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ON OGLEBAY NORTON'S PLANNED EXPANSION PROJECT

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DRAFT ENVIRONMENTAL IMPACT STATEMENT ON OGLEBAY NORTON'S PLANNED EXPANSION PROJECT

PREPARED BY

THE MINNESOTA DEPARTMENT OF NATURAL RESOURCES
AND THE MINNESOTA POLLUTION CONTROL AGENCY

NOVEMBER 1975

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Acknowledgment

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FOREWORD

Oglebay Norton Company (Oglebay) is a Cleveland based, Delaware corporation which has been engaged in the mining and sale of iron ore from Minnesota, Wisconsin and northern Michigan since 1854, has been engaged in the mining and beneficiation of taconite as Managing Agent and part owner (15%) of Eveleth Taconite Company since 1965, and holds rights to other ore reserves in Minnesota and Wisconsin. Oglebay and its wholly-owned subsidiaries also, for many years, have been engaged in the mining of coal and silica sand in Ohio and West Virginia, the transportation of iron ore, coal, and other bulk products on the Great Lakes by its fleet of eighteen vessels, the manufacture of hot tops and other products for the steel industry, and the production of gray iron foundry castings.

Oglebay obtained its first major option for a taconite mining lease in 1960, covering lands in what is now the Thunderbird Mine. Thereafter options and leases of additional taconite reserves in the Thunderbird mine area were acquired, the participation in the Eveleth Taconite project by Ford Motor Company as owner of an 85% interest was arranged (Oglebay retaining a 15% interest), Eveleth Taconite Company was formed, and in 1964 construction of the Thunderbird Crusher west of Eveleth and the Fairlane Plant at Forbes, Minnesota, was commenced. The first iron ore pellets were shipped from the Fairlane Plant in 1965. The production rate has since been increased from the original 1.6 million tons of pellets annually to the present approximately 2.4 million tons by a series of improvements in and additions to the production facilities. As of December 31, 1974, 52,017,484 tons of crude ore had been mined from the Thunderbird Mine and 17,438,216 tons of pellets had been produced by crushing, grinding, concentration and agglomeration at the Fairlane Plant.

In 1966, Oglebay obtained an option for a taconite lease covering approximately 560 acres of taconite lands south of Eveleth (the Troy area), some two miles from the present Thunderbird Mine, for the purpose of providing taconite reserves for either an entirely new project or an expansion of the Eveleth Taconite Company facilities. Negotiations were carried on with potential participants over the next several years, and concurrently Oglebay was acquiring and negotiating for additional mining leases to fill out

the lands under its control south of Eveleth to an economically attractive mining bloc. In December, 1973, letters of intent were signed by the participants for the development of the Troy area mine and the construction of additions to the taconite processing facilities at Forbes to produce 3.6 million tons of taconite pellets annually (the project). The participants are The Steel Company of Canada, Limited (23.5%), Dominion Foundries and Steel, Limited (16.0%), Armco Steel Corporation (40.0%) and Oglebay (20.5%).

Eveleth Expansion Company, a Minnesota partnership, composed of subsidiary corporations of the four participants was formed in 1974; and in December, 1974, Eveleth Expansion Company acquired title to lands and easements in the Fairlane Plant area and acquired the mining leases of lands in the Troy area from Eveleth Taconite Company and Oglebay, respectively. At the same time certain management agreements were entered into, under which Oglebay will manage the construction and operation of the Eveleth Expansion Company facilities and will continue to manage the operation of the Eveleth Taconite Company facilities. The combined rate of production will approximate six million tons of pellets annually. Under the Eveleth Expansion Company's partnership agreement, each participant is entitled to its pro-rata share of the pellets produced by the partnership. Ford Motor Company and Oglebay will continue to receive their respective shares of the production of Eveleth Taconite Company, as shareholders thereof.

Concurrently with the completion of the formation of the partnership and the acquisition of title to the project, agreements for the financing of the project by a group of insurance companies were completed. In December, 1974, a First Mortgage Indenture by Eveleth Expansion Company was executed and recorded in the office of the Register of Deeds in and for St. Louis County, Minnesota; and a first closing was held in New York, at which $50,000,000 was borrowed to reimburse the partnership for funds previously expended in the construction of the project.

After extensive preliminary engineering and site investigation which was commenced in 1973, clearing for and construction of the Troy area primary crushing plant and the additions to the Fairlane Plant were started in January, 1974. Construction has since continued substantially on schedule. As of May 31, 1975, construction of the Troy area crushing plant was 49% complete, the fine crusher and concentrator additions at the Fairlane Plant were 25% complete, and the new pelletizer was 7% complete. The cost of the work completed was approximately $72,000,000. Total cost of

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the project is anticipated to be slightly in excess of $200,000,000.

The Minnesota Environmental Quality Council regulations pertaining to environmental impact statements were adopted April 4, 1974, but the status of an action as existing under the regulations, and thus exempt from the EIS requirement, is determined as of January 1, 1974. Pursuant to the request made by Oglebay by letter to Council Chairman Gerald Christenson dated June 10, 1974, which was accompanied by an Environmental Assessment prepared by A. H. Axelson & Associates, Inc., acting as consultants to Oglebay, the EQC determined on July 9, 1974, that the project was an exempt action on the basis of MEQC 26(c)(4)(bb), which provides that:

> "Land on which the action is located is purchased or leased and any necessary zoning change is approved before January 1, 1974, and physical construction is commenced before January 1, 1975;"

In December, 1974, it came to the attention of the EQC that certain lands west of Eveleth which were designated on the maps submitted by Oglebay as "Waste Dump" and had been largely zoned "Open", had been automatically rezoned residential when the Town of Nichols was merged into the City of Mountain Iron in 1972, and thus required further rezoning for use by Oglebay; and that a part of these lands had not yet been acquired. Although these lands would have been acquired for use in connection with Eveleth Taconite Company's Thunderbird Mine regardless of the expansion project, it became clear that some members of the EQC technical committee and staff felt that the determination that the project was exempt from the EIS requirement had been improvidently made and that an EIS should be prepared with respect to the project. Oglebay then waived the exemption previously granted, and on February 5, 1975, the EQC resolved that an EIS should be prepared, designated the Department of Natural Resources and the Pollution Control Agency as responsible agencies, and resolved that physical construction of the project shall be permitted to continue through the preparation, review and acceptance of the EIS.

STATEMENT OF THE ACTION

The project that is currently being proposed by Oglebay Norton Company is a taconite mining operation which has three basic parts;

1) increase production from an existing taconite mine called the Thunderbird;
2) create an entirely new mine referred to as the Expansion mine, and
3) enlarge the existing taconite concentrating and pelletizing facility, called the Fairlane Plant, which presently services the Thunderbird mine and will eventually process ore from both mines.

Location-orientation

The mines are located within 2 miles of each other. The Thunderbird lies about ¼ mile northwest of Eveleth, Minnesota while the Expansion mine is approximately the same distance south of that city. Each mine will simultaneously produce blasted crude ore that will be crushed into pieces less than 4" in size, in crushers located at the site of each mine. This broken ore will be rail-hauled to the Fairlane Plant, about 10 miles south of the mines, where the fine magnetic particles in the ore are concentrated then pelletized. The finished pellets will then be hauled by rail to the Lake Superior docks at Two Harbors or Duluth, loaded on ore boats, and shipped to steel mills on the lower Great Lakes.

The state map (figure 1) shows the location of the Northeastern Minnesota community of Eveleth in central St. Louis County. The pair of maps, (figures 2 and 3) show with increasing detail the location of the proposed facilities and their relation to Eveleth and surrounding communities.

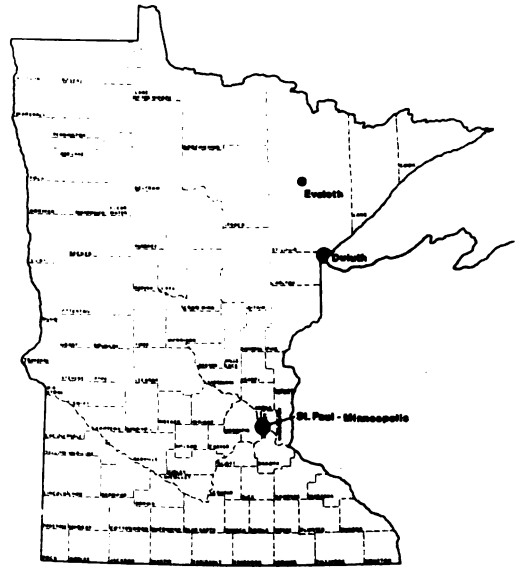

Figure 1 The Location of Eveleth in the State

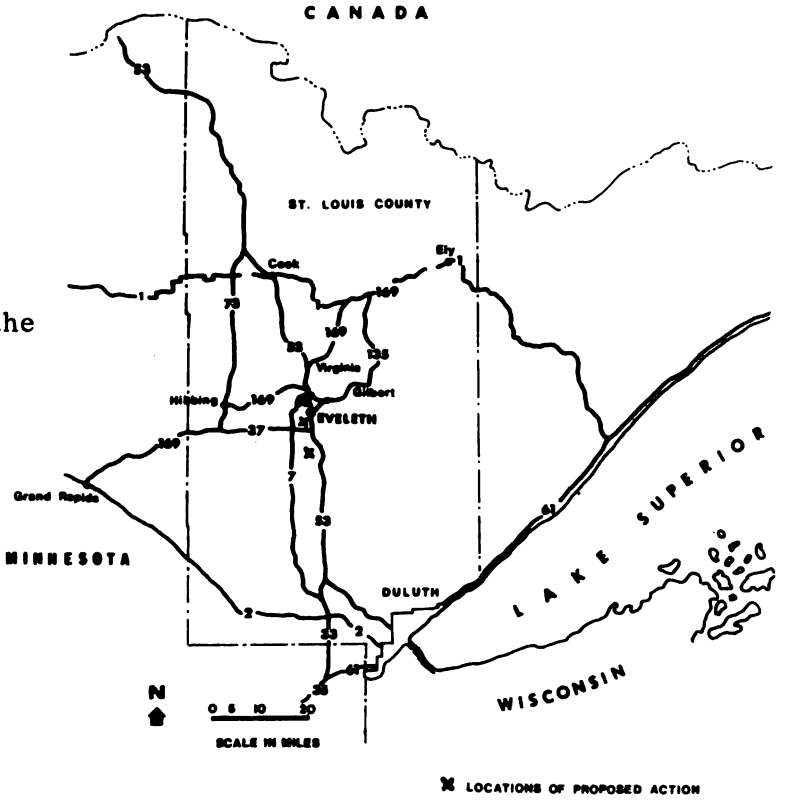

Figure 2
The Location of Eveleth in the Arrowhead Region

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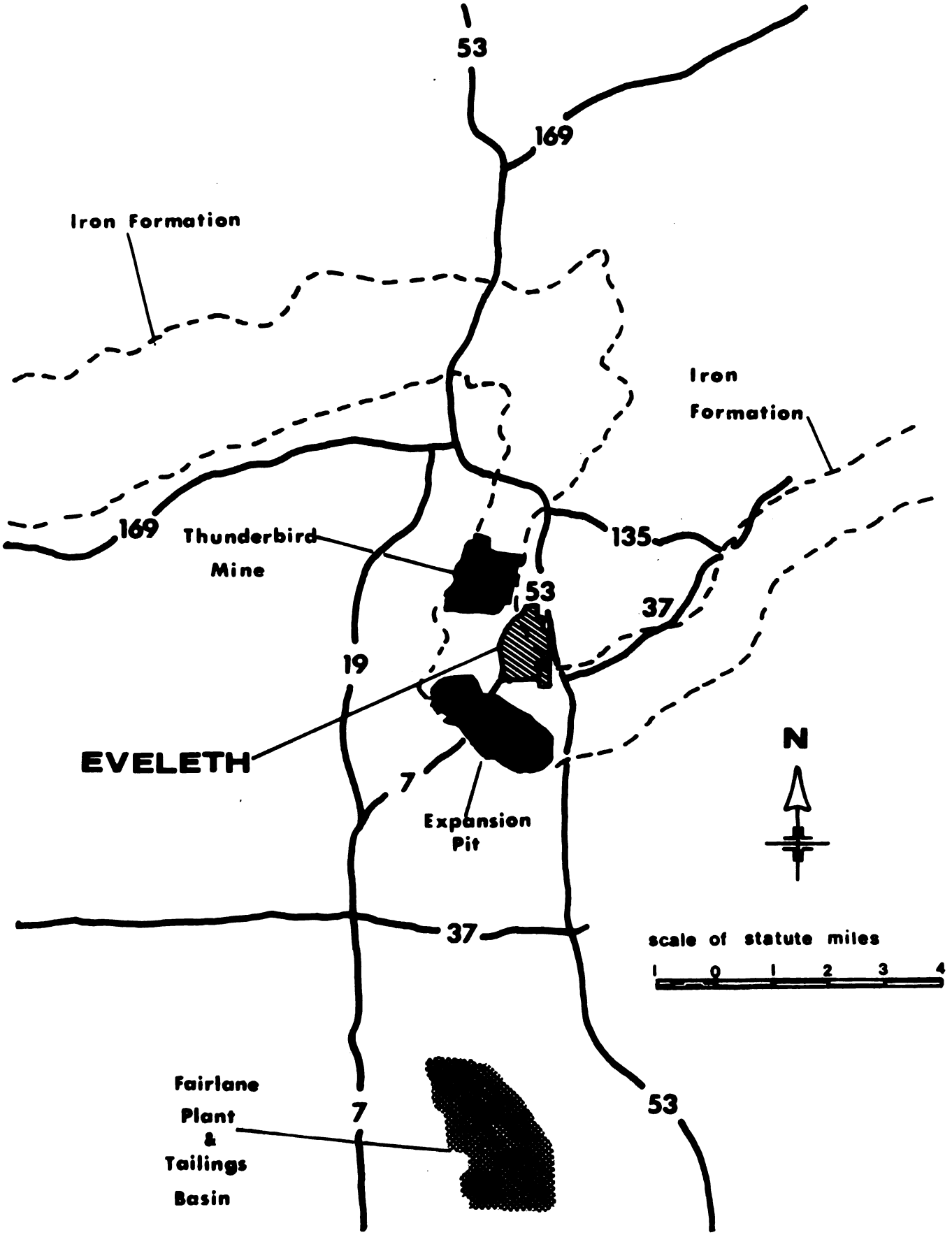

Figure 3

The location of the three action areas in the vicinity of Eveleth

DESCRIPTION OF THE ACTION

Introduction

For ease in comprehending the description of the Action, the project will be divided into its essential parts and described in the order in which they are encountered in the mineral processing sequence. The basic operations of mining and mineral beneficiation which are required to develop a marketable product can be divided into:

1. exploration and development
2. the actual mining process
3. coarse crushing
4. grinding-concentrating
5. pelletizing.

Other operations essential to mining and processing include:

mine waste disposal

mine dewatering

tailings disposal.

The actual mining of an orebody is preceeded by exploration and pre-mining, or development phase. Exploration of the mineralized body is accomplished by diamond drilling which produces a rock core. From several such cores the aerial extent, thickness, depth and grade of the mineralization can be determined. Analysis of this information will determine whether development is economic, and if mining should occur. Exploration of the Thunderbird orebody was begun in the early 1960's and paved the way for the initial ore and pellet production in 1965. Exploration has continued throughout

the mining phase and to date has proven that nearly 650 million tons of crude ore are amenable to mining.

When production began in 1965 Oglebay Norton's major responsibilities were to manage the operations at the Thunderbird mine. Additional activities included efforts to locate and develop other mineral deposits. These efforts proved fruitful and resulted in the present plans for the expansion of the taconite operations.

History of Expansion Operation

During the mid to late 1960's Oglebay Norton acquired mineral leases which permitted it to explore the iron formation south of Eveleth. Upon completion of this initial exploration a report was written (portions provided in Appendix I). With this report Oglebay Norton attempted to interest investors in a project to develop the taconite resource, that had been revealed by the exploration work. Estimates of the size and grade were determined from seventeen drill holes which indicated that nearly 350 million tons of crude ore existed in the leased area. The company felt that this reserve was sufficient to warrant a mining development. In addition, the report concluded that adjacent lands for which Oglebay Norton had not yet acquired leases also contained economic taconite. After publication of the report Oglebay Norton proceeded in two directions. First, it continued its efforts to acquire and explore the adjacent lands and second, it advanced from an exploration to a development stage on the lands which it had already acquired. As a result of its efforts, the company has acquired

additional adjacent lands. Studies of the enlarged area, based on laboratory test results from 150 holes, presently indicate that the total reserve of proven and probable magnetic taconite might well exceed 675 million tons. This enlarged mineralized reserve is the orebody in which the Expansion mine will be developed.

The second direction in which the company proceeded, once it determined the extent of the initial orebody, was to develop a mining plan.

The development stage is the time during which the entire operation is planned. The decisions made at this stage determine, for the most part, how the operation will work. The major steps which are usually taken include:

*the purchase or exchange of land

*the acquisition of governmental permits and variances in local zoning

*choice of mining method

*the choice of location for the concentrator and pelletizer, tailings basin, waste rock and overburden stockpiles, buffer lands

*the location of adequate water and energy sources

*the recruitment of construction contractors, suppliers, rail haulers, and employees

*obtaining financing

*locating a market.

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The development phase of this project has spanned almost seven years but is now almost complete. The result has been the development of a plan for the mining of two large mineral resources and the joint beneficiation of the ore from these reserves at a single plant. The actual plans for carrying this out are very detailed and will be described in the balance of this section.

Scope of Operations

Because of the size of the reserves, the capacity of available concentrating and pelletizing equipment and the various pellet requirements of the companies involved, Oglebay Norton determined that the Expansion facility would have to provide 6 million tons of pellets per year. At present, the mining plans of the Expansion cover the next 60 years, allowing the production of 360 million tons of pellets during that time. In order to produce this anticipated goal 1.08 billion tons of crude ore will be mined. However, present estimates of the proven and possible crude ore, exceed this figure by 247 million tons; giving a total in excess of 1.3 billion tons of available ore. Even though the Company felt that planning past sixty years was beyond the capability of most mineral resource planners, it accepted the state's request to provide the best estimate of how the development would appear if all the reserves were ultimately extracted (the 1.3 billion ton figure). This information has been provided by the Company

with the understanding that it was compiled using the Company's best judgment at the present time. Because of the extensive period of time involved, many changes could occur which may alter the estimates and the anticipated appearance of the mining area.

Although factors may arise which could change the company's plans, it is the opinion of the PCA and DNR, that the development of this long range plan is the only way in which potential impacts can be appraised and possible mitigative measures determined.

Ore Production

The Fairlane plant presently produces 2.4 million tons of pellets each year from approximately 6.6 million tons of crude ore. The expanded production, as already mentioned, will be 6.0 million tons of pellets which will require 18 million tons of crude ore. Current plans anticipate extration of 8.2 million tons from the Thunderbird and 9.8 million tons from the Expansion lands.

Mining Method

Both Eveleth Taconite Company which operates the Thunderbird mine, and Eveleth Expansion Company which will operate the Expansion mine will employ an open pit method of mining. Basically, this is a method in which the soil and rock overlying the ore is stripped away, exposing the mineralized material which is then excavated.

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Site Preparation

The second-growth trees, brush and other vegetable matter within the planned stripping areas are removed well in advance of the actual stripping operation. Removal is by crawler tractors with dozer blades. All material is dozed into windrows or piles, allowed to dry out over several seasons, and disposed of by burning.

Drilling

Both jet piercing and rotary drills are used for drilling blast holes at the mines. The rotary drills are utilized for drilling shallow holes in the iron formation and, when necessary, drilling of the surface overburden. In most instances, the materials overlying the rock are excavated without drilling and blasting. However, there are occasions when cemented silt, sand, gravel, and boulders, called "hardpan", and frozen materials encountered in winter stripping operations, require blasting to increase production rates.

