditions.

The following chemicals normally will be used at the water treatment facility:

Chemical	Approximate Annual Consumption t/y	(Short Tons Per Year)
Lime (CaO)	312	344
Soda Ash (Na_2CO_3)	2,811	3,099
Polymer	21	23
Sulfuric Acid	415	457
Hexametaphosphate (Scale inhibitor)	35	38

1.4.5.3 Treated Water Reuse and Disposal

As described in the previous subsection, the anticipated flow rate of feed water to the water treatment system will be about 0.111 m^3/s (1,762 gallons per minute). This flow rate was based on operation of the mill at peak capacity (5 percent greater ore tonnage than projected average capacity) and on an estimated contaminated mine water flow rate of 0.063 m^3/s (1,000 gallons per minute).

During steady state operation of the mine and mill, the volume of treated water will not vary. Short-term (daily, weekly, monthly) variations in water volume will be absorbed in the reclaim pond surge capacity and treated over extended periods of time.

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.

The treatment system will be provided with continuous on-line instrumentation to measure effluent pH, conductivity, and turbidity to monitor the treatment process. In addition, a daily composite samples of treated water will be collected and analyzed in accordance with the WPDES permit for the facilities.

Water from the treatment plant will be pumped to a water surge tank. From this tank, the water will be pumped back to the mill as makeup water and excess water will be transported and discharged to Swamp Creek near County Road M. The concentrations of contaminants in water to be discharged will meet the effluent limitations to be set by the DNR.

1.4.5.4 Water Treatment Wastes

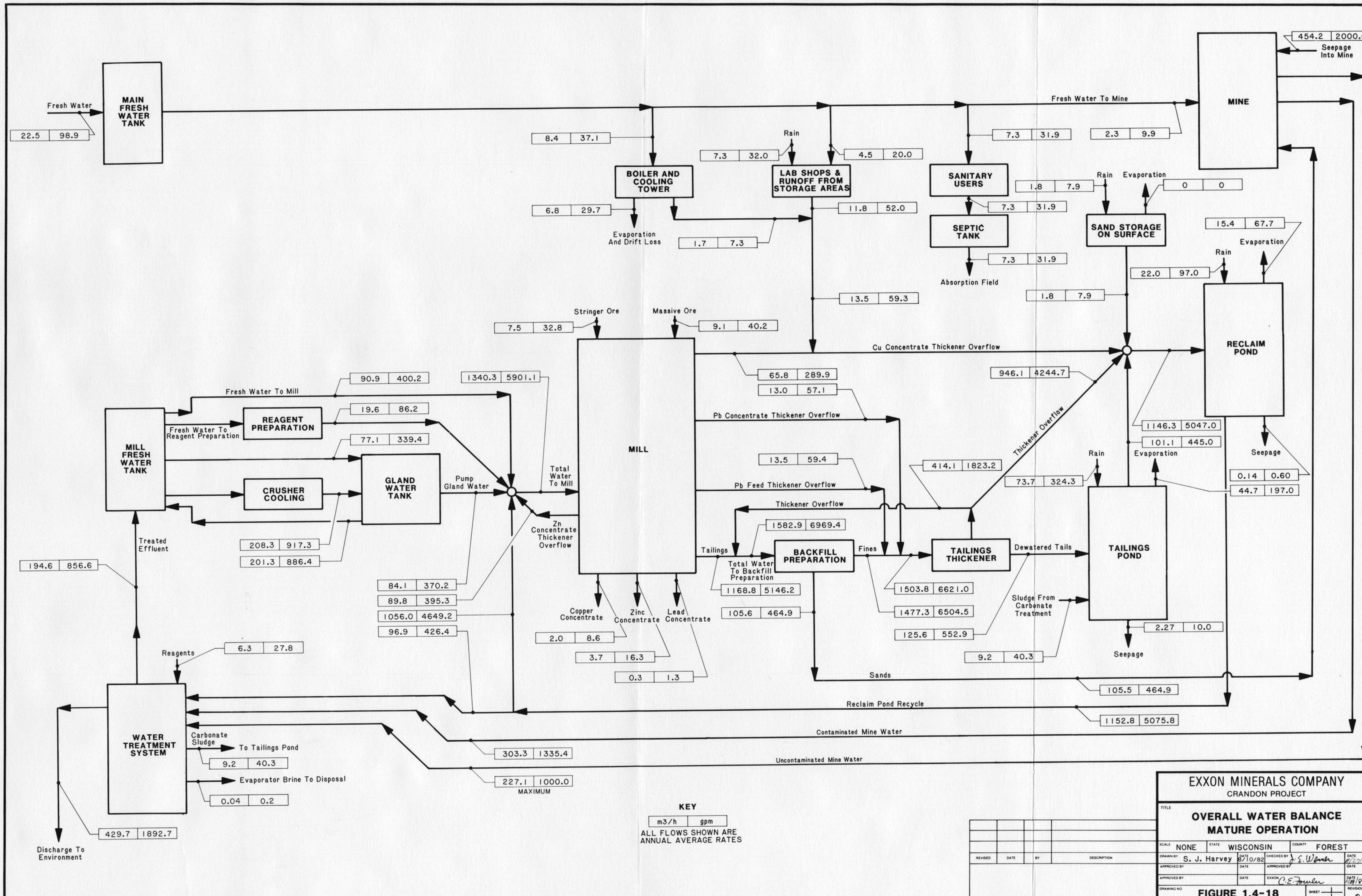
There will be two waste materials produced in the water treatment facility. One material will result from lime-soda softening (also referred to as carbonate precipitation) and the other will result from the reverse osmosis, vapor compression evaporator, and crystallizer unit processes.

The waste from the two lime-soda softening steps will consist primarily of calcium carbonate and is expected to contain less than 10 percent of other metal hydroxides, primarily zinc and iron. Other minor constituents will amount to less than 0.2 percent. The projected amount of solids in this sludge during mature operation will be 17.2 t/d (19.0 short tons per day). These projections were based upon data generated using the Water Use Computer Model (CH2M Hill, 1981). This carbonate waste will be disposed of with the mill tailing. The advantage of disposing the calcium carbonate with the tailing is its acid neutralizing capacity.

The other waste material will result from the evaporative treatment of the brine from the reverse osmosis process. This waste will consist primarily of sodium sulfate with up to 10 percent sodium thiosulfate. It will be produced at an estimated rate of 13.2 t/d (14.6 short tons per day) during mature operation of the Project. This material could potentially be marketed for use in kraft paper mills. Alternatively, it will be transported to and disposed of in a secure landfill site.

1.4.6 Overall Water Balance

The water balance for mature operation of the mine and mill facilities is presented in Figure 1.4-18. The flow rates shown were based on projections generated using the Water Use Computer Model (CH2M Hill, 1981, 1982). The required volume of water from the reclaim pond will be treated to control gypsum scaling in the mill circuits. For the purpose of modeling the mature operation of the mill and ensuring that maximum flows will be accommodated, a time period was selected when two tailing ponds were active. During mature operation, the average amount of water expected to be discharged will be up to 0.119 m^3/s (1,893 gallons per minute).