The jet piercers are utilized for virtually all of the drilling in the extremely hard taconite, which defies the use of any other type of drill. The jet piercer consists of a verticle boom from which a jet-like combustion chamber is suspended. Kerosene is combined with liquid oxygen and is burnt in the jet. As the jet is advanced into the rock the intense heat of the flame ($5000^{o}F$) causes the mineral crystals of the rock to expand and spall (disintegrate). The jet stream then carries the fragments of rock

from the hole. By adjusting the intensity of the flame, the diameter of the holes can be enlarged. This feature is used to create a chamber at the bottom of the hole which allows the placement of more explosive at that point, and this provides a more efficient breaking of the rock during the blast.

Blasting

Explosives utilized in the blasts, at the mines, will include both metalized slurries and a mixture of ammonium nitrate (a fertilizer) and fuel oil, referred to as ANFO. Initiation of the blast is done electrically and a test blast is made before the main charge is set off in order to assure that weather conditions are proper.

Ore Removal

Surface overburden and material from the formation which is broken during the blast, is excavated by electric power shovels equipped with 6 cubic yard dippers. Front end scrapers often assist in keeping the area around each shovel clear of spilled material.

Surface overburden and broken material from the iron formation is loaded into 50 and 75 ton off-highway, end-dump trucks. This material is hauled over well maintained mine roads to either the coarse crusher, the lean ore save rock stockpiles, or to the waste rock dump area.

Crushing

A coarse crusher and rail car loading facility are located at each mine. The crude ore (some pieces measuring over 5 ft. in size) is hauled by truck to the coarse crusher building where it

is dumped into the crushing unit. At this point the ore is crushed, in two stages, to produce broken material which is less than 4 inches in size. The crushed ore is then conveyed by belt to the rail car loader where it is loaded directly into 70 ton ore cars, or stockpiled until a train arrives. The crushed ore will then be rail-hauled to the Fairlane plant for additional processing.

Before following the ore to the Fairlane plant, and describing the mineral beneficiation sequence however, there are two areas related to the mining which must be addressed:

1. mine waste deposition
2. mine dewatering.

To better understand these areas, the mining plans developed by Oglebay Norton will be presented.

Waste Disposal to Date

Between the start of operations in mid-1965 and January 1, 1975, Eveleth Taconite Company's operation of the Thunderbird Mine produced 51,947,532 gross tons of crushed, crude ore. The crude ore was rail-hauled to the Fairlane Plant for additional crushing, concentration and agglomeration, to yield 17,438,216 gross tons of pellets. In order to mine this amount of crude ore, however, the following materials had to be either mined or stripped away:

Surface overburden	9,123,066 cu. yds.
Waste rock	4,405,943 cu. yds.
Total Waste	13,529,009 cu. yds.*

In addition, another material, called "lean ore", or sometimes "save rock", is also often encountered. However, since none has been stockpiled to date, it was not reported in the above list.

For a clearer understanding of the materials just mentioned the company's definitions follow:

--Crude Ore - A type of taconite containing significant quantities of magnetite (magnetic-iron mineral) which will yield a profitable product when the magnetite is concentrated. The crude taconite at the pit is required to contain in excess of about 18% magnetic iron, (by weight) if it is to be classified as crude ore. The average magnetic iron content for ores from the Thunderbird mine and Expansion pit will run between 22.5 and 23%. When this ore is processed at the Fairlane plant, pellets containing about 64% iron, between 5 and 6% silica and about 30% oxygen will be produced.

--Surface Overburden - The earthy materials that overlie the Iron Formation, which may be of either vegetable or mineral origin. These materials are classified locally as topsoil, loam, muskeg, peat, boulders, gravel, sands, silts, hardpan,

*For a better idea of the magnitude of these amounts, simple calculations reveal that if all the waste was placed on a single 40 acre parcel the resulting pile would be about 210 feet high.

and either hard or soft clays. They have no value for iron use.

--Waste Rock - Iron formation materials having a magnetic iron content less than 10%. This material, when encountered, may be comingled with surface overburden for disposal, or utilized at the operator's option for the construction of haul roads.

--Save Rock - Iron formation materials having a magnetic iron content greater than 10%, but too low in recovery to classified as crude ore. If the material encountered can be economically processed it will be included with the crude ore. If it is not economical it will be placed on a save rock stockpile for possible future inclusion with the crude ore.

Waste Production

During the ultimate life of the two mines the following quantities of these various materials will be produced:

THUNDERBIRD MINE

Item	Cubic Yards and/or Tons
Waste Material:	
Surface-Cubic Yards	31,900,000
Waste Rock-Cubic Yards	102,800,000
Total Waste-Cubic Yards	134,700,000
Save Rock-Cubic Yards	64,300,000
Crude Ore-Tons	649,000,000

EXPANSION OPEN PIT

Item	Cubic Yards and/or Tons
Waste Material:	
Surface-Cubic Yards	70,400,000
Waste Rock-Cubic Yards	136,800,000
Total Waste-Cubic Yards	207,200,000
Save Rock-Cubic Yards	40,100,000
Crude Ore-Tons	678,700,000

Summarizing these numbers shows that nearly 342 million cubic yards of waste, and the 105 million cubic yeards of lean ore must be removed during mining and deposited elsewhere. In addition, areas to accomodate; waste rock, overburden and lean ore, from earlier natural ore operations, which are now piled within the limits of the Expansion pit, have to be delineated.

Waste Disposal Areas

Because of the extremely large volumes of material that must be moved and deposited (waste material and save rock encountered during mining could cover a square mile to a height of 430 feet) it was necessary for Oglebay Norton to develop large open areas near the mine for deposition purposes. Open areas near the Thunderbird and Expansion mines however, are limited mainly to several adjacent natural ore open pits and a few small open areas on the surface. The pits, for the most part, have been abandoned because of exhaustion, although a few minor operations are scavenging small amounts of remaining ore. The Spruce, Hull-Nelson and Leonidas Mines which now comprise one pit (the largest in the immediate area) has been, in part, utilized by Oglebay Norton for

dumping during the past 10 years. All of the 13½ million tons of waste rock and overburden, produced thus far from the Thunderbird operation, have been dumped from the eastern crest of this pit. It is intended that the main bulk of the waste derived during future operations at the Thunderbird and Expansion pits will be disposed of in this same manner.

The following series of maps (figures 4 through 8) show the proposed progression of mining and waste disposal. The Spruce, Hull-Nelson, and Leonidas pit will be utilized throughout the life of the operations but will be filled to the surrounding surface elevation within the next 25 years. Beyond that point the overburden and waste rock will be stockpiled above the filled pit. This method will eventually produce a pile of material with a top elevation about 400 feet above the present elevation of Eveleth, and cover an area equal to about 600 acres.

Three additional small exhausted natural ore pits and two surface areas will also be utilized for waste deposition and lean ore stockpiling. The pits include the Alice, Fayal #2, and Fayal Mines, while each of the two surface areas are located west of the two taconite pits.

Although the areas discussed above will handle most of the waste and some of the lean ore they do not contain enough volume to handle all the material. Therefore, portions of the taconite pits themselves

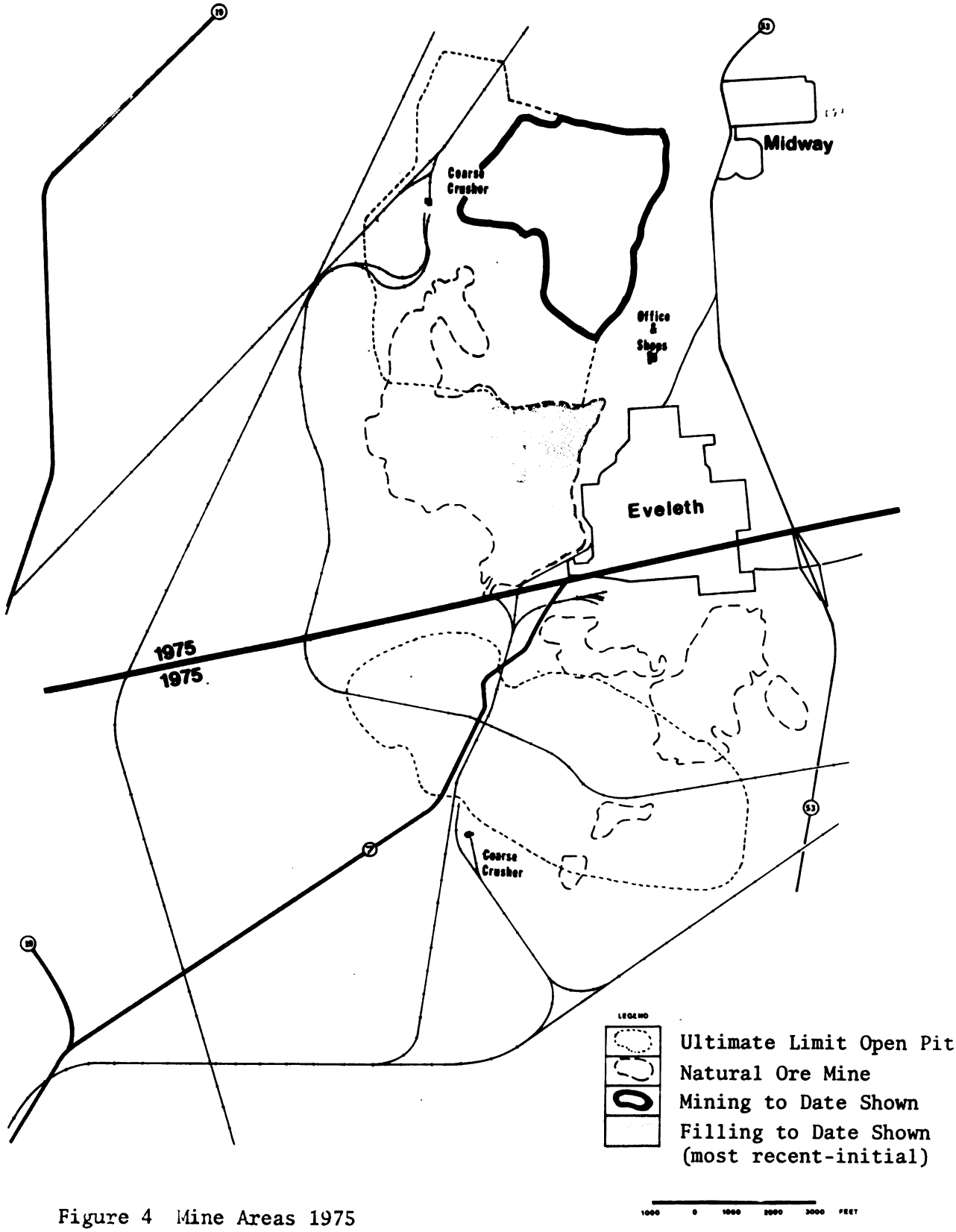

Figure 4 Mine Areas 1975

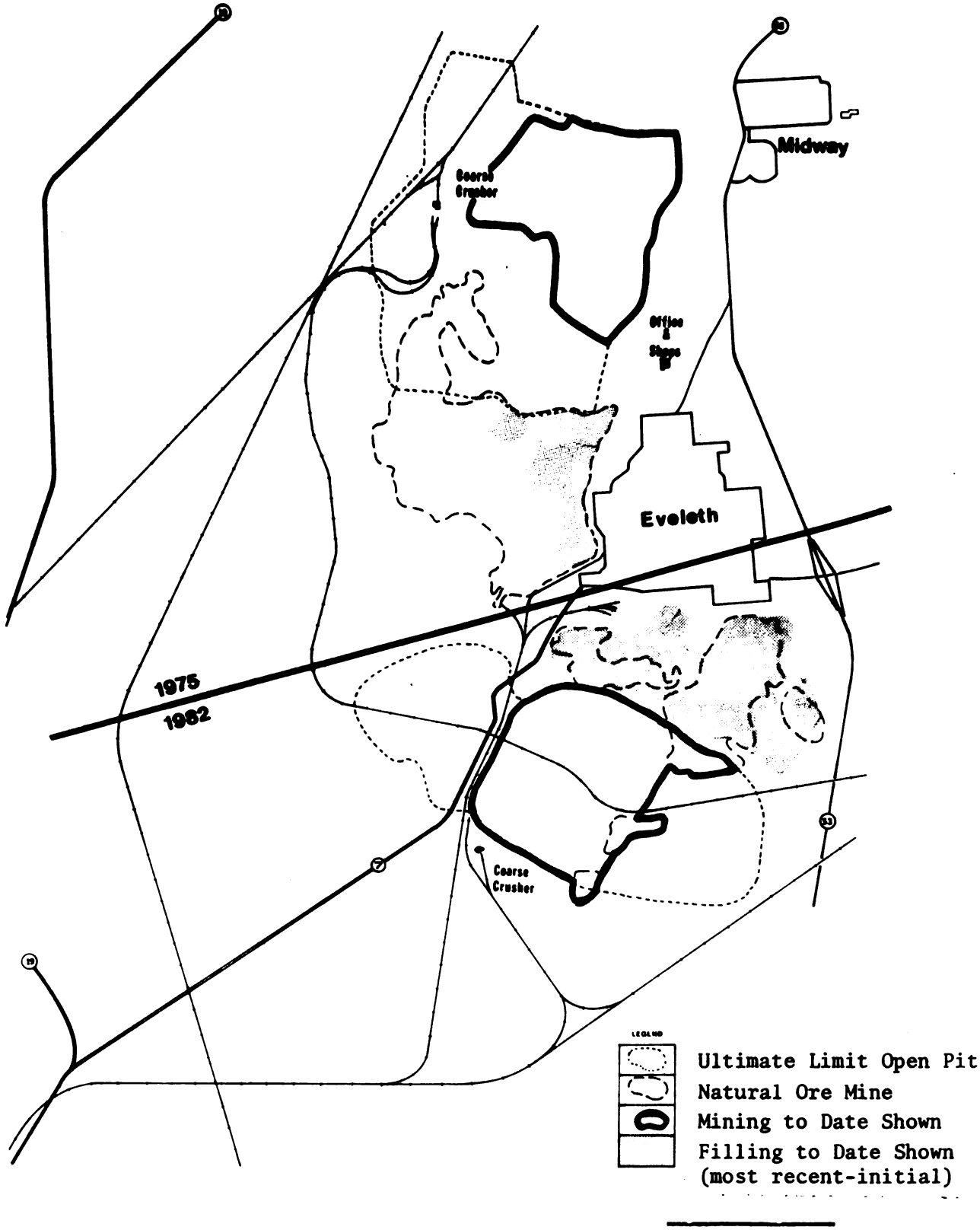

Figure 5 Mine Areas 1975 North, 1982 South

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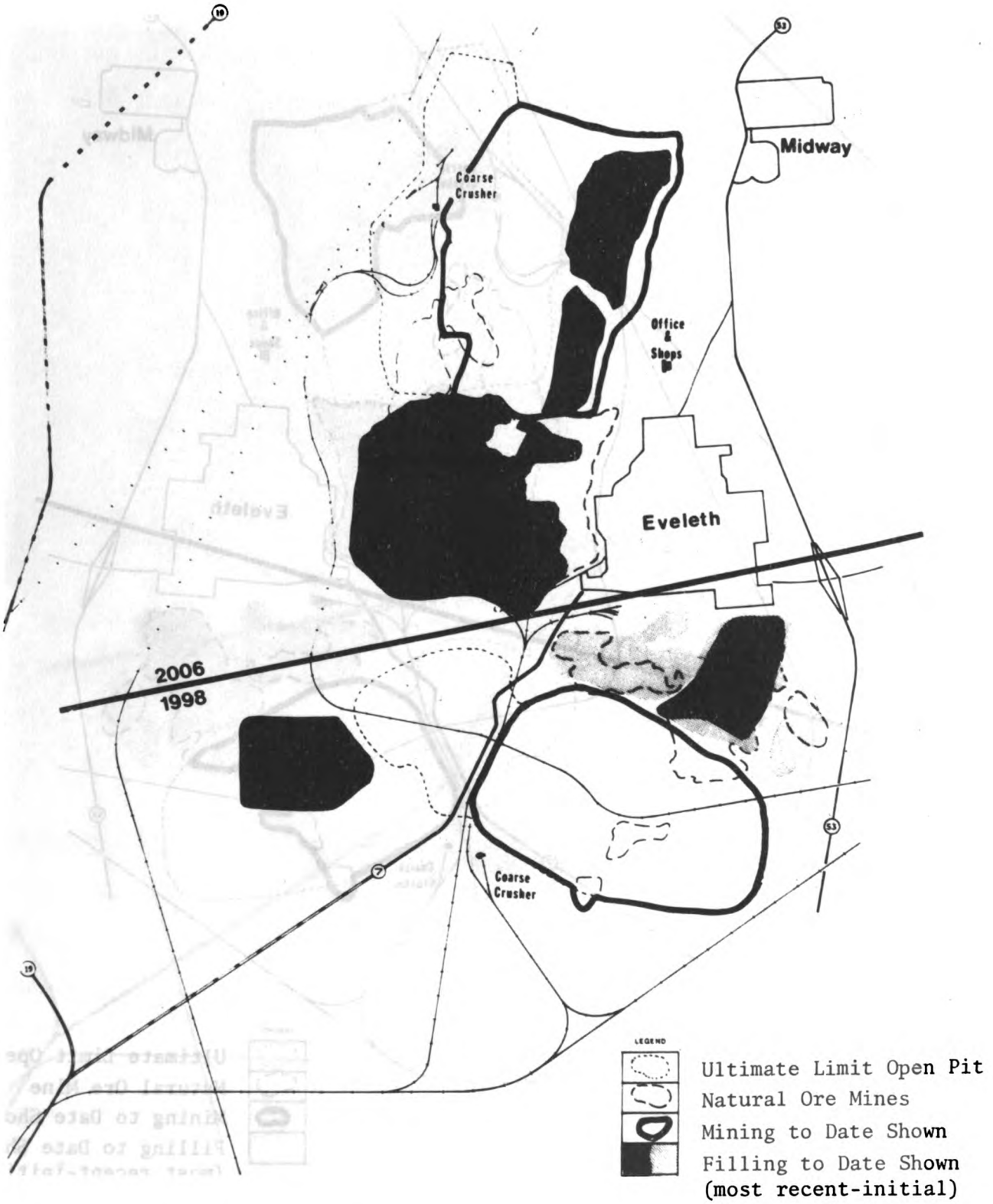

Figure 6 Mine Areas 2006 North, 1998 South

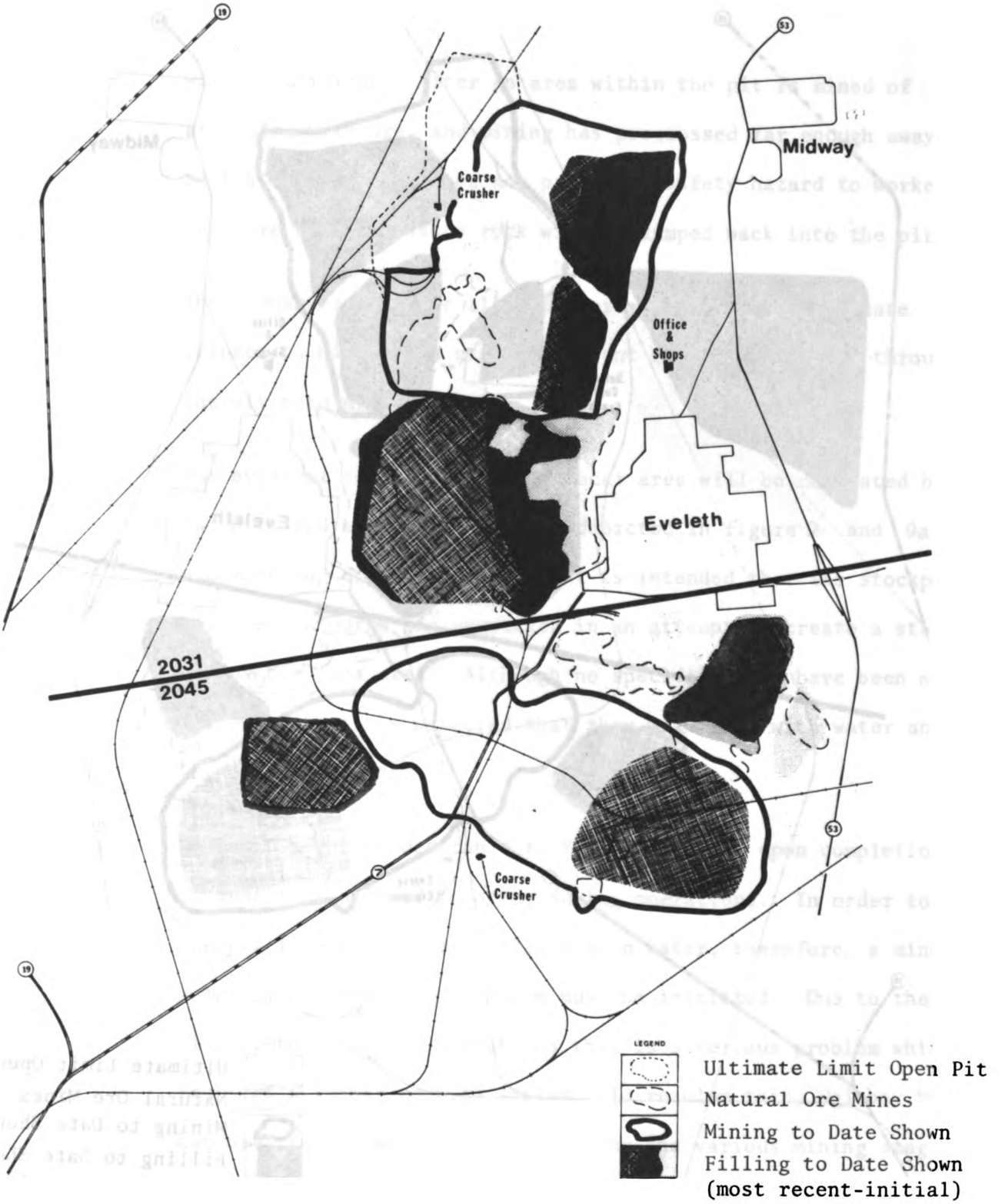

Figure 7 Mine Areas 2031 North, 2045 South

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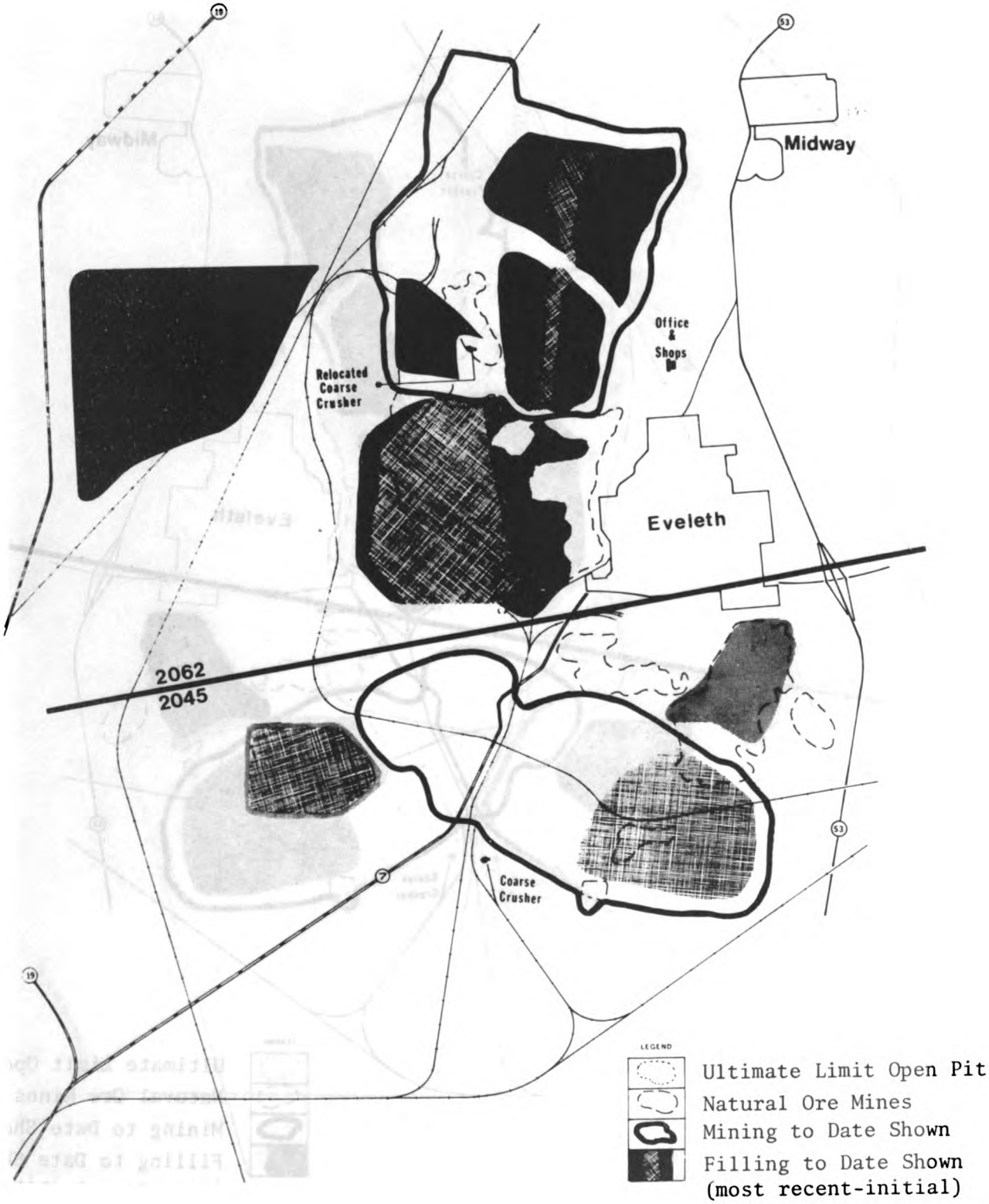

Figure 8 Mine Areas 2062 North, 2045 South

will be utilized. After an area within the pit is mined of crude taconite ore, and mining has progressed far enough away so that stockpiling does not present a safety hazard to workers, lean ore and some waste rock will be dumped back into the pits.

The company feels that all these areas will supply adequate volumes to handle the expected amount of waste material throughout the ultimate mine life.

Final Topography

The eventual topography of the local area will be dominated by the two pits and a large stockpile (depicted in figure 9 and 9a the accompanying cross-sections). It is intended that the stockpile will be contoured and vegetated in an attempt to create a stable and usable land area. Although no specific plans have been made for the pits it is expected that they will fill with water and thereby form lakes.

Dewatering

While it might be desirable to fill with water upon completion, it cannot be allowed to occur during operations. In order to keep the pit from prematurely filling with water, therefore, a mine pumping, or dewatering program must be initiated. Due to the size of the intended operations this is a serious problem which requires a rather complex system. To resolve this, Oglebay Norton has devised a plan which will, during the various mining stages, require several pumping stations (see figure 10) to keep the operation free of mine water.

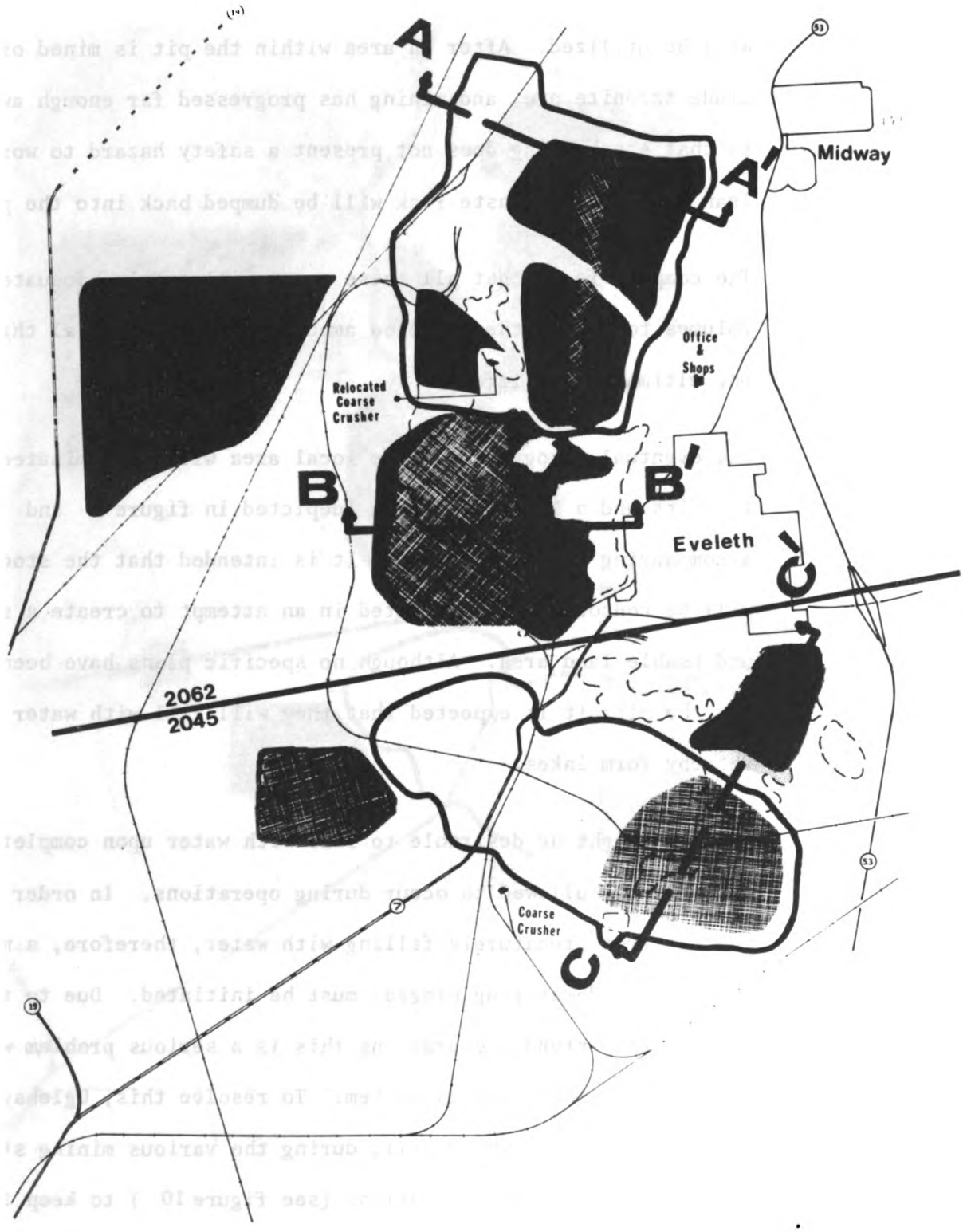

Figure 9 Cross Section Location Map

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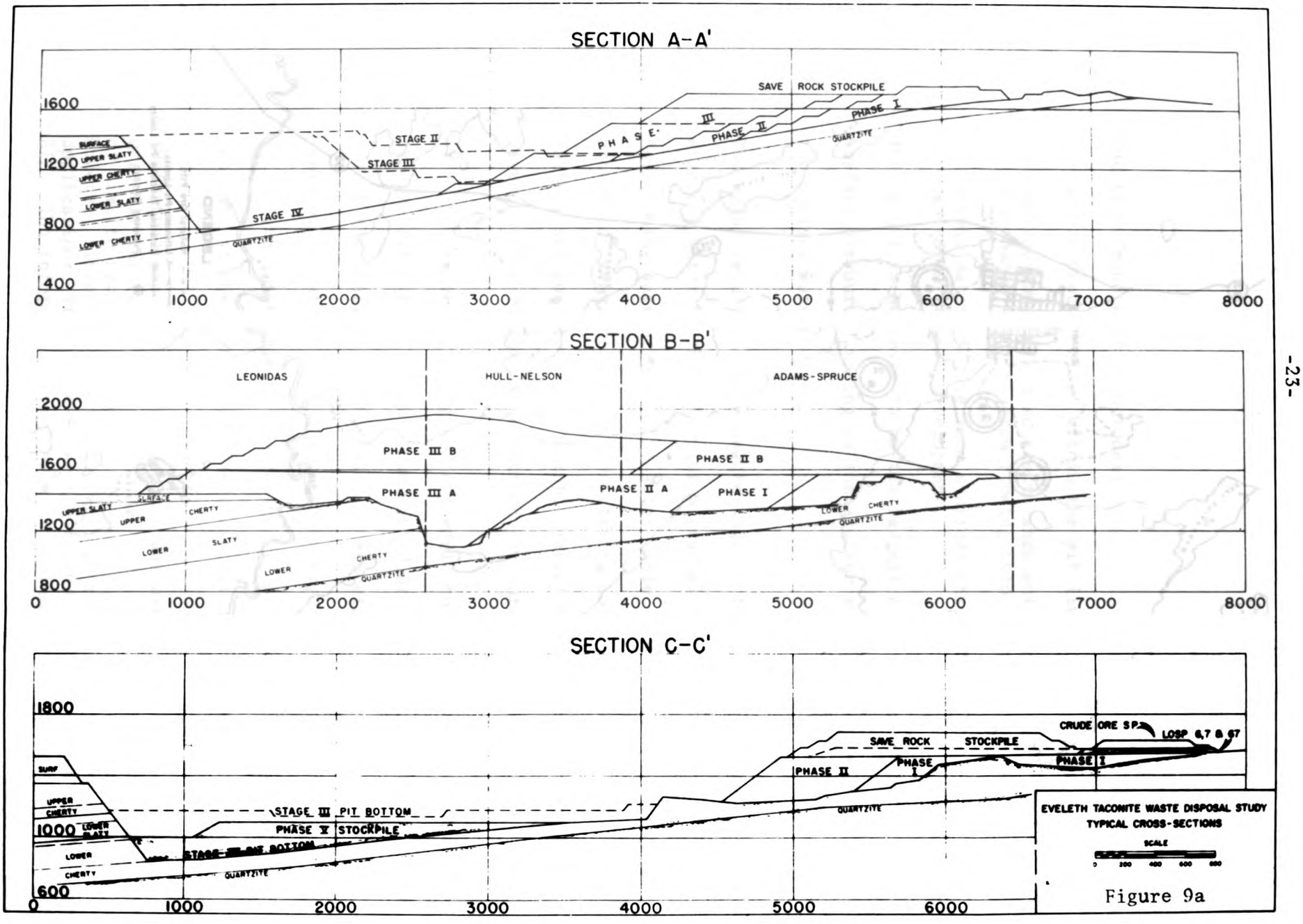
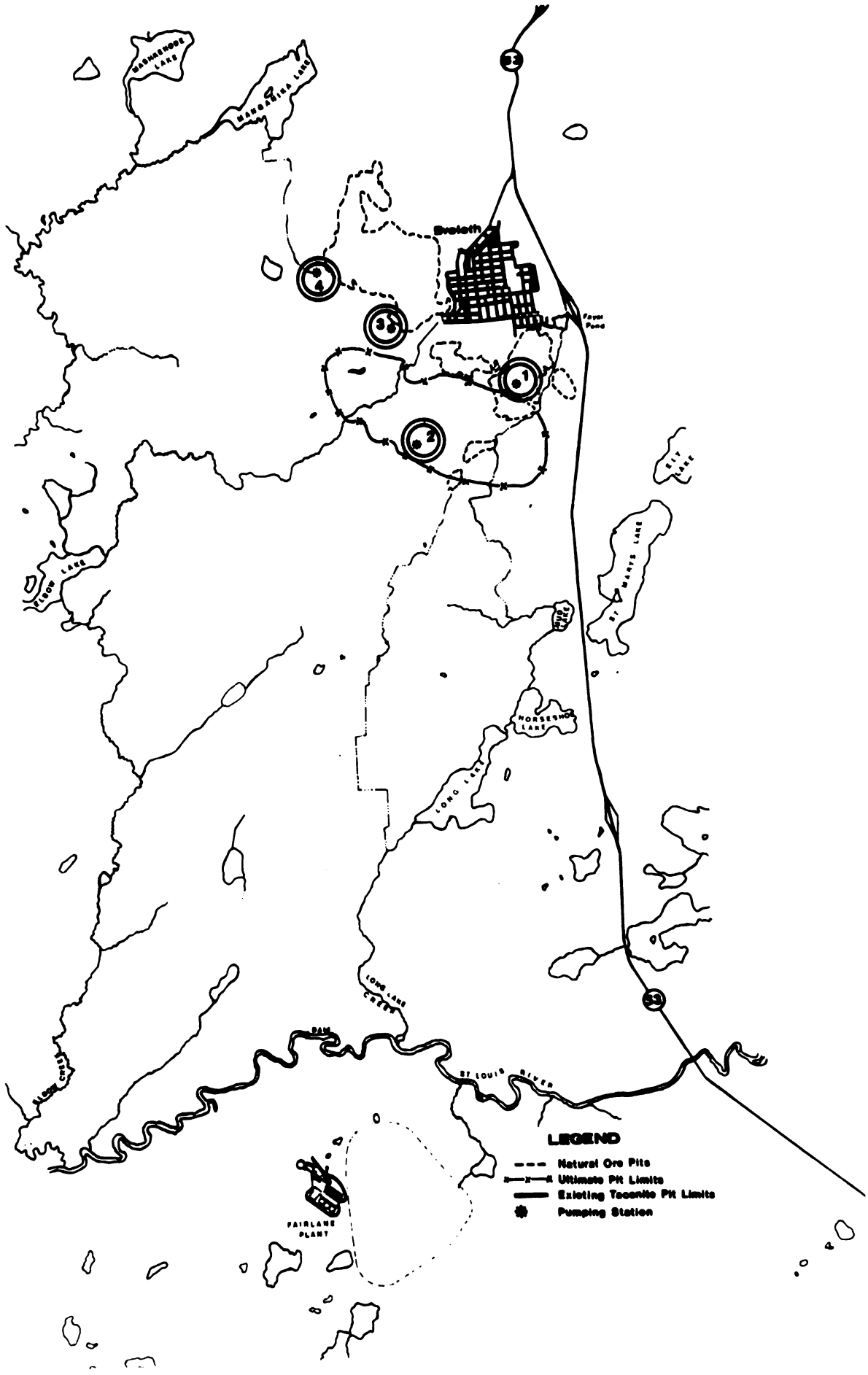


Figure 9a


Duluth
Fond Du Lac
Pond
Lake
Lake
Lake

The term "mine water" includes:

--direct precipitation within the pit limits

--surface runoff from adjacent lands which cannot be reasonably diverted from flowing into the pits

--ground water seepage from aquifers which are intercepted during pit development.

The latter is believed to be the largest contributor, with the surface overburden acting as the aquifer supplying water from the surface water table.

The major results of mine dewatering are the removal of any standing water in the pit, plus a gradual lowering of the surrounding water table. The water table drawdown is more pronounced near the point of dewatering and tapers off the farther one goes from that point. Therefore, dewatering from a given point will have an effect on the surrounding area.