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
OVERALL WATER BALANCE
MATURE OPERATION

SCALE NONE | STATE WISCONSIN | COUNTY FOREST
DRAWN BY S. J. Harvey | DATE 8/10/82 | CHECKED BY J. E. Wimmer | DATE 11/29/82
APPROVED BY | DATE | APPROVED BY | DATE
APPROVED BY | DATE | EXXON C. E. Fowler | DATE 11/29/82
DRAWING NO. **FIGURE 1.4-18** | SHEET 1 OF 1 | REVISION NO. 0

REVISED | DATE | BY | DESCRIPTION

1.4.7 Operations Traffic

Estimates for operations traffic associated with the Project were based on equivalent 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 1.25 persons per vehicle, and using projected manpower requirements in subsection 1.4.10, the numbers of equivalent vehicles used for each shift were estimated as follows:

Shift	Vehicles	Delivery Trucks
Day	328	10
Afternoon	158	2
Night	137	-
TOTAL	623	12

Project traffic from southern points of origin will comprise about 35 percent of the total average daily traffic. The number of delivery vehicles will increase by approximately 22 percent during Project operations. Traffic from northern points of origin will average about 50 to 55 percent of the total average daily traffic during the life of the operation. Truck traffic from the north for delivery services will increase by approximately 15 percent during operations.

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
4	End Dump Trucks (50 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.

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 10 cars per week. Approximately 20 to 25 railcars per day of concentrates will be moved from the mine/mill site to the sidings during weekday operations.

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 0.006 m^3/s (100 gallons per minute) well, tank, and distribution system will be provided for potable water. Treatment of the potable water probably will not be required. However, in the event that some treatment is needed, a chlorinator treatment system will be provided.

1.4.8.2 Treatment of Sanitary Wastes

Waste Water Quantity - The average daily flow rate of sanitary waste water will be approximately 0.002 m^3/s (32 gallons per minute). Total daily flow rate is, therefore, 174 m^3/day (46,000 gallons per day). On the basis of 272 showers per shift change, the peak hourly flow rate will be approximately 0.010 m^3/s (160 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. It was assumed that wastes from the mine will be put into the treatment system at the sanitary waste treatment facility.

Waste Water Quality - Typical domestic sanitary waste water contains about 200 mg/l of BOD and about the same concentration of TSS. Per capita BOD and TSS contributions obtained from the literature are listed in Table 1.4-7. The sanitary waste water contributions for the Project were estimated at 0.07 kg BOD/person/d and 0.07 kg TSS/person/d. The estimated average daily sanitary waste water flow of 173.8 m^3 (46,000 gallons) therefore has an average waste loads of 62.2 kg BOD/d (137 pounds per day) and 62.2 kg TSS/d (137 pounds per day) (CH2M Hill, 1982).

TABLE 1.4-7

SANITARY WASTE WATER QUALITY

Type of Source	BOD kg/person/day (lbs/person/day)	TSS kg/person/day (lbs/person/day)
Domestic[a]	0.04 - 0.07 (0.09 - 0.15)	0.04 - 0.07 (0.09 - 0.15)
Construction Camp - with Food Service[b]	0.07 (0.15)	-- --
Factories - with No Food Service[b]	0.03 (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.

Septic Tank System - A general process diagram for the septic tank system is presented in Figure 1.4-19. Sanitary waste will enter the septic tank where it will be held for approximately 1 day. The waste water will pass from the septic tank into a dosing chamber. Two pumps will deliver the dosing tank effluent to two soil absorption fields via a pressurized distribution system. A more detailed description of the soil absorption field for the septic tank system follows.

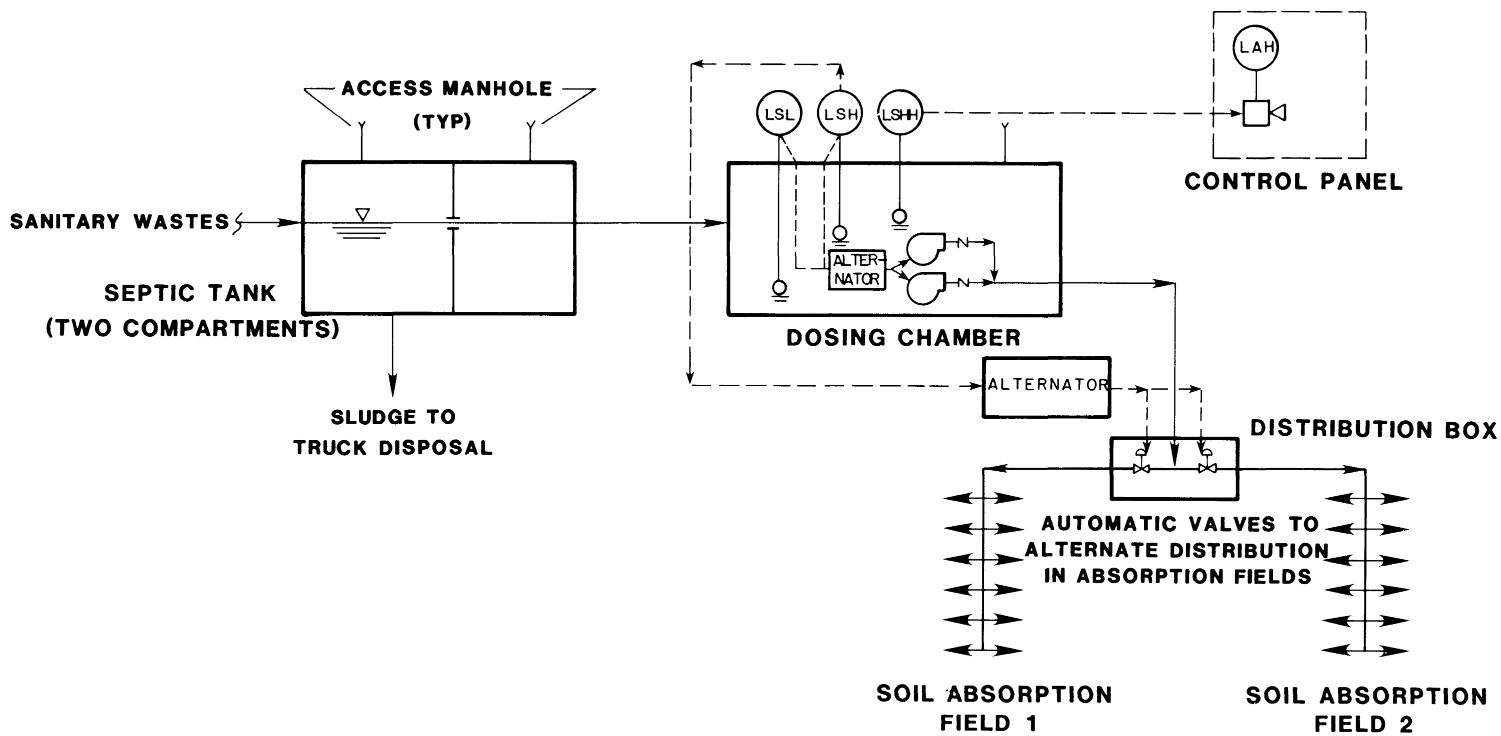
Soil Absorption Field - Area requirements for a soil absorption field using a pressurized distribution system are specified by Wisconsin Administrative Code and are based on both waste water flow rates and soil percolation rates.