From the preceeding paragraph one would conclude that dewatering at one of the pits, either Thunderbird or the Expansion, will effect the other pit. This will be especially true in the latter years of operations when the pits converge toward each other. A complete discussion of dewatering at one mine without considering the same at the other will, therefore, give an incomplete picture.*

*Unfortunately, because the company was asked to develop other, more urgently information for this Draft EIS, there was an inadequate amount of time to prepare a complete dewatering plan for the Thunderbird mine. However, since this information will be required to review permit applications, it must be presented at the public hearing on this Draft EIS. The information provided will be incorporated into the Final EIS.

Thunderbird Dewatering

To date, the only discussion of the dewatering at the Thunderbird is the following paragraph:

> Inasmuch as the operating benches in the steeply, westward sloping Thunderbird Mine have been, and still are, at a higher elevation than the west limit of that open pit, all Thunderbird Mine water flows westerly by gravity from the active mine area to discharge into a settling basin lying between the Duluth, Mesabi and Iron Range and Duluth Winipeg and Pacific trackage just west of the Thunderbird Mine crushing and shipping facilities. This settling basin, created for previous natural ore beneficiating operations, discharges into an unnamed receiving stream running to Manganika Lake.

Figure 11 has been prepared to show the various landmarks which are discussed above. Additional data, as already indicated, will have to be prepared, but the volumes of water which should be expected from the mine are presented in Table 1.

TABLE 1 Thunderbird Mine

	Average in Thousands of Gallons per Day		
	Current	Expanded Operation	
Appropriation of Water	Operation	Initial	Final
Surface Runoff (areas downstream of mine)	35.9	35.9	35.9
Mine Water	283.1	400.0	1,150.0
Ground Water (from 2 wells)	14.4	14.4	14.4
Purchase from Municipal Supply	82.0	145.0	151.5
Total Appropriated	415.4	595.3	1,351.8
Consumptive Use			
Cooling Water - Drills	13.5	17.0	17.0
Dust Control - Roads	26.5	33.0	39.5
Boiler Feed Water	22.0	60.0	60.0
Steam Room Floor Wash	1.0	4.0	4.0
Crushing Plant Sanitary Sewage	0.6	1.0	1.0
Total Consumption	63.6	115.0	121.5
Release of Water			
Release to Elbow Lake	22.6	25.2	25.2
Release to Manganika Lake	329.2	455.1	1,205.1
Total Release	351.8	480.3	1,230.3

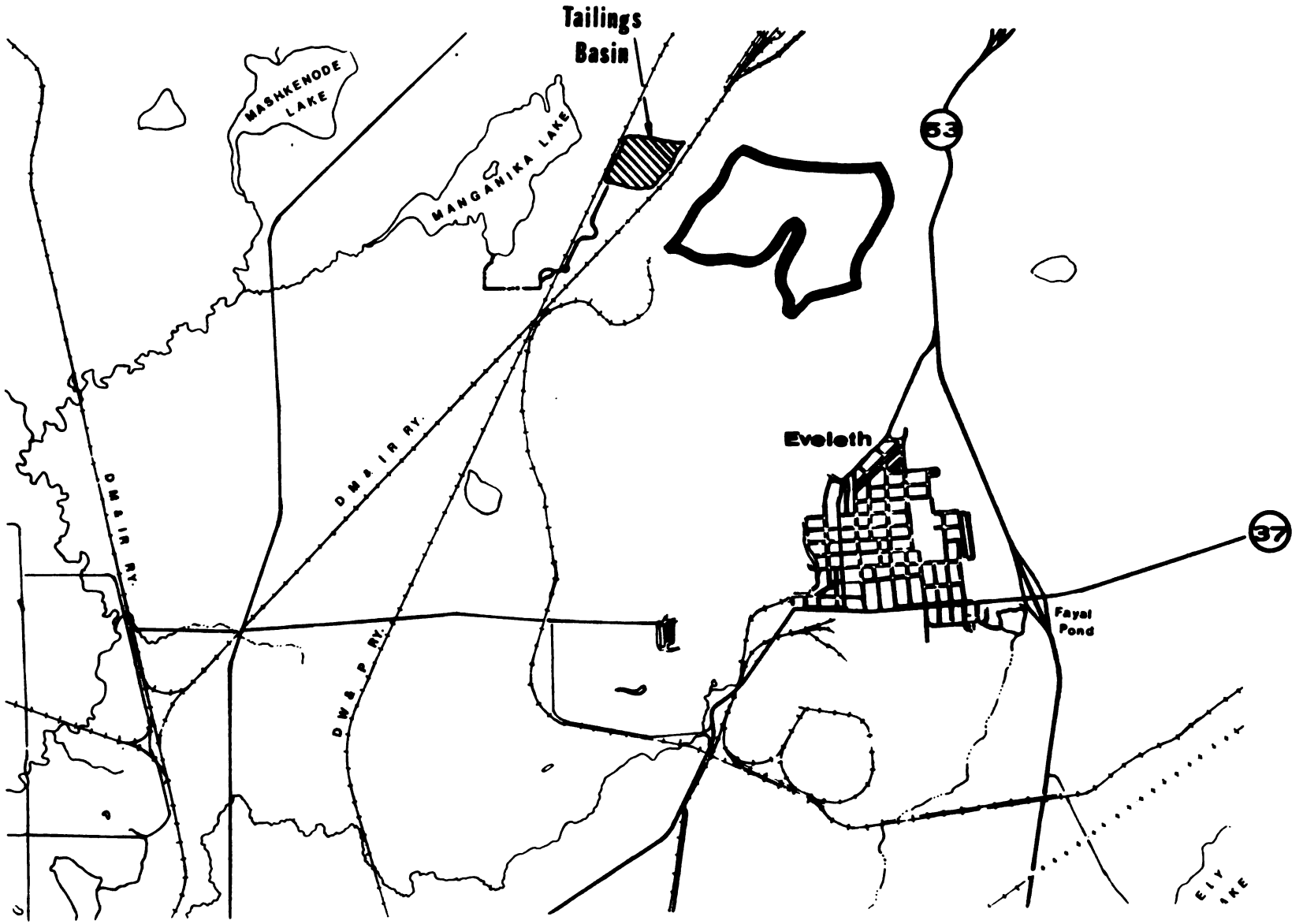


Figure 11 Dewatering of the Thunderbird Mine

From the figures in Table 1 most of the environmental impacts related to the quantity of water pumped from the Thunderbird mine can be derived.

Expansion Pit Dewatering

The mine dewatering proposed for the Expansion pit is very detailed. Just as the mining plans were divided to provide an easy understanding of the process, the dewatering has been divided into stages to make that process more understandable.

Stage I: This stage covers the period from 1975 to 1982. During this period the dewatering will involve a drawdown of the water table in the area of State I (See Figure 12). This will be accomplished by partially dewatering three water-filled natural ore pits; the Fayal, Troy and Pearsall. It is thought that this technique will eliminate major water problems during the surface stripping operations in the Stage I area.

Pump Station #1 mounted on a raft will pump water from the Fayal pit to the Troy where an overflow structure will allow the water to flow by gravity into the Pearsall pit. Another overflow at the south side of this pit allows water to flow into either one of two natural water courses (see the section, "Alternatives to the Proposed Action" for a discussion of the choice of water course). Both the Troy and Pearsall act as settling basins where the water will be clarified before being discharged into the streams.

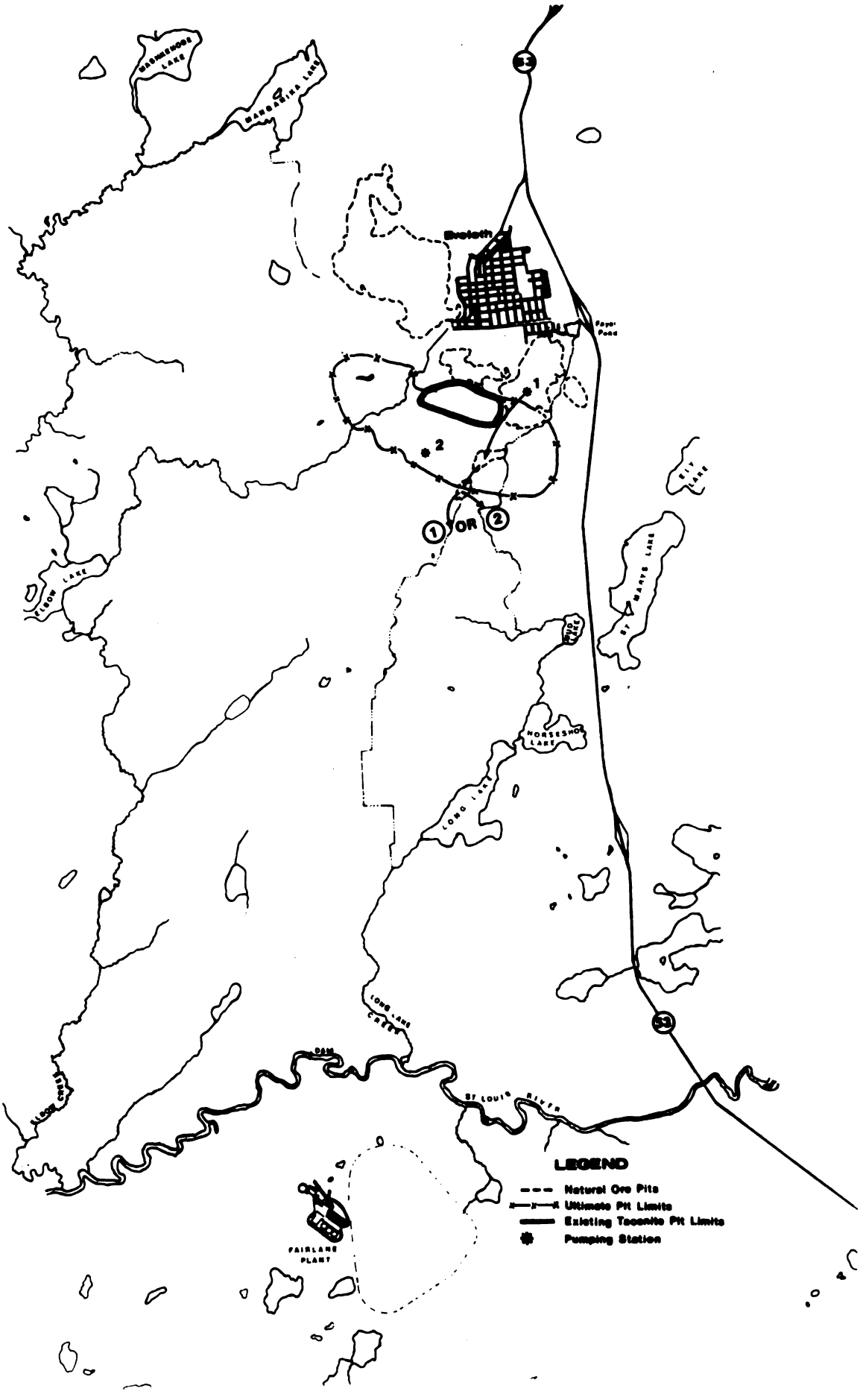


Figure 12 Dewatering of Expansion Pit - Stage I

The mine water will eventually reach the St. Louis River at a juncture point upstream from the dam and pumping station which provide process water for the Fairlane Plant.

Stage II-Initial: This stage covers the period from 1978 to about 1980. During this time stripping and mining will advance toward the limits of the pit (see Figure 13). Portable pump station #2 will be installed in a sump at the low point of the mine, and will be moved as the mine advances deeper. The water from this pump is discharged into the Fayal mine where it follows the water discharge path described in Stage I.

Stage II-Final: This stage covers the period from about 1980 to 1982. During this period mining will advance toward the Troy and Pearsall pits and will eventually intersect these, as well as the Fayal pit (see Figure14). Before this occurs, however, the pit waters must be depleted. Since this means the loss of these pits as clarifying basins, they will be replaced by the settling basin shown on the map. Pump station #2 will continue dewatering the sump in the mine, but will discharge the water into the new basin. From there, the water will be discharged into one of the streams mentioned in Stage I above.

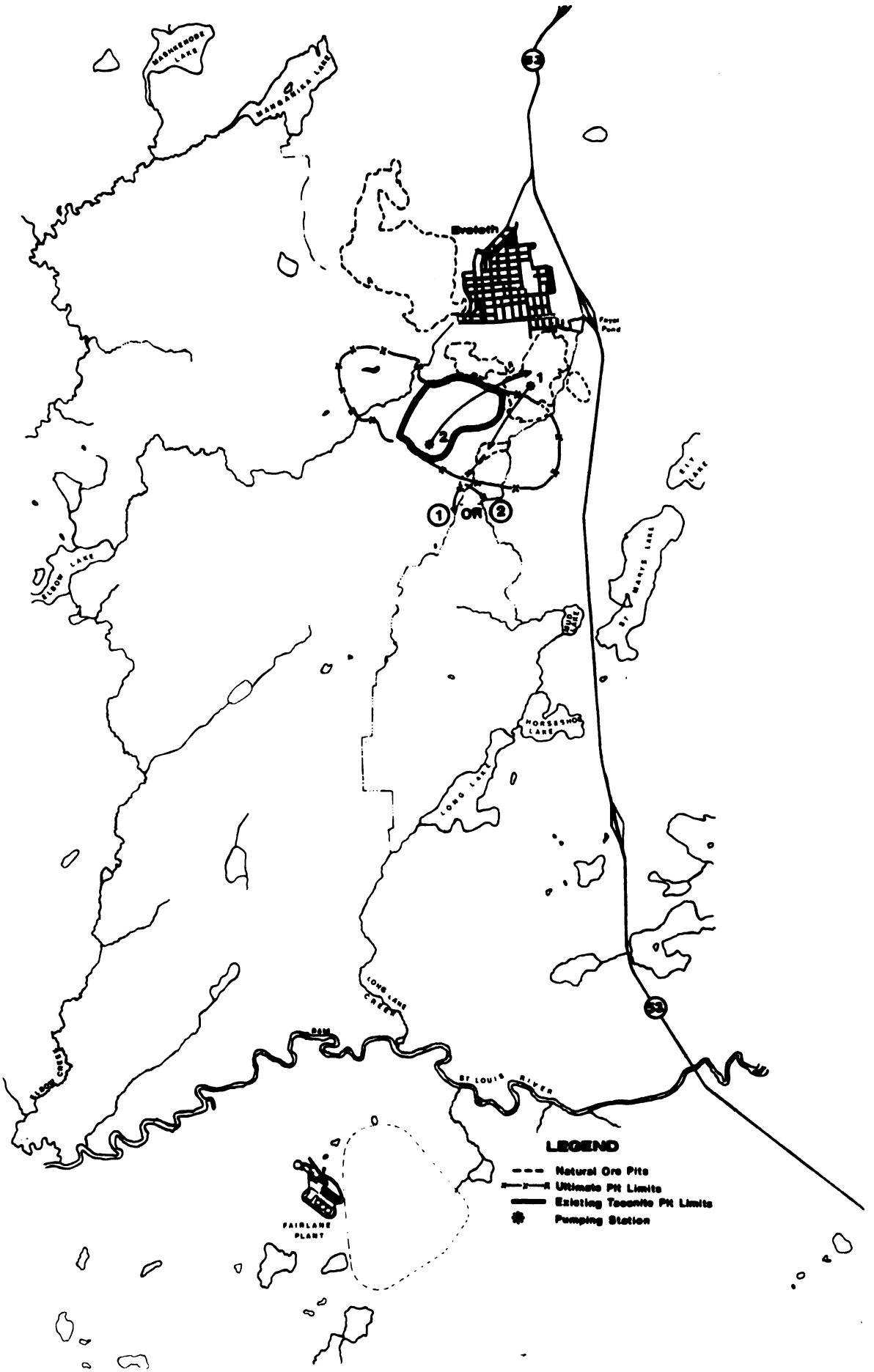


Figure 13 Dewatering of Expansion Pit - Stage II: Initial

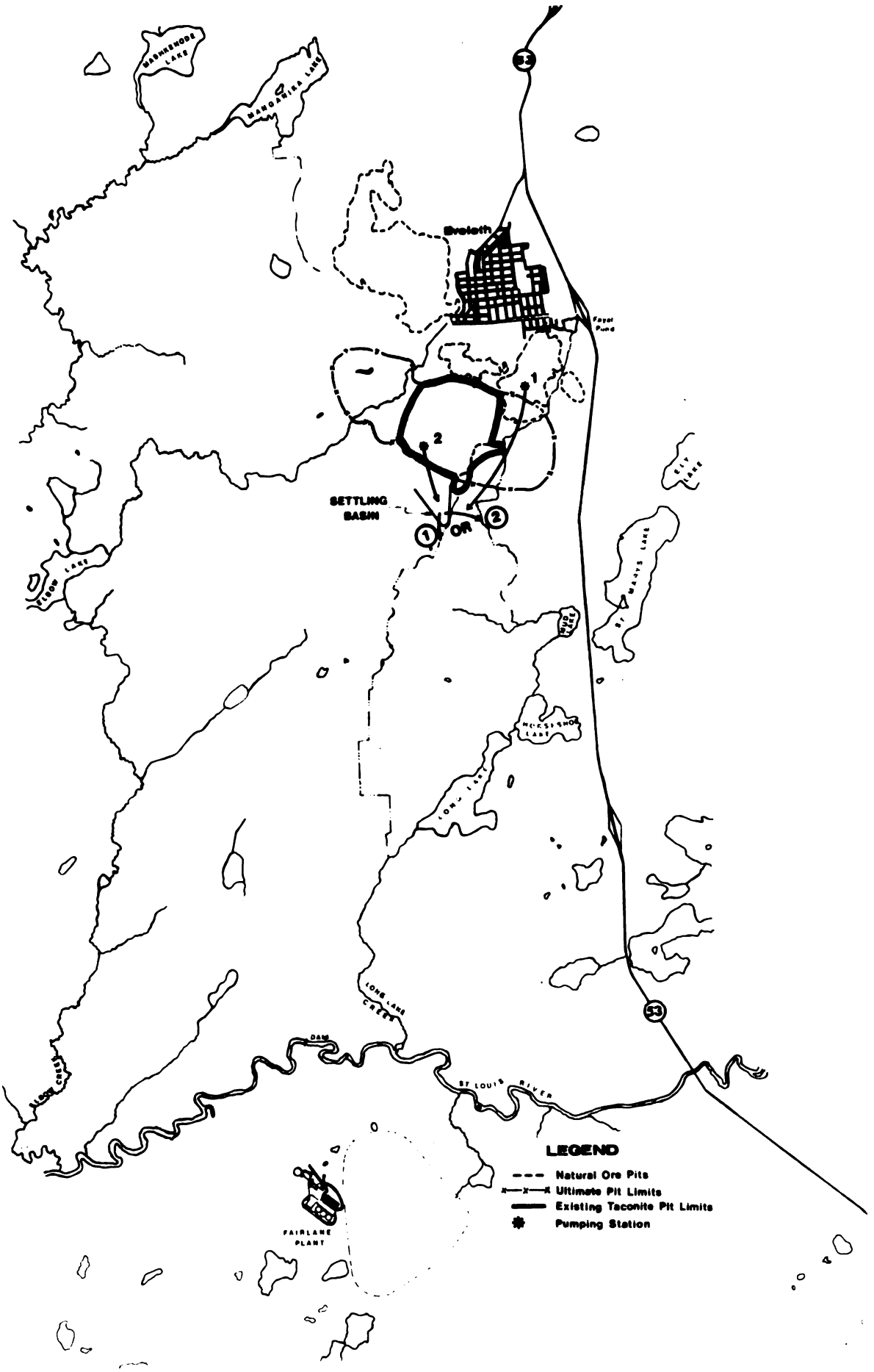


Figure 14 Dewatering of Expansion Pit - Stage II: Final

Stage III: This stage covers the period from 1982 to 1998. During this period the mining will advance eastward (see Figure 15). A small unnamed stream which carries storm sewer discharge from the City of Eveleth will be diverted around the area where mining will occur. Portable pump station #2 will continue to pump water from the low areas of the mine to the settling basin for clarification. In addition, as the mine expands from the Stage II area into Stage III, pump station No. 3 must be activated at the abandoned Spruce U.G. No. 4 shaft to assist pump station No. 2 in pit dewatering by lowering the ground water table in the mine area. Pump station No. 3 will discharge water clarified by seepage through the formation directly into the receiving creek which flows southwesterly from the shaft area to Elbow Lake. From there the flowage is southerly via Elbow Creek to the St. Louis River at a juncture point downstream from the dam and pumping system serving the Fairlane Plant.

Stage IV: This stage covers the period from 1998 to 2045. During This period the mining will advance westward (see figure 16). A small unnamed creek will be diverted around the area where mining will occur. Pump stations

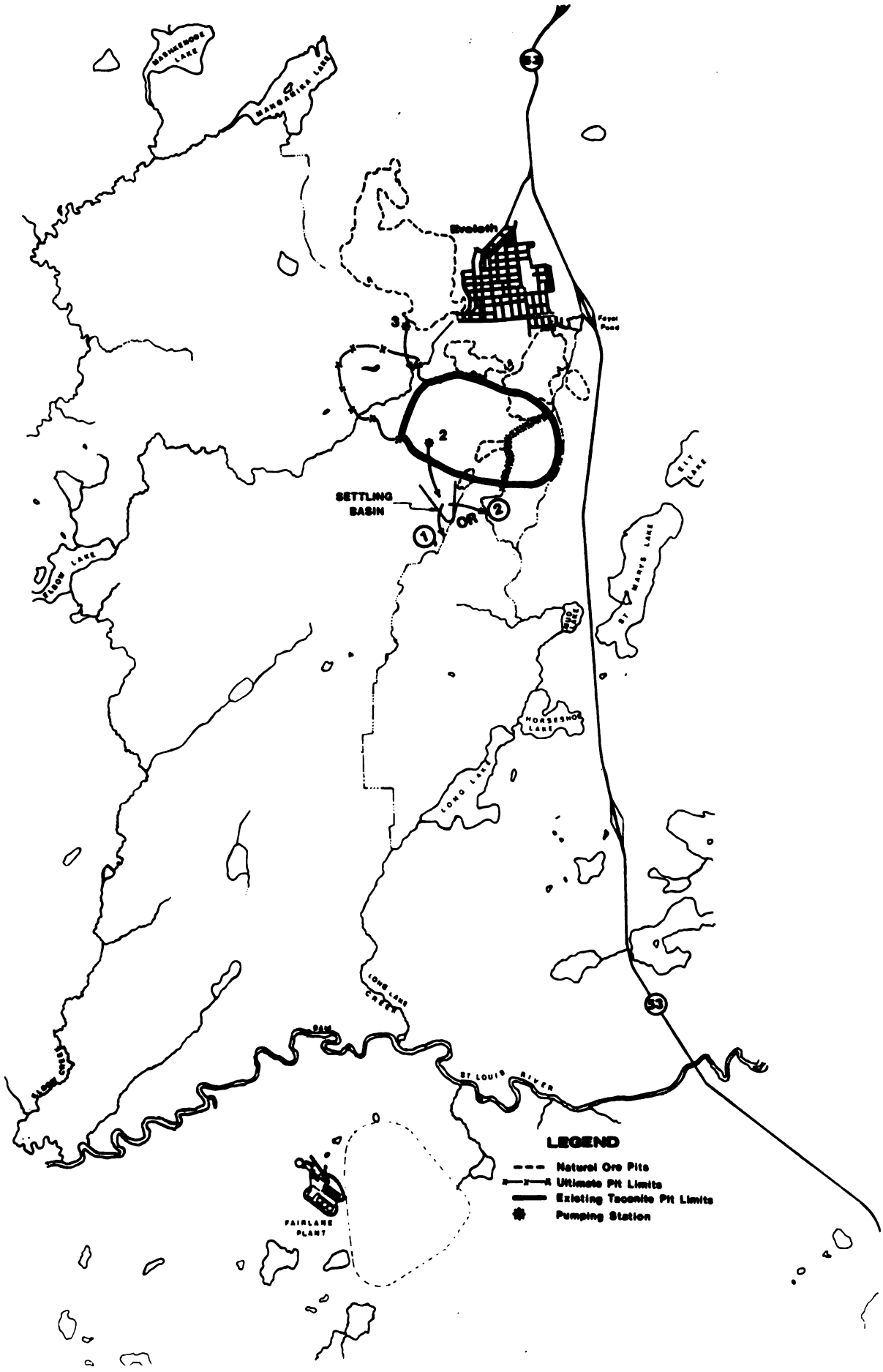


Figure 15 Dewatering of Expansion Pit - Stage III

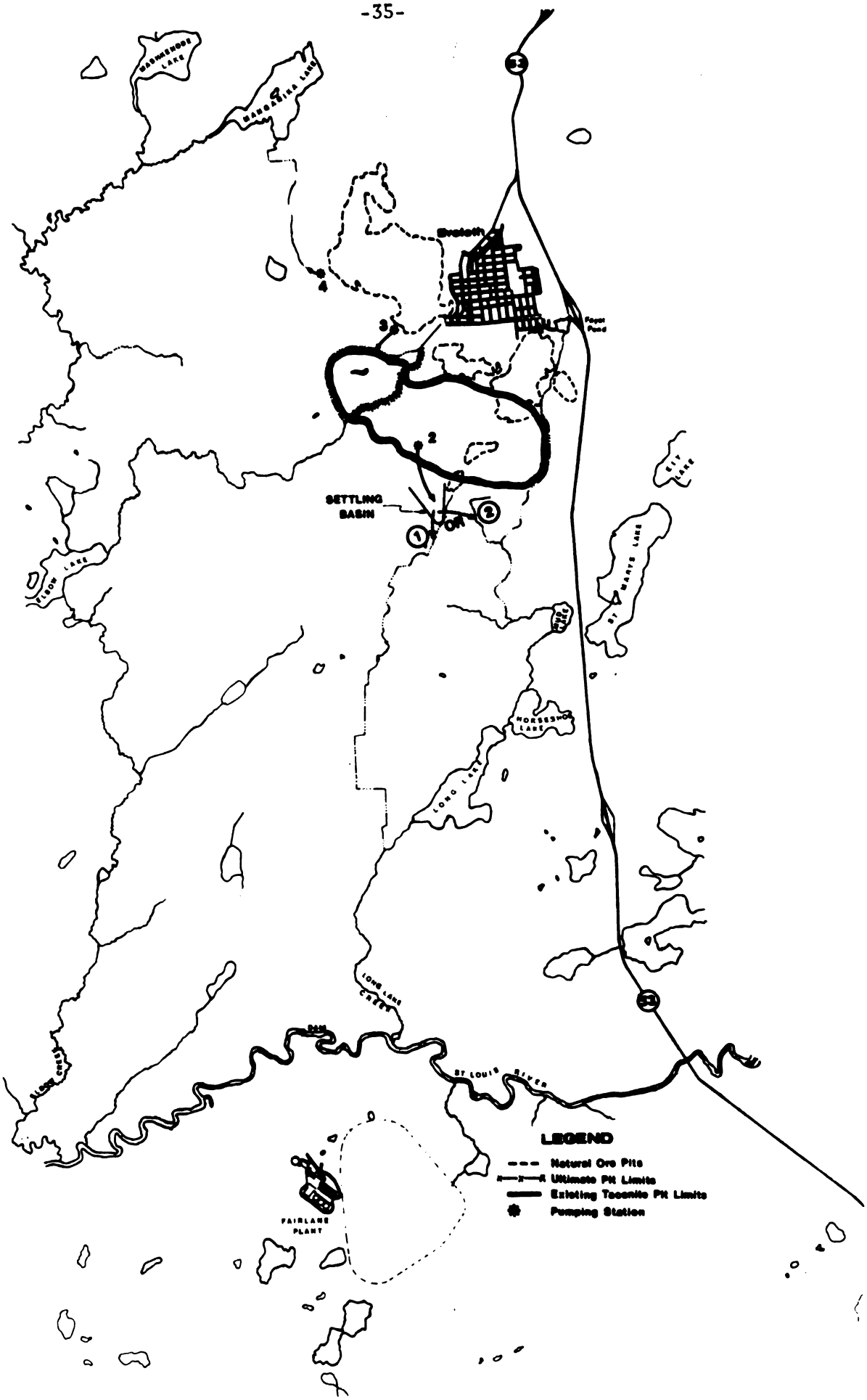


Figure 16 Dewatering of Expansion Pit - Stage IV

#2 and #3 will continue to function as described in Stage III above. In addition, pump station No. 4, located on the abandoned Leonidas U.G. No. 2 shaft, will discharge waters clarified by seepage through the formation directly into a receiving stream running northerly from the shaft area to Manganika Lake. From there, the flowage is southwesterly and southerly in the East Two River to the St. Louis River at a junction point downstream from the dam and pumping system serving the Fairlane Plant. This is the final pumping stage, and will continue until the mine shuts down. The anticipated amounts of water which are to be handled throughout the mine life are located in Table 2 .

Expansion Open Pit Table 2

	Average in Thousands of Gallons per Day				
Appropriation of Water	Stage I	Stage II -Initial	Stage II -Final	Stage III	Stage IV
Surface Runoff (areas downstream of mine)	226	149	72	72	72
Mine Water	4,320	2,160	2,160	4,320	5,760
Ground Water	2	38	38	75	75
Total Appropriated	4,548	2,347	2,270	4,467	5,907
Consumptive Use					
Cooling Water - Drills	9	13	13	17	17
Dust Control - Roads	17	26	26	35	52
Boiler Feed Water	1	2	2	3	3
Crushing Plant Sanitary Sewage	1	2	2	3	3
Total Consumption	28	43	43	58	75
Release of Waters					
Release to St. Louis River	4,520	2,304	2,227	2,969	2,952
Release to Elbow Lake	None	None	None	None	None
Release to Manganika Lake	None	None	None	None	None
Total Released	4,520	2,304	2,227	2,969	2,952

In summary, the results of a study by a consultant for Oglebay Norton indicate that; initial dewatering for development of the Expansion Open Pit will be at an average rate of 3,000 gallons per minute for a three-year period, will drop back to a probable low of 1,500 gallons per minute for a short period following initial dewatering, and will then gradually increase to a probable maximum average rate of 4,000 gallons per minute as the pit expands in area and increases in depth. (The report explaining the water data, developed by Oglebay Norton's consultant, is located in Appendix E).

Dewatering Beyond projected Life

Although the above description of mine dewatering covers the proposed 60-year life of the Expansion operation, the anticipated ore reserves could provide another 10 years of operating life. However, since the mining area would be substantially the same, even if the ultimate life were chosen, there is not much chance that the mine dewatering program would be greatly altered. This projected dewatering program would drastically change, only if a natural ore deposit located in the south end of the Spruce mine were developed. Presently Oglebay Norton does not anticipate developing this ore although other companies have expressed interest in doing so. In the event this does occur, the dewatering program may be quite different. Pump station #3 and #4, or similar stations, may begin dewatering the Spruce, Hull-Nelson, and Leonidas pit earlier than Oglebay Norton presently plans, and therefore, pumping might have to continue from that point until both the natural ore and taconite are exhausted.

Water Use Expansion

Not all of the mine water encountered in the dewatering process needs to be discharged into the natural water drainage system. Some of the mine water can be used to satisfy various nees of the mine. Such needs are:

--water sprinkled on the roads to hold down dust and help stabilize the roadbed

--cooling water for the jet piercers

--emergency water supply in case of fire

--water for irrigation during revegetation.

Oglebay Norton intends to implement a program at the Expansion mine which will utilize this mine water. Two pump stations, one at the Pearsall (during Stages I & II) and the other at the settling basin (Stages III & IV) will provide mine water for the above uses. In addition, some potable water will be required at the Expansion mine and its coarse crusher unit. This water will be provided by two ground water wells located near the Crusher (see Appendix F).

Water Use Thunderbird

To date, operations at the Thunderbird mine have used neither well water nor mine water, since source for all its water needs has been the Eveleth Municipal water system. Because the company realizes that many of its needs (water for dust control, cooling, etc.), do not require treated water, it intends to implement a water use plan similar to that proposed for the Expansion mine. Tables 1 and 2 of this section contain the consumptive uses and volumes for each mine.

Permits

Appendix G contains the status for all the water permits which are required for the company to implement its plans. The appendix concludes with a listing of all state government permits necessary to begin the action.

Other Structures

Before completing the description of the mining operation some less complex plans which are essential to the operation must be noted. Because the overall area in which mining is to occur is vast, structures will be built which conflict with existing facilities. A list of structures or facilities which must be constructed, altered or abandoned before mining can begin or advance from one stage to the next follows:

(A) The construction of an inter-mine road which will provide access for mining equipment between the Expansion pit and the shops at the Thunderbird Mine.

(B) The construction of an overpass at the intersection of this inter-mine road with Highway #7.

(C) The abandonment of the DM&IR tracks within the pit limits of the Expansion mine plus the railroad spur which provides Eveleth with rail service.

(D) The eventual abandonment of that portion of Highway #7 which lies within the Expansion pit limits.

(E) Construction of a new road to replace Highway #7 and provide continued access to Eveleth from the southwest.

(F) The construction of an overpass west of the Thunderbird mine to provide access to the western dump area

(G) The realignment of rail lines that will be affected by changes in the size of the Thunderbird mine and the western dump area.

Mineral Beneficiation

Ore from the crushers at the mines is sent by rail to the Fairlane plant for additional processing. The actual procedure of processing, and descriptions of the equipment can be found in Appendix A. Basically, the crude crushed ore from the mine is further crushed and ground into fine powder-like particles. To avoid dust problems and to provide a medium by which the fine particles can be transported the material is mixed with water, to form a pulp. This pulp is pumped into magnetic separators which divide the iron-rich magnetic particles from the non-magnetic, iron-poor particles. For every 3 tons of ore, 1 ton of iron-rich particles, called concentrate, and 2 tons of iron-poor material called tailings, are produced. The concentrate is dried and formed into ½ inch pellets for shipment to steel mills. The tailings are divided into a coarse fraction (about the size of coarse sane) and a fine portion (powder-like) which are disposed of in a tailings basin.

Plant Expansion

Present plans call for a production expansion, at the Fairlane Plant, from 2.4 million tons of pellets per year to 6.0 million tons. This action will necessitate several changes at the Plant site. The main areas which will be affected as a result of the proposed action are:

-the complex of buildings housing the concentrate and pelletizer

-the tailings pond area and

-the water appropriation system.

Enlargement of the building complex has already started, in anticipation of expansion. The new milling, concentrating and pelletizing equipment to be used for processing the increased tonnage of ore from the Expansion pit and Thunderbird mine has been ordered and some pieces are already in place. Two new materials handling areas will be added to the plant site:

-a coal storage yard and

-a fuel oil tank with associated leakage containment dikes.

These facilities (see Figure 17) are required since the present fuel, natural gas, will no longer be supplied to the taconite producers. Firing of the pellets will be fueled by a mixture of coal and fuel oil rather than natural gas.

Tailings, Pond Expansion

By far the largest visual change which will occur in the Fairlane Plant area, will be at the tailings basin. The original permit for deposition of the tailings derived from the Thunderbird ore was proposed to cover an area of about 900 acres. The present expansion plans, in comparison, calls for a tailings basin area that will approach 6 square miles, about 3,800 acres.

The new pond area will be constructed adjacent to the present basin, (see Figure 18) southeast of the plant. The basin will be built in stages (Figures 18 through 22).