Based on the Excess Water Discharge Report (Golder, 1981) a location southeast of the treatment facility was selected for the absorption fields (Figure 1.2-17). The absorption fields will be designed and constructed in accordance with Wisconsin Administrative Code (Figure 1.4-20).

A pressure distribution system will deliver the septic tank effluent to the absorption fields. The size of the distribution system will depend on the area of the absorption field and will conform with Wisconsin Administrative Code. The system piping will evenly distribute septic tank effluent over the absorption fields.

1.4.8.3 Refuse

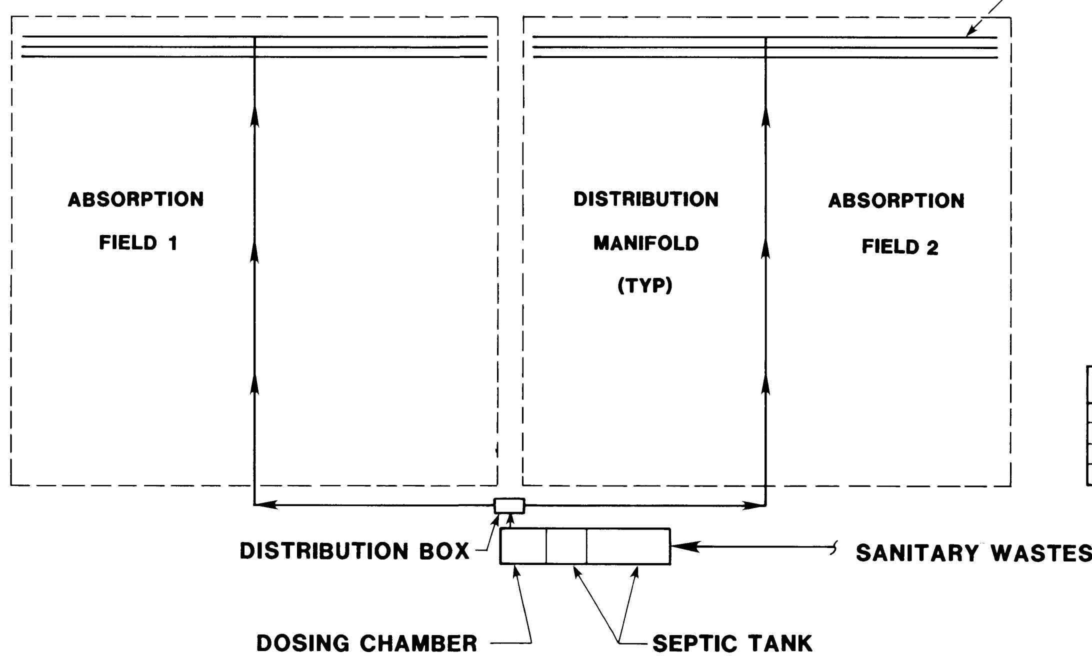
The refuse normally generated by mine/mill operations will consist of wear related products, such as metal, rubber, wood, and lubricants, as well as the daily trash and garbage typical of an industrial workforce.



LEGEND

LSL – LEVEL SWITCH LOW
LSH – LEVEL SWITCH HIGH
LAH – LEVEL ALARM HIGH
LSHH – LEVEL SWITCH HIGH HIGH

EXXON MINERALS COMPANY CRANDON PROJECT					
TITLE: CONCEPTUAL SEPTIC TANK SYSTEM PROCESS DIAGRAM					
SCALE: NONE		STATE: WISCONSIN		COUNTY: FOREST	
DRAWN BY: C.A. HACKER	DATE: 8/82	CHECKED BY:		DATE:	
APPROVED BY: C.E. Fowler	DATE: 24 AUG 82	APPROVED BY: C.E. Fowler		DATE: 10/26/82	
APPROVED BY:	DATE:	EXXON		DATE:	
DRAWING NO: FIGURE 1.4-19		SHEET 1 OF 1		REVISION NO. 0	



TOTAL FIELD AREA WILL DEPEND ON SOIL CLASS IN WISCONSIN CODE H63.10
ASSUME EACH FIELD 1/2 REQUIRED AREA
DAILY FLOW 173.8m^3 (46,000 ga.)

SOIL CLASS	PERCOLATION RATE MIN/IN	TOTAL REQUIRED AREA OF FIELDS m2 (ACRES)
1	0 TO 10	3561 (0.88)
2	10 TO 30	5342 (1.32)
3	30 TO 40	5949 (1.47)
4	45 TO 60	10684 (2.64)

NOTE:

STATE CODE REQUIRES AN EQUIVALENT AREA AVAILABLE FOR REPLACEMENT OF THE ABSORPTION FIELD

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
TYPICAL SEPTIC TANK SYSTEM PRESSURE DISTRIBUTION SCHEMATIC PLAN

SCALE NONE	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY C A HACKER	DATE 8/82	CHECKED BY		DATE	
APPROVED BY C.E. Fowler	DATE 24AU482	APPROVED BY C E Fowler		DATE 10/26/82	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 1.4-20**		SHEET 1 OF 1		REVISION NO. 0	

Each year, large quantities of scrap metal 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 on a periodic basis it will be sorted and sold to a scrap metal contractor.

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, most of the scrap rubber will require off-site disposal.

The scrap wood materials and the trash and garbage will be collected in proper containers throughout the facilities, including the underground mine. This waste material will then be transported to a central point and compacted, and will then be removed from the mine/mill site to an off-site landfill disposal area in the Town of Nashville.

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 and fluids 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.

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 quantities of these fuels required are shown in Table 1.4-8.

Electrical power will be used to operate all process equipment, ancillary facilities, waste disposal facilities, 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 24 km (14.9 miles) west of the mine/mill site, and a 115 kv transmission line will be constructed by WPSC from this source to the mine/mill site.

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 13 km (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 mine 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.

TABLE 1.4-8

FUEL AND ENERGY REQUIREMENTS DURING OPERATION*

	Estimated Daily Peak	Estimated Yearly Average
Diesel Fuel	21,015 l (5,552 gallons)	5,277,525 l (1,394,176 gallons)
Gasoline	473 l (125 gallons)	170,280 l (44,983 gallons)
Natural Gas - Winter	49,843 m^3 (1,760,000 cubic feet)	712,276 m^3 (251,510,000 cubic feet)
- Summer	850 m^3 (30,000 cubic feet)	
Electrical Power	880,000 kwh	253,440,000 kwh

*The fuel and energy requirements for the Crandon Project as shown in this table are estimated only. The actual quantities shown may change with actual type of equipment utilized, variances in operating schedules, and other factors.

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.