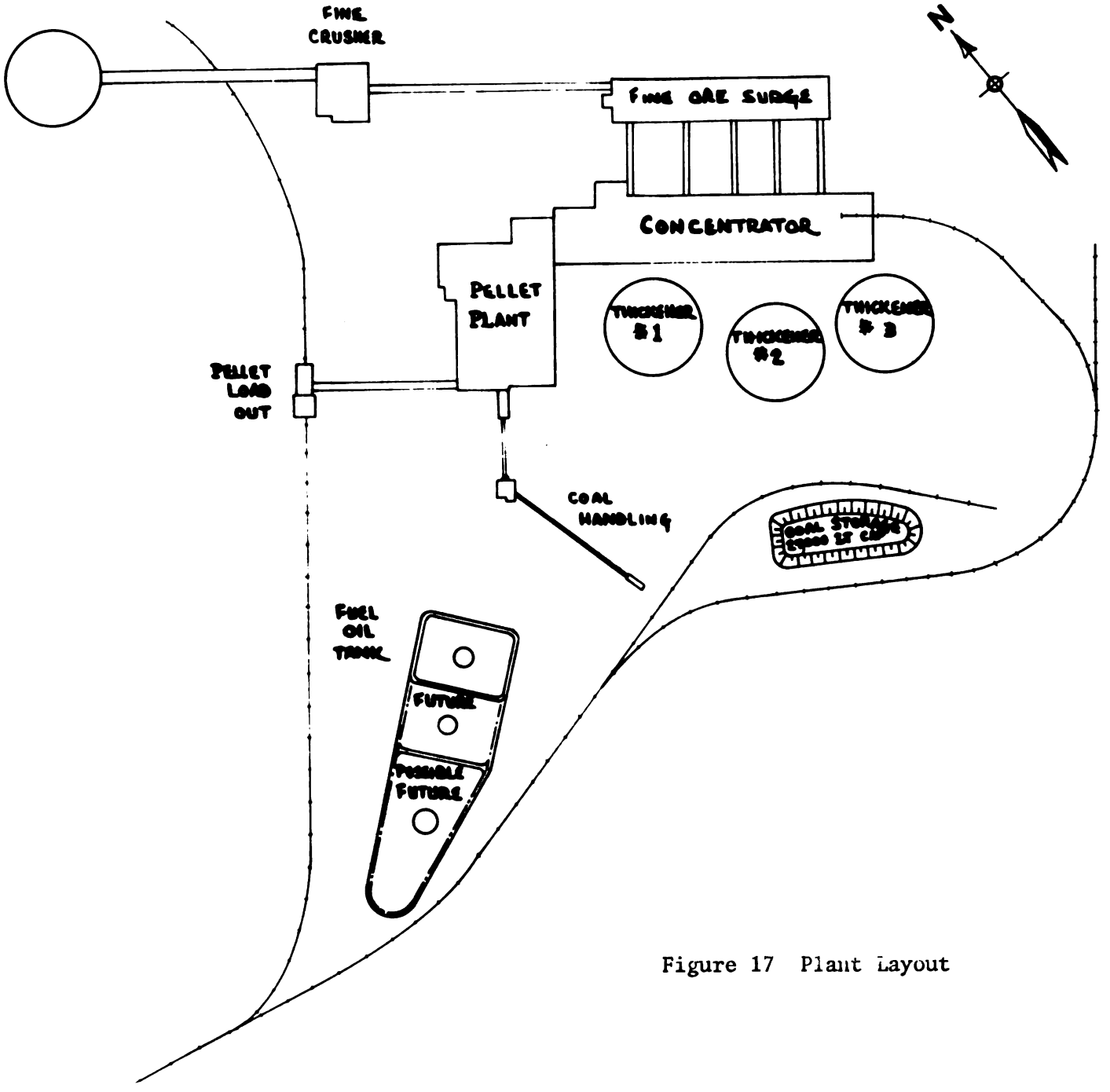


Figure 17 Plant Layout

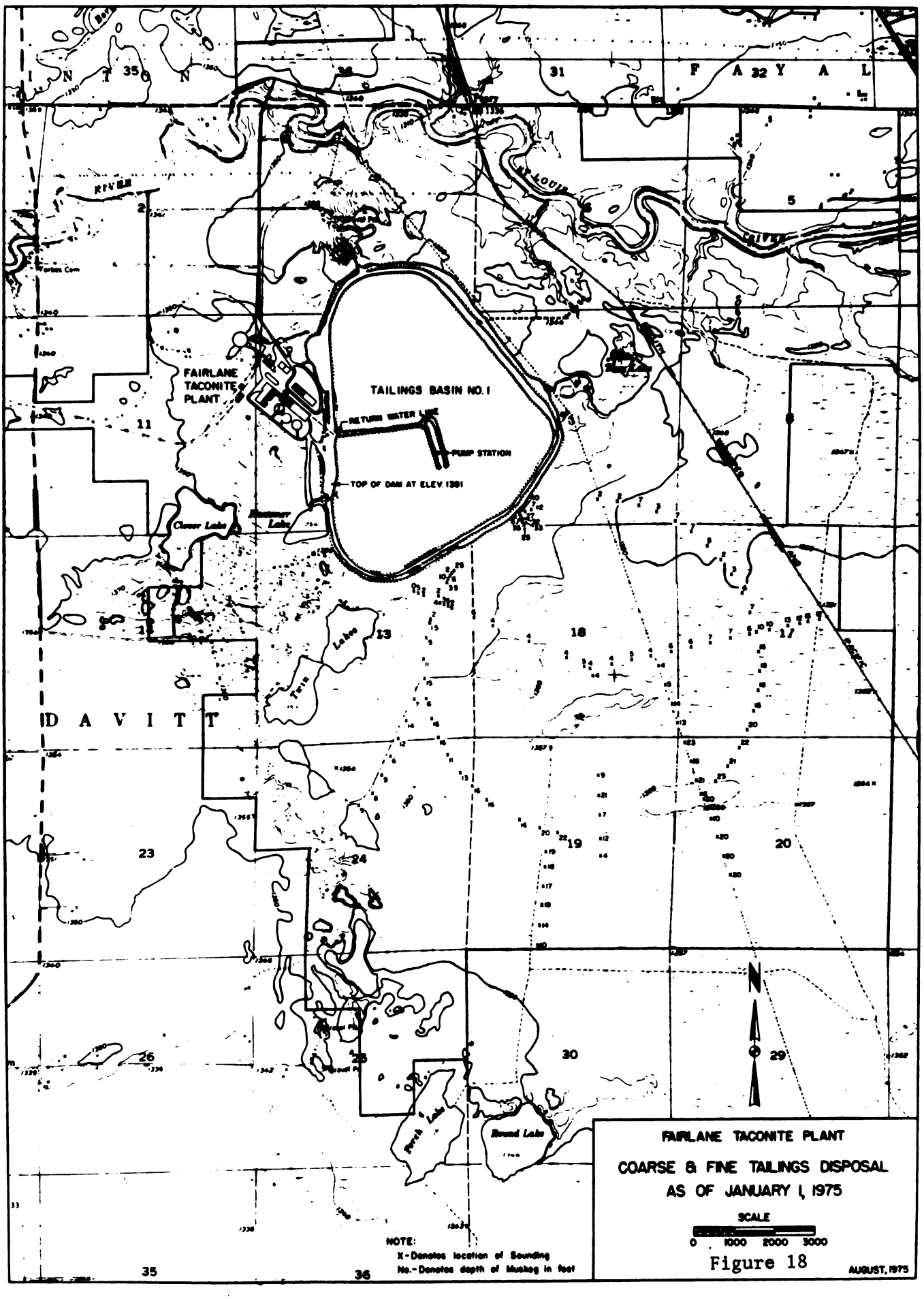
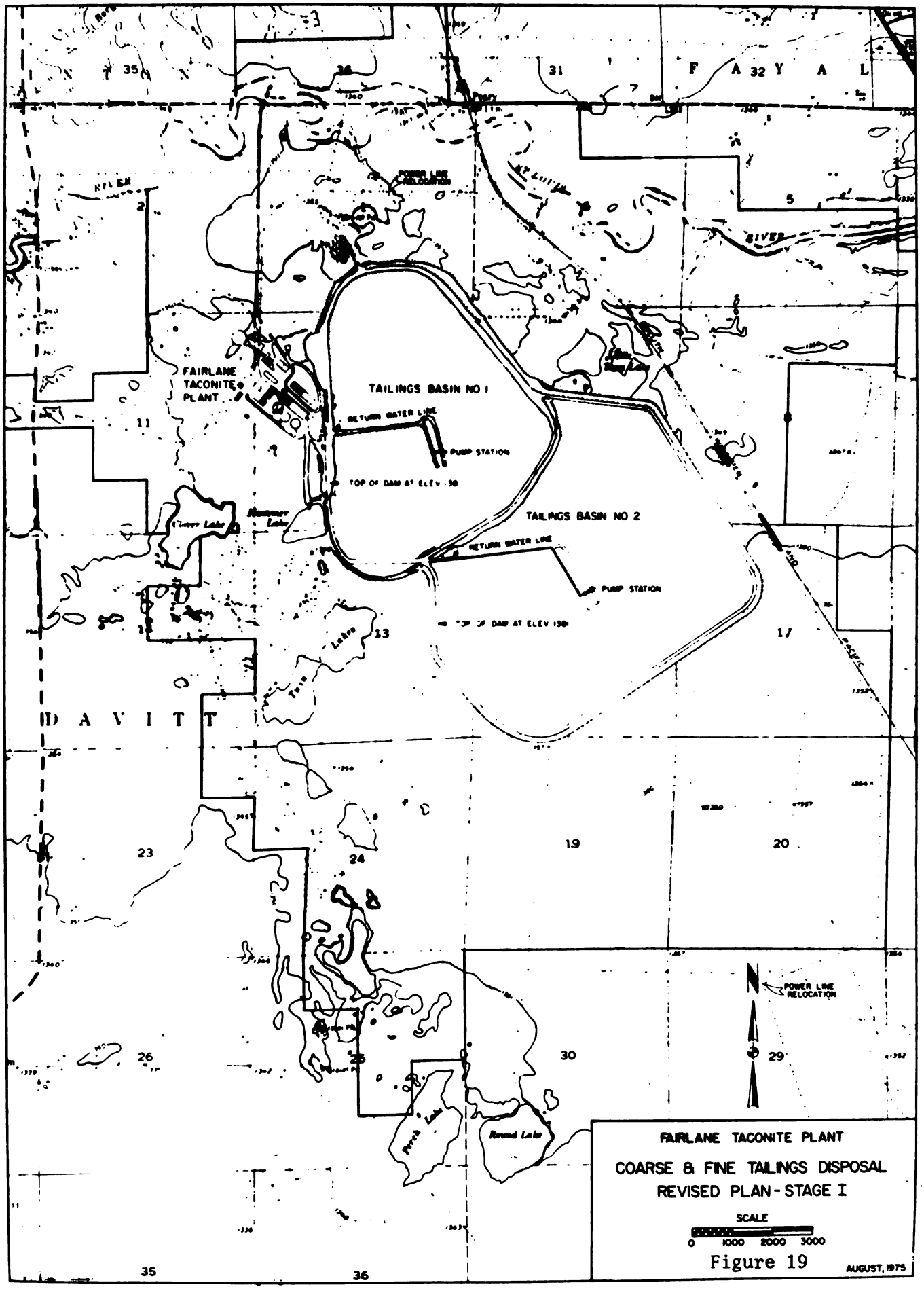
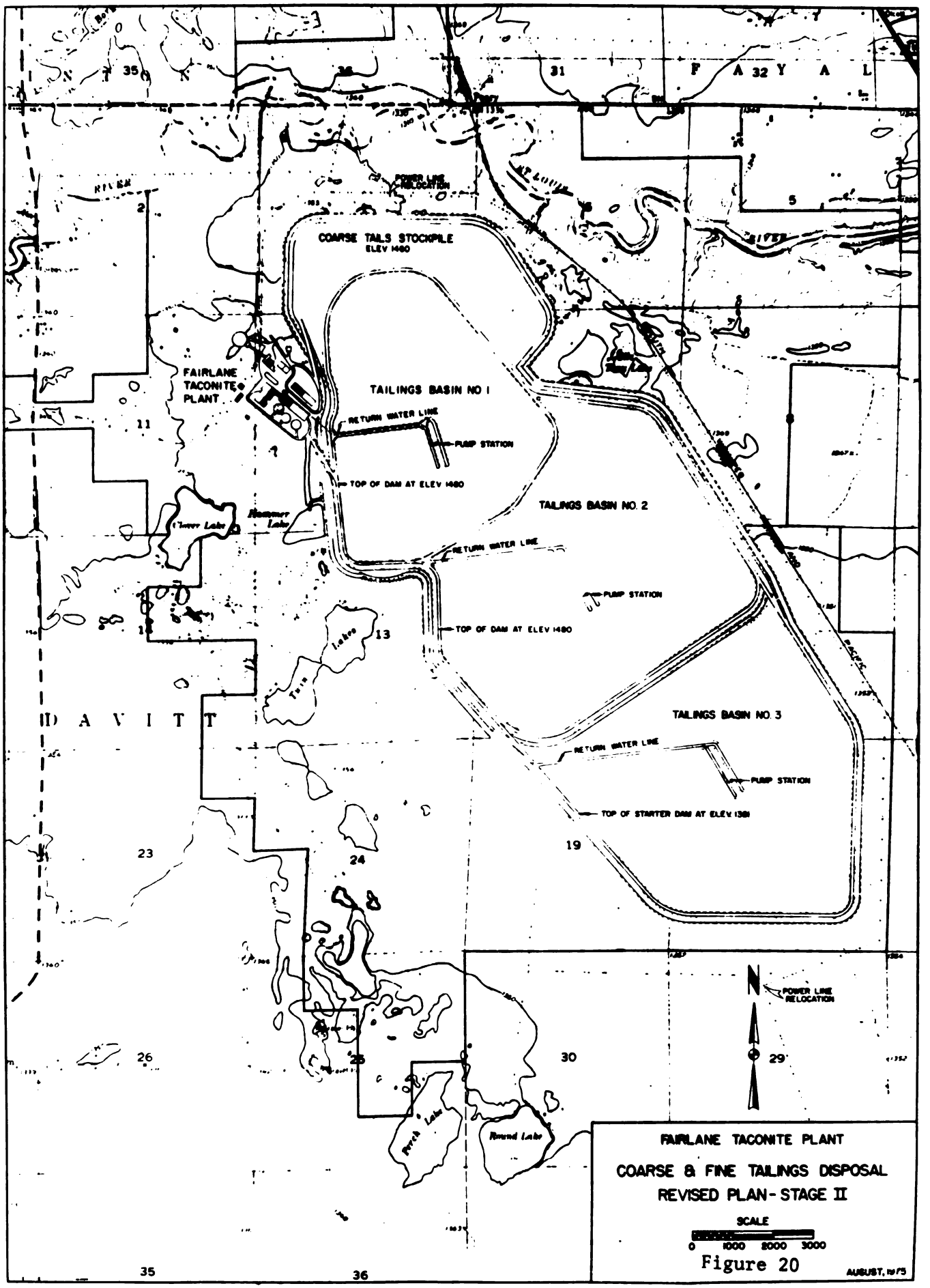

FAIRLANE TACONITE PLANT
TAILINGS BASIN NO. 1
RETURN WATER LINE
PUMP STATION
TOP OF DAM AT ELEV. 1381
Clover Lake
Rosemary Lake
Lake
Twin Lake
Round Lake
D A V I T T
F A Y A L
T 35 N
RIVER
ST. LOUIS
NOTE:
X - Denotes location of Sounding
No. - Denotes depth of Muskeg in feet
FAIRLANE TACONITE PLANT
COARSE & FINE TAILINGS DISPOSAL
AS OF JANUARY 1, 1975
SCALE
0 1000 2000 3000
AUGUST, 1975

Figure 18


T 57 N
T 58 N
T 59 N
T 60 N
F A Y A L
D A V I T T
FAIRLANE TACONITE PLANT
TAILINGS BASIN NO 1
RETURN WATER LINE
PUMP STATION
TOP OF DAM AT ELEV 1361
TAILINGS BASIN NO 2
RETURN WATER LINE
PUMP STATION
TOP OF DAM AT ELEV 1361
POWER LINE RELOCATION
RIVER
Lake
Twin Lakes
Round Lake
Rice Lake
N
POWER LINE RELOCATION
FAIRLANE TACONITE PLANT
COARSE & FINE TAILINGS DISPOSAL
REVISED PLAN - STAGE I
SCALE
0 1000 2000 3000
Figure 19
AUGUST, 1975



FAIRLANE TACONITE PLANT

COARSE & FINE TAILINGS DISPOSAL

REVISED PLAN - STAGE II

SCALE

0 1000 2000 3000

Figure 20

AUGUST, 1975

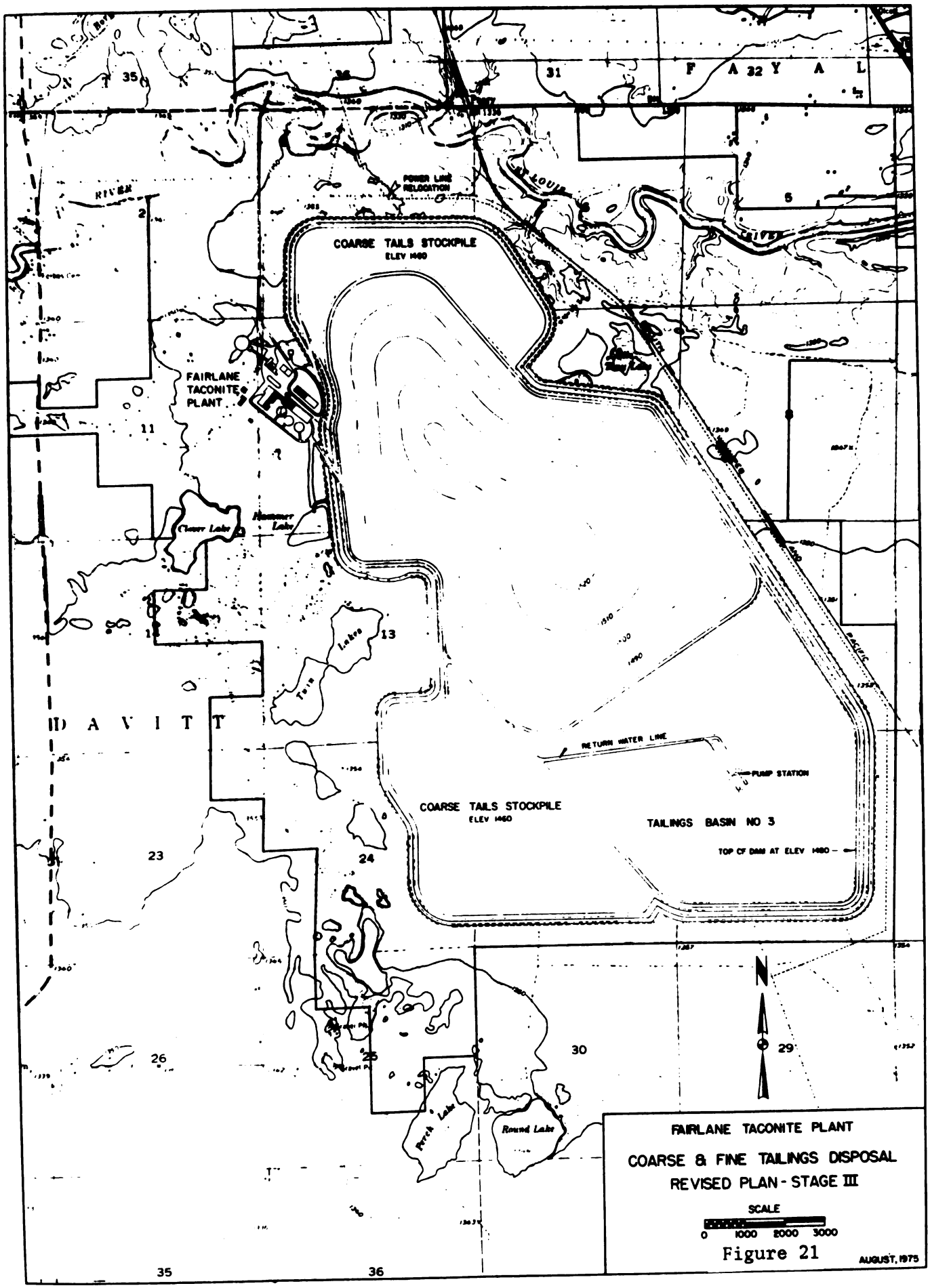

COARSE TAILS STOCKPILE
ELEV 1460
FAIRLANE TACONITE PLANT
POWER LINE RELOCATION
ST LOUIS RIVER
RETURN WATER LINE
PUMP STATION
COARSE TAILS STOCKPILE
ELEV 1460
TAILINGS BASIN NO 3
TOP OF DAM AT ELEV 1480
Clover Lake
Hammer Lake
Twin Lakes
Perch Lake
Round Lake
DAVITT
FAYAL
N
SCALE
0 1000 2000 3000
FAIRLANE TACONITE PLANT
COARSE & FINE TAILINGS DISPOSAL
REVISED PLAN - STAGE III
AUGUST, 1975

Figure 21

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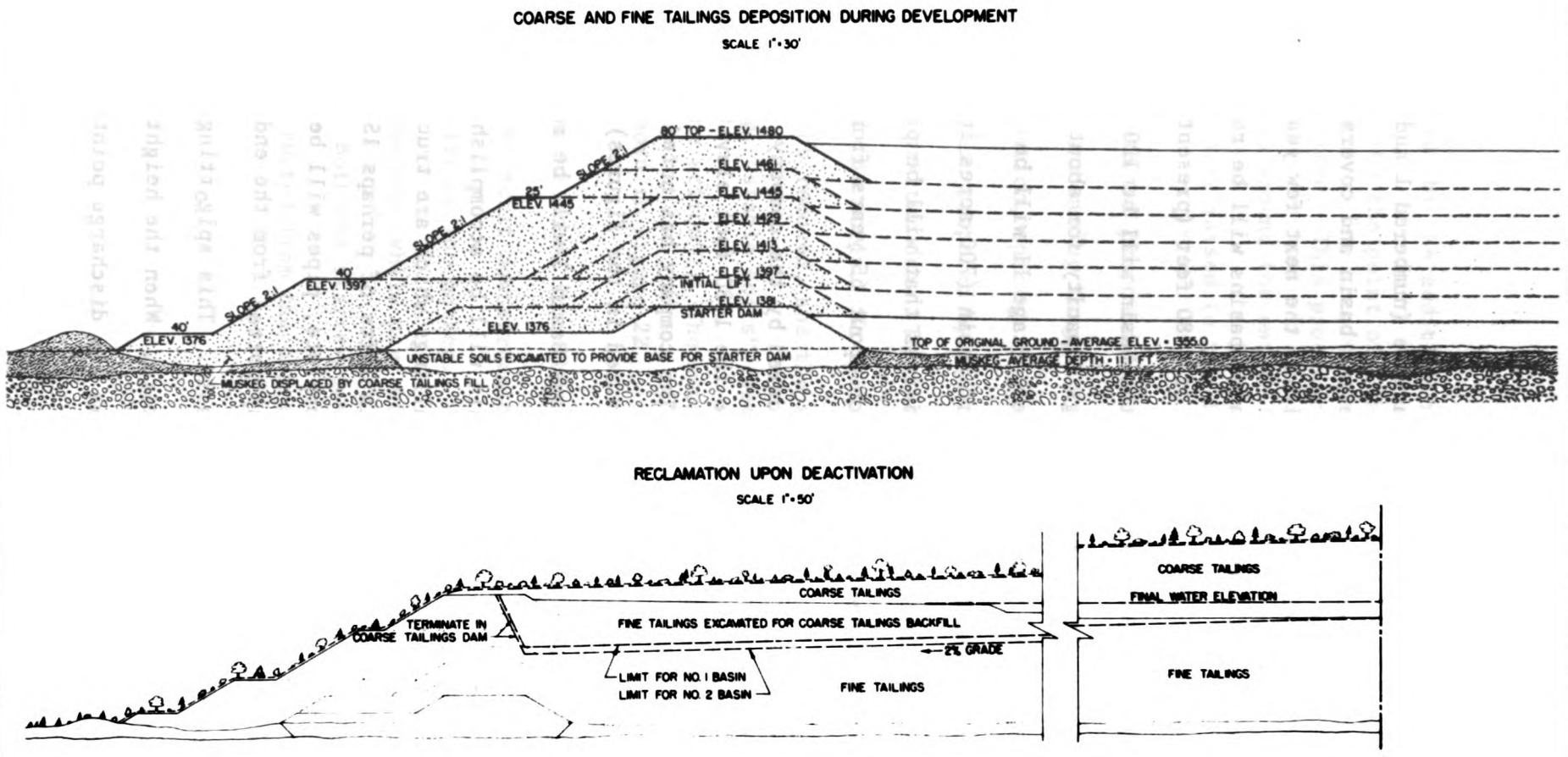


During Stage I two basins will be active (numbered 1 and 2 in the figures). Basin 1 is the present basin and covers about 680 acres. Basin 2 will be built within the next few years and will cover about 900 acres. Both these basins will be raised simultaneously to a final elevation of 1480 feet (present ground surface is at 1360 feet, therefore the basin will be 120 feet deep). These two basins will supply tailings capacity for about 35 years. Before this point is reached, however, Stage II will be implemented. During Stage II a third basin (700 acres in size) will be developed to contain the tailings that will be produced until the designed end of production about 65 years from now.