1.4.9 Pollution Control, Emissions and Effluents

Potential air emissions, noise levels, and soil erosion will be controlled during operation 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. The dust control systems will utilize reliable and effective technology. Selections of baghouses and scrubbers to control emissions from the surface mine/mill operations were based upon the physical characteristics of the particulates. Baghouses were specified where the captured material was fine and could be returned directly to the process. Scrubbers were employed where the collected material would be recycled directly to the wet process. Baghouses located in a building will be provided with adequate dewpoint controls and heaters to prevent bag blinding during varying climatic conditions. Similarly, scrubbers located outside of the building will also be provided with heaters to assure continuous operation during freezing weather.

Air Emissions - Projected operational air emissions, proposed control techniques, and control efficiencies are presented in Table 1.4-9. A comparison of emissions from Project surface facilities to State of Wisconsin allowable emission rates is presented in Table 1.4-10.

Ore handling and crushing, vehicle travel, and fuel transfer and storage constitute the major air emission sources from surface facility operations. All potential air emission sources will have reliable and effective controls.

To contain dust, conveyors used to transport ore and waste rock will operate inside covered galleries, or will be housed within a building.

TABLE 1.4-9

ESTIMATED AIR CONTAMINANT EMISSION RATES BY SPECIFIC SOURCES DURING OPERATION

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL CONTROLLED COMPONENT EMISSION RATES kg/h	(Pounds per hour)	kg/d	(Pounds per day)	t/y	(Short tons per year)
MINE/MILL OPERATIONS (Surface facilities)								
Stationary Sources								
Coarse Ore Transport to Headframe	TSP	Wet scrubber - 99.5%	.26	(.57)	6.2	(13.7)	.8	(.9)
	Pb		.01	(.017)	.19	(.42)	.02	(.02)
Coarse Ore Storage Building	TSP	Conveyor enclosure wet scrubber 99.5%	.26	(.57)	6.2	(13.7)	.8	(.9)
	Pb		.005	(.011)	.12	(.26)	.01	(.01)
Surge Bins to Sec. & Tert. Crush. & Screening	TSP	Passive bin filter 90%	.64	(1.4)	12.5	(27.5)	3.2	(3.5)
	Pb		.01	(.03)	.20	(.43)	.04	(.04)
Sec. & Tert. Crush. & Screening	TSP	Conveyor enclosure wet scrubber - 99.4%	11.9	(26.2)	197	(435.0)	61.6	(67.9)
	Pb		.13	(.29)	2.2	(4.85)	.68	(.75)
Fine Ore Crushing Transfer Tower	TSP	Conveyor enclosure wet scrubber - 99.5%	.16	(.35)	3.1	(6.9)	.8	(.88)
	Pb		.003	(.007)	.06	(.14)	.01	(.01)
Zn-Cu-Pb Fine Ore Bin Loading	TSP	Conveyor enclosures wet scrubber - 99.4%	.07	(.15)	1.3	(2.9)	.35	(.39)
	Pb		.001	(.002)	.02	(.04)	.01	(.01)
Cu-Zn Fine Ore Bin Loading	TSP	Conveyor enclosures wet scrubber - 99.4%	.06	(.13)	1.1	(2.5)	.29	(.32)
	Pb		.0001	(.0002)	.002	(.004)	.0005	(.0006)
Zn-Cu-Pb Fine Ore Bin Unloading	TSP	Conveyor enclosures wet scrubbers - 99.4%	.07	(.15)	1.6	(3.6)	.55	(.61)
	Pb		.001	(.002)	.02	(.05)	.01	(.011)
Cu-Zn Fine Ore Bin Unloading	TSP	Conveyor enclosures Wet scrubber - 99.4%	.05	(.11)	1.2	(2.6)	.45	(.50)
	Pb		.0001	(.0002)	.002	(.005)	.001	(.001)
Milk of Lime Facilities	TSP	Conveyor enclosures wet scrubber - 98.6%	.70	(1 .54)	4.9	(20.8)	1.3	(1 .43)
Reagent Mixing Area	TSP	Wet scrubber - 98% passive filters - 90%	.08	(.17)	1.8	(4.0)	.63	(.69)

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL CONTROLLED COMPONENT EMISSION RATES kg/h	(Pounds per hour)	kg/d	(Pounds per day)	t/y	(Short tons per year)
Concentrate Handling and Shipping	TSP	Conveyor transfer enclosures wet scrubber (3) - 99.4%	0.04	(0.08)	0.83	(1.82)	0.29	(0.32)
	Pb		0.001	(0.002)	0.02	(0.04)	0.006	(0.007)
Backfill System	TSP	Waste handling baghouse - 99.6% Cement storage tank passive filter - 90%	0.67	(1.48)	5.7	(12 .5)	1.6	(1 .8)
Waste Rock Bins and Loadout	TSP	Conveyor enclosures baghouse - 99.6% Water sprays - 95%	0.94	(2.07)	2.82	(6.21)	0.76	(0.84)
Waste Rock Crushing Plant	TSP	Conveyor baghouse - 99.5%	0.08	(0.17)	1.5	(3.22)	0.86	(0.94)
Concrete Batch Plant	TSP	Baghouse on mix truck loading hopper and silo filter vents - 90%	0.13	(0.28)	1.02	(2.2)	0.26	(0.29)
Mine/Mill Surface Facilities Heating	TSP	Use of clean burning natural gas	0.42	(0.92)	9.93	(21.9)	1.32	(1.46)
	SO_2		0.03	(0.06)	0.59	(1.3)	0.08	(0.09)
	NO_x		5.01	(11.04)	119.2	(262.8)	15.9	(17.5)
	CO		0.83	(1.84)	19.9	(43.8)	2.65	(2.92)
	HC		0.34	(0.74)	7.94	(17.5)	1.06	(1.17)
Fuel Trans. & Stor. Bulk Storage Fac.	HC	Vapor balance on loading systems - 95%	N/A[a]		0.17	(0.38)	0.061	(0.067)
Service Station	HC		N/A		2.37	(5.23)	0.83	(0.91)
Emergency Diesel Generators	TSP	Emergency use only	6.5	(14.3)	156.0	(343.9)	N/A	
	SO_2		6.0	(13.2)	144.0	(317.5)	N/A	
	NO_x		90.2	(199.0)	2164.8	(4772.6)	N/A	
	CO		19.4	(42.8)	465.6	(1026.5)	N/A	
	HC		7.2	(15.9)	172.8	(381.0)	N/A	