Stage III is the final period considered by the company. During this stage Basin 3 will be filled to the 1480 foot elevation and basins 1 and 2 will be reclaimed. The company has noted that an additional stage number IV (not pictured in the figures) should also be considered. During that stage Basin 3 will be reclaimed.

The development of the tailings basin will be accomplished by building a closed dike of coarse tailings which are trucked into position. The dike will be built in lifts of perhaps 15 feet. (See Figure 22). When a lift is complete, pipes will be placed on the top and fine tailings will be spigotted from the end of the pipe toward the interior of the basin. This spigotting will locally cause the formation of a delta. When the height of the delta approaches the top of the dike the discharge point will be

raised, by the addition of a new lift. In turn this area will again be the point of spigatting and in time the dike will again be raised. This procedure will take place at all spigatting points around the entire basin. In this manner the basin will be gradually raised to the design height.

Foundation Conditions

Because the proposed basin is located on a bog and the underlying peat and muskeg (organic soil types) do not provide a very stable foundation, special design of the basin structures must be developed. The plan proposed by the company is to build the dikes on the top of a starter dam. This starter dam (see Figure 22) must be built on stable soils. To provide this stable base the peat and muskeg will be removed, and the starter dam will be placed on the underlying, "stable soils" (see "soils", in the "environmental setting of the action"). The remainder of the dike will be constructed as shown in Figure 22.

It may be noted from this figure that the portion of the dike which will be built downstream of the starter dam will be constructed directly on the muskeg. Part of the muskeg will be compressed under the loading, while part will be displaced out ahead of the downstream toe. Both the starter dam and the remainder of the dike will be constructed from the coarse tailings.

Seepage

Because the dikes will be built to retain water as well as tailings, seepage is also a design consideration. Seepage estimates for the tailings basin are reported to be 1300 gallons per minute. In order to prevent excessive seepage the company is proposing that a dry beach of fine tailings, between the upstream (interior) side of the dike and the water level of the pond be maintained. The purpose of the beach is to keep water away from the very previous dike. The fine tailings which constitute this beach are highly impermeable and therefore do not allow easy transmission of water. The fine tailings in effect act as a sealant on the interior face of the dike.

Tailings Basin Reclamation

A program of reclamation will be initiated by the company:

-upon completion of each basin and

-when any portion of the dike has reached a point where it will no longer be covered with coarse tailings.

The reclamation procedures proposed by the company include:

1. removal of floating pump stations together with tailing and return water pipelines
2. excavation of a trench in each basin, leading from the basin's center to the coarse tailings dike
3. backfilling of the trench with coarse tailings to form a "French Drain"
4. depositing of coarse tailings over the fine tailings to eliminate dusting
5. contouring the tailings on the top of the basin
6. covering the tailings with a two foot layer of muskeg
7. seeding and mulching the top of the basin and those slopes not previously vegetated

8. planting of seedlings to expedite the vegetative process.*

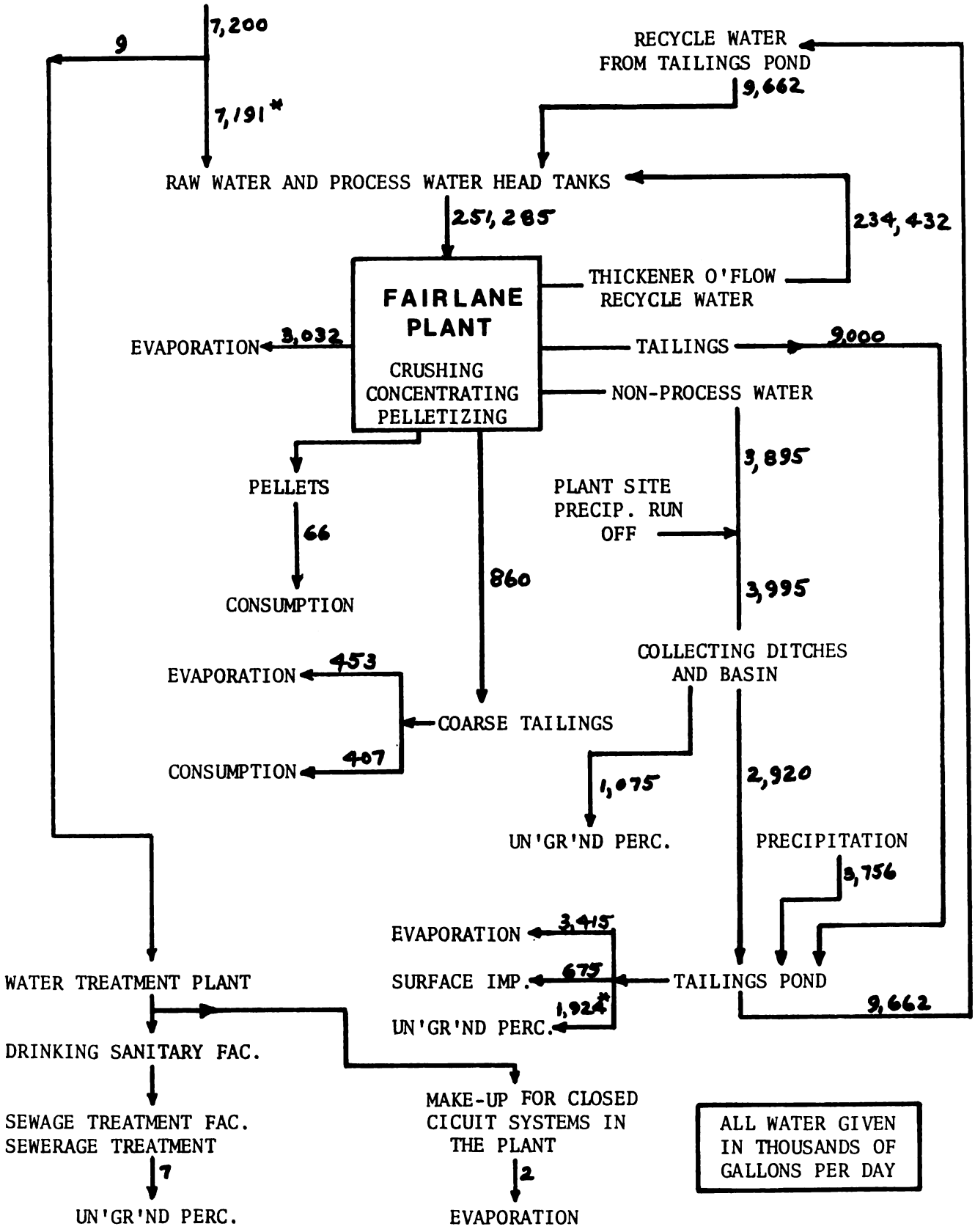
These steps are graphically depicted on a typical cross-section (Figure 22) and on the Stage III plan map (Figure 21). Most of the reclamation steps are self-explanatory with a few exceptions. Numbers 2 and 3 describe the steps to construct a "French Drain". The purpose of the drain is to keep the interior of the basin from refilling with rainwater and overstopping the dikes. Because the fine tailings in the basin are highly impermeable, any water which might enter the basin would tend to form a pond rather than seep through the fines. To avoid this, the company intends to dig a trench through the fine tailings, into the porous dike. This trench will then be refilled with coarse tailings, thus forming a channel through which the water can flow and exit the basin.

The reclamation procedures outlined by the company will substantially increase the basin's height above the height of the dikes. The final surface of the basin will reach an ultimate height of 160 feet above the surrounding topography.

Water Use

Water is an extremely important part of the concentrating process. For every ton of crude ore that will enter the expanded plant, 5,095 gallons of water will be required (see flow sheet, Figure23). As the flow sheet (Figure 23) indicates the greatest percentage is supplied

*An important step has not been included on this list; drawdown of water pond upon abandonment of the basin.



NOTE: ALL PROCESS SPILLS ARE CONTAINED AND RETURNED TO THE TAILINGS POND
*AFTER POND STABILIZATION

Source: Arthur G. McKee & Company

Figure 23 SCHEMATIC OF WATER FLOW - EVELETH EXPANSION CO.

by recycling the thickener overflow and clarified water from the tailings basin (see Appendix A). However, these sources do not supply the entire quantity required. Therefore, appropriation of water will be made from the St. Louis River, which is about a mile north of the plant. Present estimates of the average quantity to be appropriated each day are 7,200,000 gallons, which equals about 11.1 cubic feet per second of flow.

The DNR currently permits the appropriation of up to 17 cubic feet per second by the Fairlane Plant, with the stipulation that a minimum flow in the St. Louis River is to be maintained. Therefore, the 11.1 cfs anticipated by the company is within the quantity already reserved for the Fairlane Plant's use.

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ENVIRONMENTAL SETTING OF THE ACTION

Climate

Weather observation data is available from the Virginia Weather Station which is located in the center of the north half of the northwest quarter of Section 19 of T58N, R17W.

The climatology of the area as described by Joseph H. Strub, Jr. of the U. S. Weather Bureau (1) follows:

Precipitation

"Located in the center of a great land mass the climate of Virginia is typically continental with cold winters and warm summers. Precipitation, resulting chiefly from thunderstorms, is heaviest during the summer. Snowfall in winter is moderate to heavy. Slightly over 19 inches, about 70 per cent of the annual precipitation, falls during the period April through September. Yearly totals have ranged from 42.83 inches in 1905 to 17.80 inches in 1923. The greatest monthly total was 10.34 inches in August 1900. Measurable precipitation of 0.01 inch or more can be expected about 120 days per year, 61 of which will have 0.10 or more and 4 or 5 with a total of one inch or more. Rainfall intensities of about 1 inch per hour can be expected to recur about once in two years. On the average 32 thunderstorms occur each year, some accompanied by hail and damaging winds. Tornadoes are very infrequent with only 6 reported in St. Louis County during the period 1916-1959. During a typical year 80 clear days, 104 partly cloudy days and 181 cloudy days can be expected."

"Measurable snowfall occurs in October in about 1 year in 2 with the snow cover remaining usually until late April. Snow can be expected in early May about 1 year out of 3. The most notable May snowfall was the 17.8 inches total during the first 7 days of May 1954. With an annual average snowfall of near 70 inches this is an ideal area for winter sports. The greatest annual snowfall was 135.5 inches in 1950."

Temperature

"Being near the source region of cold Canadian air the winters in Virginia are cold with a mean temperature of 11.0 degrees above zero for the three major months of December, January and February. Readings of 25^{o} to 30^{0} below zero can be expected on several days during the winter. But, with light wind speeds and low humidity accompanying the cold, the severity is not as great as would be expected. The all time low for the area is 45^{o} below on January 24, 1904, when the station was located 4½ miles northwest of Virginia at Mountain Iron."

"The summers are pleasant with an average temperature of 65.5 degrees for the three summer months of June, July and August. Hot days are not common with only 6 days during the summer expected to be 90^{o}F or higher. Even in the warmest months a drop at night to the mid-fifties is usual. Warm pleasant days, cool nights, green forests and many lakes within a 50-mile radium have been a factor in making the Virginia area a mecca for summer vacationers."

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"The following table gives occurrences of some critical temperatures:

(Source: U. S. Weather Bureau "Climatography of the U.S. No. 20")

Table 3

Temperature	Ave. Date of Last in Spring	Ave. Date of First in Fall	Ave. Number of Days between Dates
32°F	May 16	September 18	115
28°F	May 13	September 29	139
24°F	May 4	October 9	158
20°F	April 22	October 23	184
16°F	April 12	November 2	205

The latest spring occurrence of a temperature of 32 degrees is June 23 and the earliest in the fall August 23. The probability of a temperature of 32 degrees after April 30 is 50 years in 50, after May 10, 44 years in 50, after May 20, 37 years in 50, after May 30, 27 years in 50. The probability of a temperature of 32 before September 1 is 9 years in 50, before September 10, 18 years in 50, before September 30, 39 years in 50 and before October 1, 48 years in 50."

Evaporation

The mean monthly temperature and precipitation for the year 1930 through 1969 are presented in tables 4&4. The means and extremes for the period 1930 through 1959 are presented in Table 6. The average annual lake evaporation in inches for the period 1946-1955 is presented in figure 14." Evapotransporation for the area was estimated by the DNR using temperature data from Table 4 , to be 20.31 in./yr.

Average Temperature (°F)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1930	-1.0	18.8	24.6	42.8	53.2	64.2	67.3	68.4	55.2	43.1	29.8	16.7	46.3
1931	16.6	24.2	26.6	43.4	51.8	65.6	69.8	64.2	61.4	49.9	34.9	23.2	44.3
1932	14.6	12.2	16.0	40.6	53.8	66.6	67.1	66.2	55.0	40.6	23.9	8.8	38.8
1933	13.5	4.4	23.8	38.2	54.4	69.0	69.5	63.8	58.8	38.4	22.0	4.8	38.4
1934	13.6	8.4	18.8	37.6	59.0	63.0	66.8	57.8	53.6	46.9	32.4	8.4	38.9
1935	2.1	17.8	24.1	37.4	49.0	57.3	71.6	64.6	51.9	42.1	20.2	13.2	37.6
1936	-0.4	-4.8	23.4	32.2	55.0	59.2	72.0	65.2	57.7	37.0	21.2	13.5	35.9
1937	-1.2	9.4	21.0	37.4	54.5	62.0	68.2	70.0	55.8	39.7	25.1	9.8	37.6
1938	5.5	16.9	32.8	39.8	51.4	61.7	67.0	68.4	55.8	48.7	23.8	12.3	40.3
1939	11.9	2.2	20.3	36.7	55.2	62.6	68.8	66.1	56.4	41.0	32.0	23.6	39.7
1940	5.1	15.8	19.3	38.0	50.2	59.3	67.1	63.0	59.3	46.4	22.4	14.0	38.3
1941	9.7	10.9	23.0	46.6	57.8	63.3	71.5	64.0	57.0	44.6	28.5	18.4	41.3
1942	13.2	12.8	29.1	47.0	50.4	60.8	64.8	65.0	52.6	45.0	26.6	8.4	39.6
1943	1.2	12.7	16.2	38.6	51.0	62.9	70.8	65.5	52.8	45.8	23.4	14.5	38.0
1944	18.7	10.8	21.5	39.4	56.0	63.3	66.5	65.4	56.0	45.8	33.2	12.6	40.8
1945	7.2	13.4	34.6	37.0	47.0	57.2	64.6	64.5	52.8	42.1	24.8	8.8	37.8
1946	8.4	7.7	35.8	42.4	50.8	61.7	68.0	63.6	55.0	43.8	27.0	11.3	39.6
1947	11.3	7.7	22.4	35.6	48.4	58.9	68.6	69.8	54.7	52.5	22.5	12.6	38.8
1948	4.2	7.8	23.4	43.0	52.8	60.9	67.6	66.9	60.6	46.8	29.5	12.9	39.7
1949	10.5	7.4	21.1	43.5	55.0	65.1	68.1	68.2	53.6	45.0	30.2	12.0	39.9
1950	-1.1	11.7	17.9	30.2	49.5	60.9	64.2	59.5	56.5	46.6	22.4	7.8	35.5
1951	6.0	14.1	19.9	38.6	56.8	60.2	66.3	60.7	51.2	42.8	20.9	10.2	37.3
1952	7.7	20.6	23.4	46.2	53.8	65.2	67.8	64.2	57.6	39.6	30.8	20.9	41.5
1953	12.4	14.2	27.2	37.8	52.3	63.8	66.7	68.0	55.4	51.9	34.0	15.0	41.6
1954	3.8	25.4	22.2	38.6	47.6	65.0	68.0	64.8	54.9	43.6	32.8	19.0	40.5
1955	9.6	11.2	18.1	43.2	57.5	65.4	72.1	69.9	56.0	47.1	21.1	8.0	40.4
1956	14.6	12.1	21.2	36.4	51.3	67.1	64.9	64.4	53.1	51.8	29.5	14.6	40.1
1957	0.2	12.2	25.0	40.4	53.7	62.0	70.8	65.7	55.1	46.1	28.7	17.2	39.8
1958	16.1	12.3	30.2	44.8	54.6	57.4	66.1	65.4	57.2	47.6	30.0	4.2	40.5
1959	1.7	11.1	28.4	40.6	55.5	65.2	69.0	69.2	57.1	40.9	18.5	23.2	40.0
*1960	11.0	15.4	19.5	40.2	54.4	61.8	68.2	68.8	57.0	46.1	30.9	10.7	40.3
1961	6.5	21.9	32.9	36.9	52.9	66.3	68.7	70.0	56.9	46.8	28.8	14.0	41.9
1962	3.5	9.6	28.6	37.8	55.4	62.5	64.8	65.7	54.6	45.8	32.1	13.8	39.5
1963	-2.6	4.9	26.9	41.4	49.2	63.0	67.3	62.1	57.1	53.2	32.5	5.5	38.4
1964	13.6	13.2	19.4	40.1	55.3	59.7	67.2	59.2	52.0	42.6	29.3	5.7	38.1
1965	1.6	2.1	14.3	38.0	53.5	59.1	62.3	61.0	46.2	44.4	25.7	19.3	35.6
1966	-4.2	10.2	27.3	34.8	46.7	62.5	68.4	61.6	53.7	41.6	23.3	11.0	36.4
1967	7.8	.6	23.8	37.0	45.9	60.0	63.0	59.9	55.2	40.8	23.7	13.4	35.9
1968	6.5	7.8	29.7	39.8	49.1	58.9	63.7	61.9	55.4	45.8	27.8	10.1	38.0
1969	5.3	14.0	20.5	42.2	52.2	54.0	63.9	66.2	55.0	39.1	27.1	16.2	38.0
1970	1.0	8.5	19.0	38.2	49.0	63.0	68.7	64.6	55.0	44.4	25.4	9.1	37.2