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	kg/h	(Pounds per hour)	kg/d	(Pounds per day)	t/y	(Short tons per year)
			TOTAL CONTROLLED COMPONENT EMISSION RATES					
MINE/MILL OPERATIONS (Surface Facilities)								
Mobile Sources								
Vehicular Travel Plant Vehicle Exhaust	TSP	Federal vehicular emission standards	N/A		3.09	(6.81)	1.08	(1.19)
	SO_2		N/A		5.93	(13.08)	2.08	(2.29)
	NO_x		N/A		49.5	(109.1)	17.3	(19.1)
	CO		N/A		138.5	(305.4)	48.5	(53.4)
	HC		N/A		19.2	(42.3)	6.72	(7.40)
Vehicular Travel Employee Vehicles	TSP	Federal vehicular emission standards	N/A		.68	(1.5)	.24	(.26)
	SO_2		N/A		.26	(.57)	.10	(.11)
	NO_x		N/A		9.2	(20.3)	3.2	(3.5)
	CO		N/A		73.8	(162.7)	25.9	(28.5)
	HC		N/A		9.6	(21.2)	3.4	(3.7)
Locomotive Exhaust Emissions	TSP		2.5	(5.5)	15.0	(33.1)	5.18	(5.70)
	SO_2		.93	(2.1)	5.58	(12.3)	1.9	(2.0)
	NO_x		18.0	(39.7)	108.0	(238)	37.4	(41.2)
	CO		2.3	(5.1)	13.8	(30.4)	4.8	(5.3)
	HC		.39	(.86)	2.34	(5.16)	.81	(.89)
Fugitive Sources								
Total Road Dust Emissions	TSP	Paving	N/A		27.6	(60.9)	9.7	(10.7)

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL CONTROLLED COMPONENT EMISSION RATES kg/h	(Pounds per hour)	kg/d	(Pounds per day)	t/y	(Short tons per year)
MINE OPERATIONS								
Drilling & Blasting	TSP	Residence settling and the humid mine environment - 95%	310.0	(683.4)	372.0	(821.0)	8.2	(9.0)
	SO_2		4.2	(9.3)	50.0	(110.0)	2.4	(2.7)
	NO_x		33.6	(74.1)	420.0	(926.0)	19.3	(21.3)
	CO		142.8	(314.8)	1800.0	(3968.0)	82.0	(90.4)
	Pb		5.8	(12.9)	7.0	(15.4)	.15	(.17)
Mine Air Heating	TSP	Use of clean burning natural gas	.77	(1.7)	18.4	(40.5)	.69	(.76)
	SO_2		.045	(.1)	1.1	(2.4)	.04	(.05)
	NO_x		9.2	(20.3)	220.0	(486.0)	8.3	(9.1)
	HC		.61	(1.4)	14.7	(32.4)	.55	(.61)
	CO		1.5	(3.4)	36.8	(81.0)	1.4	(1.5)
Mine Mobile Vehicles	TSP	Clean burning engines catalytic scrubbers	1.2	(2.6)[b]	22.6	(49.8)	5.2	(5.7)
	SO_2		3.3	(7.2)[b]	63.6	(140.3)	14.6	(16.1)
	NO_x		11.4	(25.2)[b]	222.8	(491.2)	51.0	(56.2)
	HC		.2	(.46)[b]	4.0	(8.9)	.9	(1.0)
	CO		.2	(.46)[b]	4.1	(9.1)	.9	(1.0)

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL CONTROLLED COMPONENT EMISSION RATES kg/h	(Pounds per hour)	kg/d	(Pounds per day)	t/y	(Short tons per year)
MINE WASTE DISPOSAL FACILITY								
Fugitive Sources								
Windblown								
Haul Road	TSP	Speed control and chemical stabilization if necessary - 85%	N/A		N/A		0.729	(0.804)
Disposal Area	TSP	Watering	N/A		N/A		5.062	(5.58)
Support Area	TSP	Speed control and chemical stabilization if necessary - 85%	N/A		N/A		0.128	(0.141)
Truck Hauling	TSP	Watering						
Till to Dike and Storage	TSP	Speed control	N/A		N/A		21.709	(23.93)
Waste Rock to Tailings Area	TSP	Speed control and chemical stabilization if necessary - 85%	N/A		N/A		2.195	(2.42)
Bentonite to Batch Plant	TSP	Speed control and chemical stabilization if necessary - 85%	N/A		N/A		1.388	(1.53)
Till/Bentonite Mixture from Batch Plant to Pond	TSP	Watering	N/A		N/A		7.022	(7.74)
Underdrain Material from Support Area to Pond	TSP	Watering	N/A		N/A		6.967	(7.68)
Filter Material from Support Area to Pond	TSP	Watering	N/A		N/A		8.110	(8.94)
Rip-Rap from Support Area to Pond	TSP	Watering	N/A		N/A		8.963	(9.88)

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL CONTROLLED COMPONENT EMISSION RATES kg/h	(Pounds per hour)	kg/d	(Pounds per day)	t/y	(Short tons per year)
MINE WASTE DISPOSAL FACILITY (Continued)								
Loading								
Pond Excavation with Scraper	TSP			N/A		N/A	252.53	(278.37)
Loading Till into Batch Plant and Processing Plant	TSP	Minimize drop height		N/A		N/A	4.87	(5.37)
Loading Underdrain Filter Material and Rip-Rap	TSP	Minimize drop height		N/A		N/A	8.72	(9.61)
Dumping								
Till and Bentonite Mixture in Pond	TSP			N/A		N/A	1.89	(2.08)
Waste Rock at Stockpile	TSP			N/A		N/A	1.12	(1.23)
Underdrain, Filter Material and Rip-Rap	TSP			N/A		N/A	6.48	(7.14)
Mobile Sources								
Tailpipe Emissions								
Diesel	TSP		8.93	(19.69)	116.02	(255.78)	12.52	(13.80)
	SO_2		7.03	(15.50)	91.40	(201.50)	9.86	(10.87)
	NO_x		85.33	(188.11)	1,109.20	(2445.37)	119.66	(131.90)
	CO		25.47	(56.15)	331.10	(729.95)	35.72	(39.37)
	HC/VOC		12.79	(28.20)	166.29	(366.60)	17.94	(19.77)
Gasoline	TSP	Catalytic converter (on trucks)	0.068	(0.149)	0.86	(1.9)	0.094	(0.104)
	SO_2		0.009	(0.020)	0.12	(0.258)	0.013	(0.014)
	NO_x		0.180	(0.397)	2.34	(5.158)	0.252	(0.278)
	CO		0.827	(1.823)	10.75	(23.70)	1.159	(1.278)
	HC/VOC		0.132	(0.292)	1.72	(3.797)	0.186	(0.205)

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL CONTROLLED COMPONENT EMISSION RATES kg/h	(Pounds per hour)	kg/d	(Pounds per day)	t/y	(Short tons per year)
MINE WASTE DISPOSAL FACILITY (Continued)								
Stationary Sources								
Liner Batch Plant	TSP	Enclose dumping areas and vent to filters - 90%	N/A		N/A		0.925	(1.02)
Soil Processing Plant	TSP	Emissions vented to bag-house - 99.6%	N/A		N/A		0.025	(0.028)

[a] Not applicable.

[b] These values do not occur at the same time as blasting and should not be included in hourly totals.

TABLE 1.4-10

COMPARISON OF ESTIMATED STATIONARY SOURCE AIR EMISSION RATES WITH STATE OF WISCONSIN ALLOWABLE EMISSIONS FROM THE MINE/MILL SURFACE FACILITIES

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL EMISSION RATES kg/h	TOTAL EMISSION RATES (pounds per hour)	ALLOWABLE EMISSIONS kg/h	ALLOWABLE EMISSIONS (pounds per day)
Stationary Sources						
Coarse Ore Transport to Headframe	TSP	Wet scrubber - 99.5%	.26	(.57)	24.0	(53.0)
	Pb		.01	(.017)		
Coarse Ore Storage Building	TSP	Conveyor enclosure wet scrubber 99.5%	.26	(.57)	24.0	(53.0)
	Pb		.005	(.011)		
Surge Bins to Sec. & Tert. Crush. & Screening	TSP	Passive bin filter 90%	.64	(1.4)	17.2	(38.0)
	Pb		.01	(.03)		
Sec. & Tert. Crush. & Screening	TSP	Conveyor enclosure wet scrubber - 99.4%	11.9	(26.2)	22.3	(49.0)
	Pb		.13	(.29)		
Fine Ore Crushing Transfer Tower	TSP	Conveyor enclosure wet scrubber - 99.5%	.16	(.35)	22.3	(49.0)
	Pb		.003	(.007)		
Zn-Cu-Pb Fine Ore Bin Loading	TSP	Conveyor enclosures wet scrubber - 99.4%	.07	(.15)	20.3	(44.7)
	Pb		.001	(.002)		
Cu-Zn Fine Ore Bin Loading	TSP	Conveyor enclosures wet scrubber - 99.4%	.06	(.13)	19.6	(43.3)
	Pb		.0001	(.0002)		
Zn-Cu-Pb Fine Ore Bin Unloading	TSP	Conveyor enclosures wet scrubbers - 99.4%	.07	(.15)	18.9	(41.6)
	Pb		.001	(.002)		
Cu-Zn Fine Ore Bin Unloading	TSP	Conveyor enclosures wet scrubber - 99.4%	.05	(.11)	18.3	(40.3)
	Pb		.0001	(.0002)		
Milk of Lime Facilities	TSP	Conveyor enclosures wet scrubber - 98.6%	.70	(1.54)	15.0	(32.9)
Reagent Mixing Area	TSP	Wet scrubber - 98% passive filters - 90%	.08	(.17)		

Table 1.4-10 (continued)

EMISSION SOURCE	COMPONENT	CONTROL MEASURES AND EFFICIENCY	TOTAL EMISSION RATES kg/h	TOTAL EMISSION RATES (pounds per hour)	ALLOWABLE EMISSIONS kg/h	ALLOWABLE EMISSIONS (pounds per day)
Concentrate Handling and Shipping	TSP	Conveyor transfer enclosure wet scrubber (3) 99.4%	.04	(.08)	25.9	(57.1)
	Pb		.001	(.002)		
Backfill System	TSP	Waste handling baghouse - 99.6% Cement storage tank passive filter - 90%	.67	(1.48)	18.1	(39.8)
Waste Rock Bins and Loadout	TSP	Conveyor enclosures baghouse - 99.6% Water sprays - 95%	.94	(2.07)	24.2	(53.3)
Waste Rock Crushing Plant	TSP	Conveyor baghouse - 99.5%	.08	(.17)	17.8	(39.2)
Concrete Batch Plant	TSP	Baghouse on mix truck loading hopper and silo filter vents - 90%	.13	(.28)	10.9	(24.0)
Mine/Mill Surface Facilities Heating	TSP	Use of clean burning natural gas	.42	(.92)		
	SO_2		.03	(.06)		
	NO_x		5.01	(11.04)		
	CO		.83	(1.84)		
	HC		.34	(.74)		
Fuel Trans. & Stor. Bulk Storage Fac.	HC	Vapor balance on loading systems - 95%	N/A*			
Service Station	HC		N/A			
Emergency Diesel Generators	TSP	Emergency use only	6.5	(14.3)		
	SO_2		6.0	(13.2)		
	NO_x		90.2	(199.0)		
	CO		19.4	(42.8)		
	HC		7.2	(15.9)		

* Not Applicable

Material transfer points will be enclosed and exhausted through appropriately-sized dust collection hoods and systems.

Baghouses will be used to control dust emissions from the crushed backfill waste rock storage tank and waste rock surge bins, and the entire waste rock crushing plant. The dust collection efficiencies of these baghouses will normally exceed 99 percent. Dust from the baghouses will be recycled to the appropriate process. Passive bin filter vents will be used to control dust emissions from the fine ore crushing and screening surge bins, and from the cement storage tanks. In addition, wet scrubbers will be used to control dust emissions in the coarse ore storage area, fine ore crushing and screening area, and fine ore bin discharge with dust collection efficiencies exceeding 99 percent. Slurried dust will be returned to the processing circuit. Flotation is a wet process and will not present dust emission problems.

Estimated air emission rates listed in Table 1.4-9 for ore or waste rock handling and crushing are an order of magnitude less than the allowable emission rates set by the State of Wisconsin, Department of Natural Resources, April 1972 (Table 1.4-10). The largest controlled dust emission rate (from the secondary and tertiary crushing and screening) constitutes only 53 percent of the corresponding allowable emission rate.

To minimize potential dust emissions from zinc, copper, and lead concentrate handling, dust collection systems will be used, if required, for each concentrate loadout circuit. Each collection system would consist of ventilation hoods, ducting, and a wet scrubber to control dust emissions during concentrate loadout to railcars. These scrubbers will have a collection efficiency exceeding 99 percent. All collected material will be returned to the process.

Burnt pebble lime will be stored and processed within a separate facility. To minimize potential dust emissions from this facility, dust collection hoods and ducting will be used to exhaust the inlet hopper, bucket elevator, storage bins, and slaked lime inlet conveyor through a wet scrubber. This scrubber will have a collection efficiency exceeding 98 percent. Collected material will be returned to the process.

Transfer and storage of fuels will occur primarily at the 190 m^3 (50,000 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.

A soda ash scrubber will be used to control SO_2 exhausted during handling of reagents. In addition, filtered vents and a wet scrubber will be used to control dust and fumes from the reagent mixing area. Slurry from the wet scrubber will be pumped to the tailing sump. The particulate emissions rate from this area will be 1.8 kg/d (4 pounds per day). A tabulation of air emissions from the reagent area is presented in Table 1.4-9.

Estimated air emissions resulting from surface support diesel-powered equipment use are summarized in Table 1.4-9. While construction of the mine waste disposal facility (MWDF) will be conducted sequentially, it was conservatively assumed that emissions from the MWDF construction would occur continuously during operation of the mine/mill facilities. As all of the ponds will be constructed in a similar manner, the emissions presented in subsection 1.3.5 for the initial tailing pond construction are also contained in the operational emission values.

Air emission controls that will be used during construction of the initial tailing pond will continue to be used in the construction of subsequent ponds during operation. All roadways and excavation sites will be watered 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 emissions from haulage vehicles and minimizing drop distances will reduce loading and dumping emissions. 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 passive filter vents. 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.

The underground mine 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 Table 1.4-9.

Noise Emissions - The U.S. EPA (1972) employs the day-night noise level (L_{dn}) to provide a single number for measurement of community noise exposure on a daily basis (see Chapter 2.0, Section 2.8). The EPA outdoor guideline is L_{dn} 55 dBA. The L_{dn} levels at the Project boundary are estimated to be 55 dBA or less during operation.

An estimate of the noise emanations has shown that industrial noise levels will be within the Occupational Safety and Health Administration (OSHA) Industrial Noise Code, Section 1910.95, 8-hour standard of 90 dBA. Localized areas in the mill, not requiring continuous presence of personnel, may have noise levels of 95 dBA, the MSHA 4-hour/day standard. Noise levels from the various sources within the mine/mill site are summarized in Table 1.4-11.

During mine operations, the highest surface noise levels will be emitted from the main mine exhaust fans. The main mine exhaust fans will be located on the surface at the west exhaust raise and at the east exhaust raise. These fans will operate 24 hours per day, 7 days per week. Actual fan loads will vary with the demand for air in the mine.

A locomotive will be used for moving railcars of concentrate and materials for the reagent and concrete batch plants. Noise emission levels will be approximately 85 dBA at a distance of 20 m (65.6 feet) from the locomotive and will be intermittent.

Air compressors will be housed in a separate building and will have noise levels at the building exterior well within acceptable levels, approximately 65 dBA at a distance of 1 m (3.28 feet) from the outside of the building. Emergency generators to provide electrical power during outages will operate intermittently. These generators will be housed in an enclosed building with an external discharge for diesel exhaust. Noise levels during emergency generator operation will not exceed 70 dBA at a distance of 1 m (3.28 feet) from the building exterior.

TABLE 1.4-11

SUMMARY OF NOISE SOURCES DURING OPERATION OF THE MINE/MILL

OPERATIONS UNIT DESCRIPTION	ESTIMATED MAX. NOISE LEVEL dBA*	PERIOD OF OPERATION (hours/day)
Mine Operations		
Air Compressors (each)	90	24
Emergency Generator (2000 KW) (ea.)	90	Intermittent
Emergency Generator (1000 KW) (ea.)	90	Intermittent
Mine Shaft Ventilation System	89	24
Air Intake Ventilation System	89	24
Ore Transport Drive Motor	90	24
Mine Elevator Drive Motor	90	24
Mine Exhaust Fans	103	24
Mill Operations		
Coarse Ore Transport and Fine Crushing	61 - 95	14 - 24
Grinding and Flotation	75 - 95	24
Concentrate Loadout	75 - 85	24
Fine Tailings Thickening and Transport	75	24
Reagent Receiving, Storage and Use	75 - 90	7

*Noise level 1 m (3.28 feet) from noise source.

Erosion Control (Operational Drainage) - The measures employed to control erosion which will be incorporated during construction of the mine/mill are presented in the mining permit application Reclamation Plan. 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 rainwater runoff during mine/mill operations include retention barriers to contain mine/mill site stormwater. These barriers, established during the construction phase, are formed by the roads, railroad, and special runoff retention barriers which direct surface water drainage to retention basins located at the perimeter of the mine/mill site. The retention basins allow settling of suspended materials and slow discharge from both percolation and outfall piping.

Runoff water from the area around the equipment maintenance shop will be captured and passed through an interceptor for removal of oil and solids. The wastewater will be treated in the water treatment facility. Collected waste oil will be disposed of off-site at an approved facility.

Water Treatment - The water treatment system for the Project is described in subsection 1.4.5. The system will treat water pumped from the mine and sufficient water from the reclaim pond to control scaling in the mill water circuit. It is anticipated that an average of 0.111 m^3/s (1,762 gallons per minute) will require treatment. Chemical reagents to be used in the water treatment system are discussed in subsections 1.4.3.7 and 1.4.5.2. The primary use of the reagents in the water treatment process and the approximate rate of consumption are presented in Table 1.4-4. Treated water will be used as the makeup water for the mill to the maximum extent possible, excess treated 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; carbonate precipitaton (lime-soda softening); pH adjustment; mixed media filtration; reverse osmosis; vapor compression evaporation; and evaporator/crystallizer.

Treated water 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.

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 up to 0.119 m^3/s (1,893 gallons per minute). The excess water will be pumped and transported via pipeline to Swamp Creek for discharge downstream from County Road M. A plan view and cross-section of the discharge structure are shown in Figure 1.2-18. The quality of the water to be discharged will meet the effluent limitations for that discharge location as developed by the DNR.

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 of with the tailings. The sodium sulfate product, if the product meets specifications, could be marketed to kraft paper mills. Alternatively, the material could be placed in a secure landfill.

Water Discharge Sources - There will be three sources of water discharge: (1) effluent from the water treatment plant, (2) any seepage from the reclaim and tailing ponds, and (3) effluent from the sanitary wastewater treatment plant. The environmental loading factors to surface and ground water that would occur during operational phases 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 in Figure 1.4-7.

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 given in the Mine Waste Disposal Feasibility Report (Appendix 1.2A).

Reclaim and Tailing Ponds - Some discharge or seepage will occur from the two reclaim and four tailing ponds. It is estimated that the maximum rate of seepage from the tailing ponds and reclaim ponds will be 0.0013 m^3/s (20 gallons per minute) 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 0.0032 m^3/s (50 gallons per minute) and then decline to an eventual steady state seepage of approximately 0.0011 m^3/s (17 gallons per minute). 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 174 m^3/d (46,000 gallons per day). An estimate of the TSS and BOD loadings is presented in Table 1.4-12. The sanitary sewage system will consist of a septic tank, dosing chamber, and soil absorbtion field as described in subsection 1.2.4.5. Operation of the system is discussed in subsection 1.4.8.2.

TABLE 1.4-12

CRANDON PROJECT
ESTIMATED SANITARY WASTEWATER LOADINGS

Parameter	mg/l	kg/person/day	kg/day	lb/day
TSS	367	0.07	62.2	137
BOD	357	0.07	62.2	137

Source: CH2M Hill Inc. (1982)

1.4.10 Operations Personnel

The Project will employ an estimated total of 780 people at full production. Only 6 percent of the work force will be classified as "unskilled." This category includes jobs such as laborers, janitors, and warehouse attendants. Most of the work force will be in the "skilled" category, which includes personnel trained as mechanics, equipment operators, miners, technicians, and clerks. A group of 35 individuals will comprise the non-managerial professional work force. These employees will hold jobs such as accountants and engineers. The supervisory/managerial staff consists of jobs ranging from project manager to production and mechanical supervisors. Where feasible and to maximum extent practicable, employees will be drawn from the local labor force.

Type of Personnel	Administrative Staff	Mill	Mine	Total
Unskilled	10	25	15	50
Skilled	45	165	410	620
Professional	15	10	10	35
Supervisory/Managerial	10	20	45	75
TOTAL	80	220	480	780

The Project will operate on a three shift schedule. Below is the estimated number of personnel assigned to each shift. (A number of personnel will be working shifts which include weekends. Therefore, the numbers presented on the next page do not add to the 780 total.)

Shift	Administrative Staff	Mill	Mine	Total
Day	65	120	195	380
Afternoon	8	40	145	193
Night	7	30	135	172

A more detailed description of the work schedule for specific operations is contained in subsection 1.1.3.3.

1.4.11 References Cited

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Sax, M. Irving, 1979, Dangerous properties of industrial materials (5th ed.).

U.S. Department of Agriculture, Soil Conservation Service, 1975, Standards and specifications for soil erosion and sediment control in developing areas: College Park, Maryland.

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1.5 FACILITIES CLOSURE

The useful economic life of the Project is estimated to be approximately 26 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 7 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.

Backfill placed in stopes as a part of the normal mining sequence will prevent surface subsidence which could otherwise potentially be caused by caving of abandoned openings. 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 late in the mine life will be performed and suitably documented and will specifically address the question of stability of mine workings upon abandonment of the underground portions of the mine facilities. 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, particular attention will be directed, prior to termination of mining, to the area of preventing surface subsidence.

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.

Finally, the underground mine pumps will be shut down and removed, and the mine will flood with water. Once flooding is complete, the hydraulic gradient will be restored to that which existed prior to the beginning of mining, and no flow through the mine workings will be possible.

All shafts to surface will be sealed with concrete plugs supported by structural steel beams constructed at the bottoms of the collar sections, or at top of competent bedrock. These plugs will be connected to the shaft linings so that they are completely supported on competent rock. The steel will be entirely encased in concrete to prevent rusting.

The portions of the shafts above the plugs will be stripped of steel and cables, and filled with overburden material.

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 landscaped and revegetated.

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. Landscaping during this period is 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, site revegetation will be undertaken, as needed, 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 initiating invasion into cleared areas. Seed colonies located on the perimeter and in the interior of the mine/mill site will promote the natural invasion of 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 non-competing vegetative ground cover 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 will be the source of the invading plants.

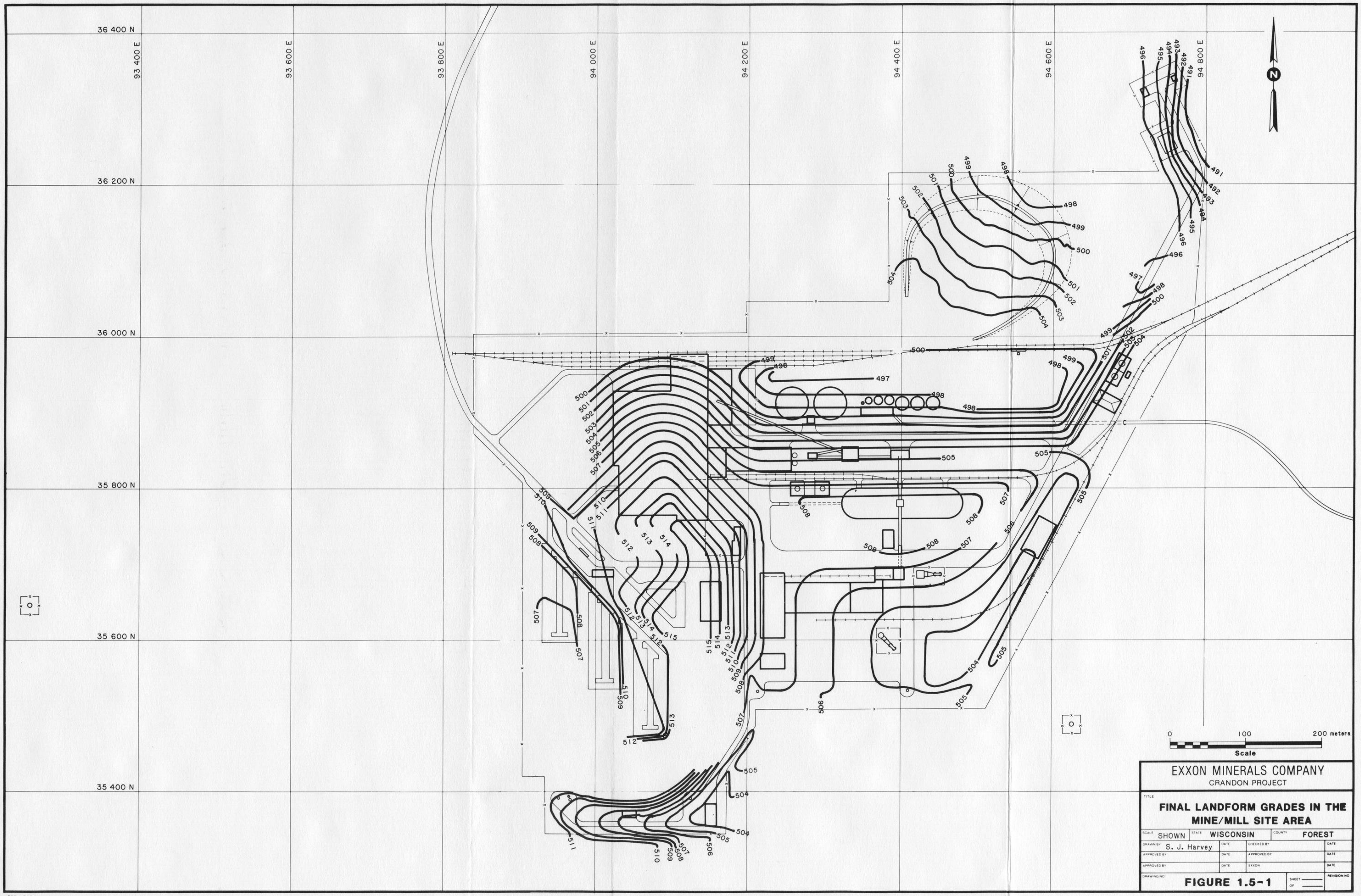
Within the mine/mill site area, approximately 32 ha (80 acres) will be regraded to meet backfill and earthern cover requirements. During regrading, existing vegetation will be preserved and existing drainage features and retention basins will be maintained. Building foundations and other Project features not removed following facilities closure will be covered with a minimum of 0.6 m (2 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 grades of landforms within the mine/mill site are shown in Figure 1.5-1. These grades will allow surface runoff to drain into the retention basins before release.

Upon completion of the facilities removal and regrading phases, disturbed areas will be seeded with legumes and grasses to provide erosion control. 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.

Additional reclamation information is presented in the Reclamation Plan.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EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
FINAL LANDFORM GRADES IN THE MINE/MILL SITE AREA
SCALE SHOWN
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COUNTY FOREST
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1.5.3 Waste Disposal Facilities Reclamation

The reclamation plan for the waste disposal facilities 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 (Figure 1.4-14).

The specific erosion control and reclamation procedures during construction, operation, and abandonment of the waste disposal facilities are presented in the Reclamation Plan. The plan includes a discussion of the earthwork and staged construction, physical aspects of reclamation, and a description of revegetation of the disposal facility. Engineering erosion control techniques and vegetation control techniques that will be used during the various phases of reclamation are also presented in the plan.