*Data from 1960 on is not included in Means & Extremes, Table 6.
Source: U.S. Weather Bureau "Climatography of the U.S. No.20"

Table 4

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Total Precipitation (Inches)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1930	0.59	1.59	0.53	0.57	4.11	4.13	3.42	1.76	3.87	1.80	3.05	0.33	25.75
1931	0.42	0.21	1.05	0.86	3.12	5.22	1.33	2.95	4.09	3.74	3.08	0.41	26.48
1932	1.25	0.60	1.22	1.50	3.15	3.04	2.76	2.57	0.35	2.01	3.07	0.82	22.34
1933	0.86	0.82	0.71	2.02	2.39	1.56	2.40	1.34	3.22	4.33	1.73	1.72	23.10
1934	0.80	0.93	0.84	0.84	1.01	2.83	1.70	2.36	2.83	2.09	0.99	1.07	18.29
1935	1.59	0.33	1.82	1.68	1.96	3.95	6.23	6.58	1.99	2.87	1.03	0.68	30.71
1936	0.63	0.68	1.87	1.17	3.00	1.65	1.53	2.95	1.88	0.82	1.52	2.61	20.31
1937	1.31	1.17	0.30	2.94	4.17	1.17	3.43	4.48	4.81	1.03	1.46	1.00	27.27
1938	0.80	0.71	1.77	3.16	4.26	3.38	1.78	2.32	1.09	0.45	2.58	0.82	23.12
1939	1.59	1.18	0.63	0.58	3.93	3.89	0.65	6.89	1.58	2.10	0.12	0.34	23.48
1940	0.43	0.79	1.29	3.23	1.75	3.43	5.20	1.41	2.68	2.00	2.86	0.28	25.35
1941	1.49	0.53	0.90	2.46	1.94	2.94	6.20	4.83	4.45	2.66	0.27	0.50	29.26
1942	0.61	0.31	1.80	1.78	2.71	3.48	3.53	4.99	2.04	1.81	1.14	1.02	25.22
1943	1.41	0.88	1.00	1.92	3.67	4.82	2.78	4.05	3.63	1.33	1.38	0.33	27.20
1944	0.26	0.35	1.65	0.60	4.50	9.31	4.70	4.37	1.96	0.43	2.54	0.58	31.25
1945	0.82	1.10	2.72	3.52	0.97	3.14	2.69	3.12	3.56	1.22	1.31	0.97	25.14
1946	0.96	0.93	1.23	2.26	3.26	7.36	2.07	3.79	5.12	5.37	2.54	1.30	36.19
1947	0.43	0.59	0.64	2.86	1.92	3.35	2.32	4.63	9.41	0.72	2.99	1.00	30.86
1948	1.06	0.80	1.66	4.98	1.03	2.81	5.40	3.34	0.29	0.90	1.64	1.58	25.49
1949	1.28	0.75	1.69	0.86	3.38	3.30	6.00	4.44	1.38	4.70	1.59	1.31	30.68
1950	2.21	0.31	2.24	3.92	4.59	4.02	3.32	3.57	2.09	2.23	1.47	0.99	30.96
1951	0.58	1.79	2.12	2.20	1.90	4.80	2.94	5.54	4.01	3.57	1.10	1.32	31.87
1952	0.88	0.14	1.01	1.68	0.63	5.78	6.26	4.47	0.76	0.31	1.35	0.31	23.58
1953	1.39	0.55	1.52	1.98	4.49	4.28	4.99	5.08	6.00	0.59	1.70	1.16	33.73
1954	1.34	0.91	1.64	3.67	3.94	1.69	1.23	1.73	3.44	1.40	1.75	0.13	22.87
1955	0.50	1.44	1.57	0.78	3.64	3.54	9.24	2.08	4.45	2.45	2.18	1.01	32.88
1956	1.31	0.32	0.61	2.20	1.38	1.47	1.26	4.70	1.14	2.17	1.47	1.45	19.48
1957	0.34	1.00	1.21	2.96	2.64	4.92	7.56	1.97	3.47	1.26	1.90	0.51	29.74
1958	0.75	0.31	0.45	0.49	2.05	5.17	5.32	3.57	3.42	1.03	2.98	1.06	26.60
1959	0.40	0.20	0.20	1.00	4.84	4.00	3.24	7.24	3.53	2.10	1.70	0.40	28.85
*1960	.81	.15	.52	3.17	4.84	2.56	4.87	2.06	2.36	1.84	1.48	.84	25.50
1961	.37	.55	1.44	3.98	2.53	1.32	3.93	1.60	6.48	2.02	.96	.89	26.07
1962	.63	1.07	.18	2.54	4.29	2.67	4.20	2.26	2.51	.30	.36	.37	21.38
1963	.15	.29	.97	2.62	2.57	6.14	4.45	3.36	2.14	.81	1.28	.59	25.37
1964	.55	.29	.58	3.23	4.26	5.28	1.07	4.37	3.68	.93	.70	1.86	26.80
1965	.59	.50	1.91	2.43	4.07	3.67	3.41	2.25	5.45	3.62	3.42	1.51	32.83
1966	1.77	.82	2.33	2.30	1.13	4.39	2.07	6.68	.92	2.34	.83	.88	26.46
1967	1.63	.34	.80	2.35	2.23	5.09	2.92	2.07	1.48	1.83	.59	1.10	22.43
1968	.65	.15	1.98	2.44	2.24	6.01	2.99	8.52	3.21	4.29	.25	1.71	34.44
1969	3.03	.38	.25	1.39	4.14	2.80	5.06	3.41	3.78	1.72	.85	1.34	28.15
1970	.61	.30	.93	2.81	2.63	3.65	1.84	.68	2.45	7.00	2.11	1.26	26.27

*Data from 1960 on is not included in Means & Extremes, Table 6.
Source: U.S. Weather Bureau "Climatography of the U.S. No20"

Table 5

U. S DEPARTMENT OF COMMERCE, WEATHER BUREAU
IN COOPERATION WITH OLIVER IRON MINING DIVISION
UNITED STATES STEEL CORPORATION
CLIMATOGRAPHY OF THE UNITED STATES NO. 20 – 21

LATITUDE 47°32'N
LONGITUDE 93°32'W
ELEV. (GROUND) 1245 Feet

CLIMATOLOGICAL SUMMARY

STATION VIRGINIA, MINNESOTA

MEANS AND EXTREMES FOR PERIOD 1930–1959

Month	Temperature (°F)							**	Precipitation Totals (Inches)								Mean number of days					
	Means			Extremes								Snow, Sleet						Temperatures				
																		Max.		Min.		
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean degree days	Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year	Precip. .10 inch or more	90° and above	32° and below	32° and below	0° and below	Month
(a)	30	30	30	30		30		10	30	30		30	30		30		30	30	30	30	30	
Jan.	18.0	-2.4	7.8	52	1942	-42	1935	1796	0.94	0.91	1941	12.8	30.4	1950	8.0	1954	3		28	31	17	Jan.
Feb.	23.7	0.5	12.1	53	1949	-41	1936	1621	0.74	0.65	1946	9.9	26.2	1939	7.5	1937	2		22	28	14	Feb.
Mar.	35.0	12.4	23.7	81	1946	-29	1943	1284	1.26	1.65	1945	12.0	26.6	1951	10.0	1954	4		13	30	6	Mar.
Apr.	51.9	26.0	40.0	91	1952	- 8	1954	794	2.02	1.91	1948	7.3	31.8	1950	11.8	1950	5	*	1	21	*	Apr.
May	66.2	39.7	52.9	96	1939+	18	1945	364	2.88	1.60	1949	2.1	17.8	1954	8.0	1950	7	*	*	6		May
June	75.3	50.6	63.0	102	1931	27	1946	106	3.81	2.17	1932	T	5.0	1945	5.0	1945	7	1		*		June
July	81.0	55.1	68.1	103	1936	35	1951	32	3.72	3.67	1955	0	0		0		7	3				July
Aug.	77.7	53.1	65.4	97	1959+	31	1941+	70	3.77	2.68	1947	0	0		0		7	2		*		Aug.
Sept.	67.4	43.9	55.7	99	1931	21	1942+	296	3.09	5.42	1947	0.1	4.1	1942	2.7	1942	6	*		4		Sept.
Oct.	55.7	33.8	44.8	88	1930	1	1933	591	1.98	2.32	1946	2.6	18.9	1951	4.0	1955	5		1	13		Oct.
Nov.	34.9	18.6	26.8	68	1953	-15	1958	1139	1.82	1.75	1930	11.4	29.2	1947	11.0	1947	5		12	27	3	Nov.
Dec.	22.3	4.0	13.2	54	1939	-41	1933	1577	0.90	0.77	1946	11.4	28.4	1936	7.0	1955	3		24	31	12	Dec.
Year	50.3	28.1	39.5	103	1936	-42	1935	9460	26.93	5.42	1947	69.5	31.8	1950	11.8	1950	61	6	101	191	52	Year

(a) Average length of record, years.

T Trace, an amount too small to measure

** Base 65°F

+ Also on earlier dates, months, or years.

* Less than one half.

Table 6

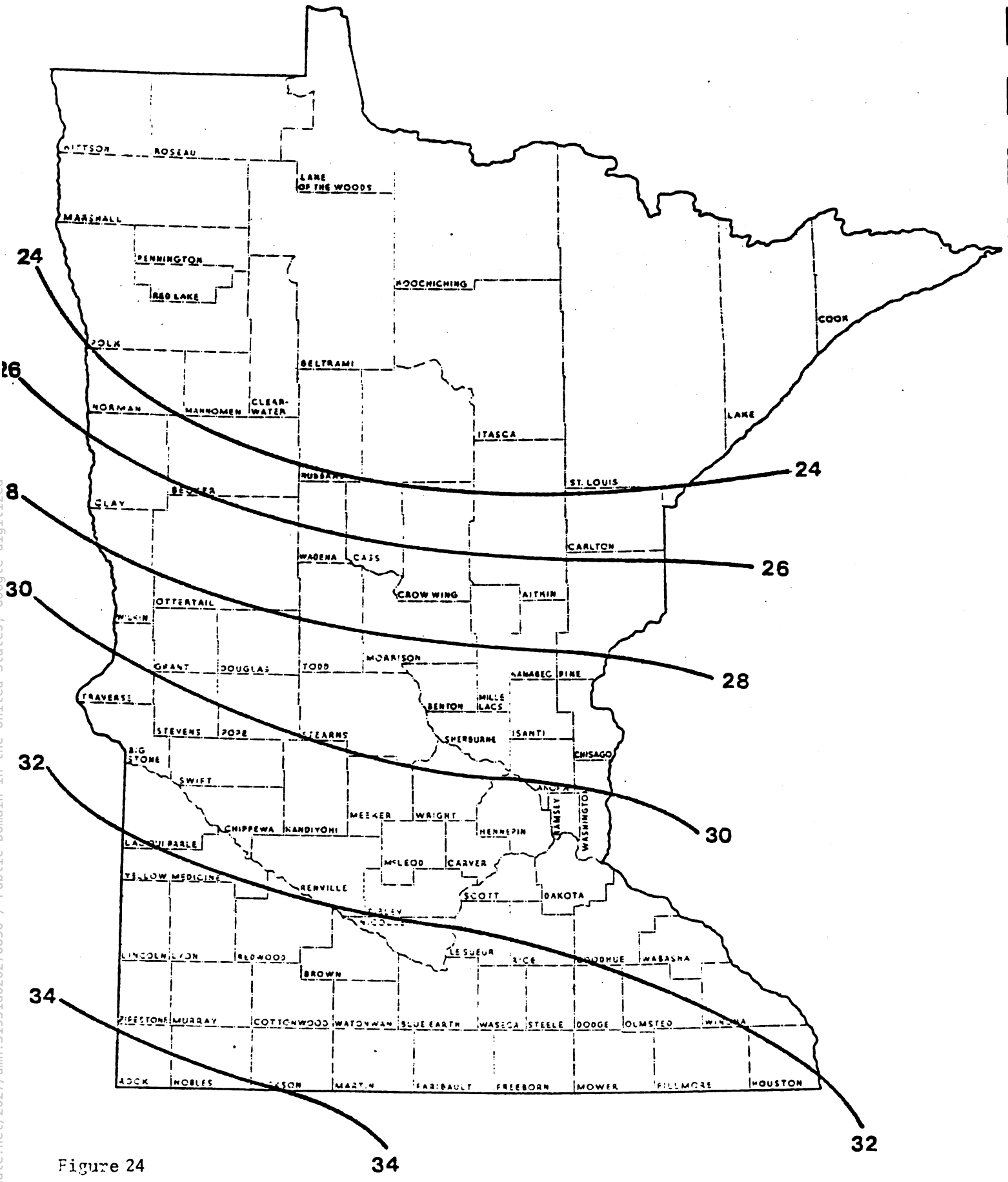


Figure 24

AVERAGE ANNUAL LAKE EVAPORATION IN INCHES

(1946 -1955) Source (2)

Upper Winds

These winds are relatively constant and vary only slightly in speed and direction. Mean yearly wind speed generally varies from 12 mph at approximately 5,000 ft. to a maximum of 45 mph in the 30,000 to 40,000 foot range. The mean direction from which the wind blows shows a relatively small variance of nine degrees, between 279° and 288° (individual directions were added vectorially to find the mean direction). Table 7 shows a summary of the upper wind speed and direction. The variance during any one year from the mean wind-speed and direction are insignificant. (3)

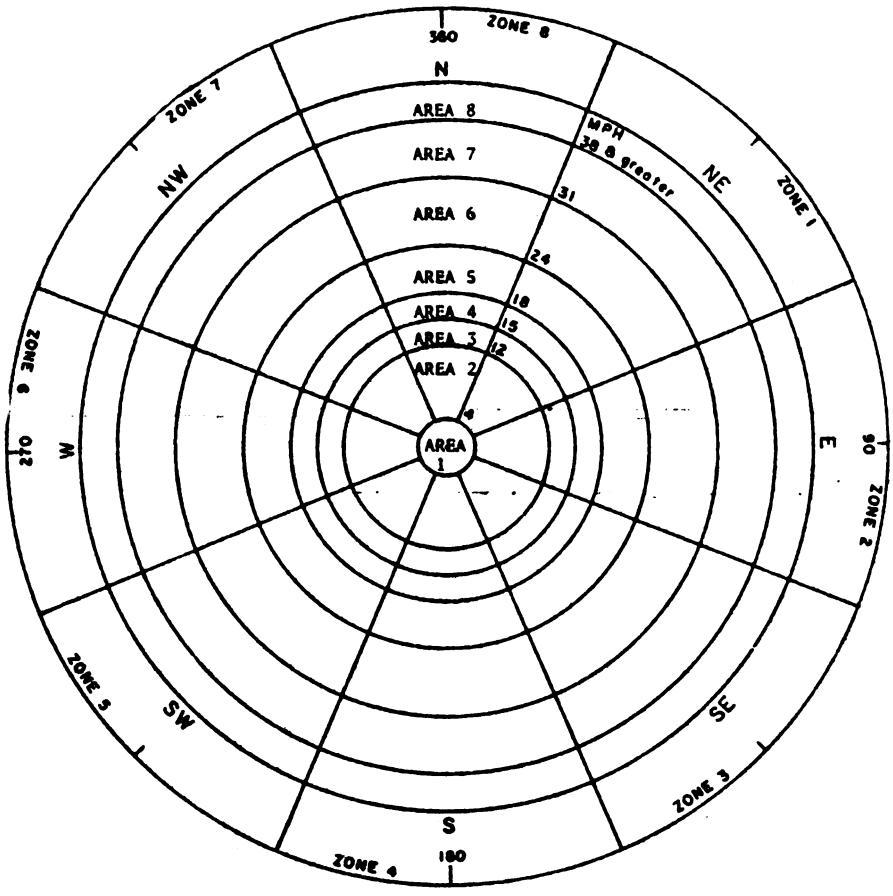
Table 7
Upper Wind Statistics for Northeastern Minnesota

Elevation in Standard Atmospheres (millibars)	Elevation (feet)	Mean Yearly Wind Speed (mph)	Vector Mean Direction (Degrees Clockwise From North)
850	4,800	12	283
700	9,900	20	288
500	18,400	32	285
300	30,200	45	280
200	38,800	45	279
100	53,500	32	284

Lower Winds

The nearest wind monitoring location with data collected over several years is the Chisholm-Hibbing Airport. Figure 25. describes the key for interpreting the wind rose in Figure 26.

The prevailing winds are from the northwest while the least frequent wind directions are from the southwest and the northeast or perpendicular to the predominant wind direction. The wind velocities described in the wind rose are daily averages over a three-year period. (3) This amount of time is not long enough



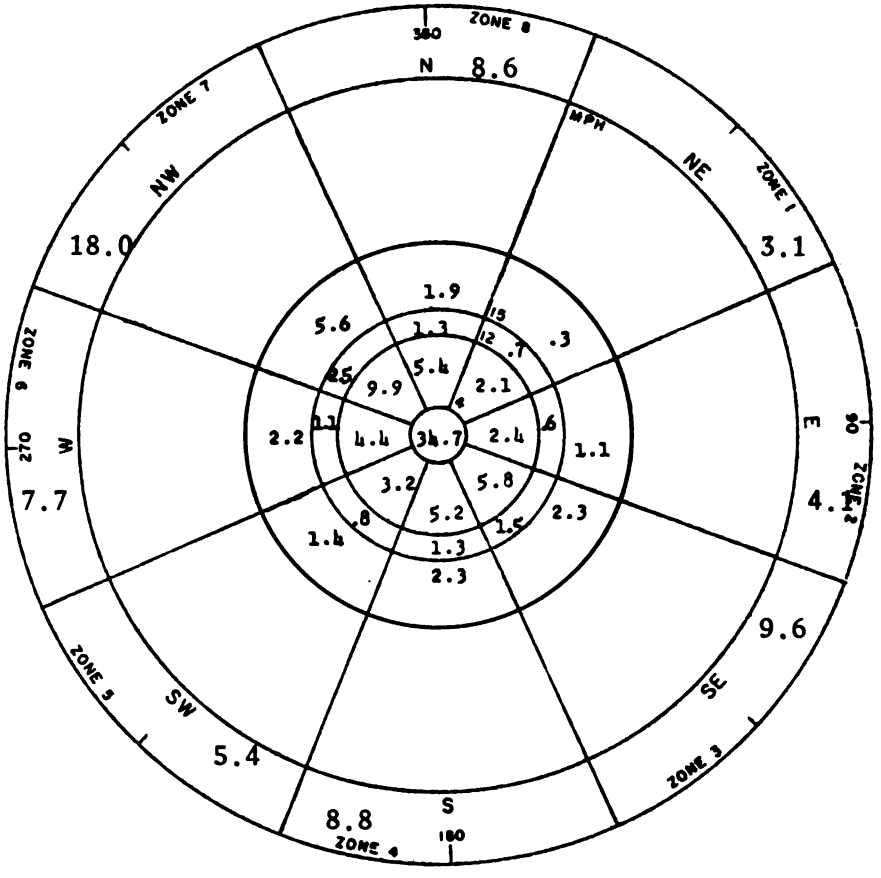
The wind rose is divided into eight equal zones; each one represents the direction from which the wind is blowing. For example, Zone 8 represents wind blowing from the northerly direction. Each rose is further divided into eight radial areas and a perimeter region. The eight areas stand for different wind speeds as follows:

Area	Wind Speed (mi/hr)
1	<4
2	4 – 11
3	12 – 14
4	15 – 17
5	18 – 23
6	24 – 30
7	31 – 37
8	≥38

The number in the perimeter region is the percent of the time the wind is blowing for the entire zone. Numbers are expressed as a percentage of the time the wind is blowing in a zone and area.

Figure 25 Key to Wind Rose Data Sheet

Source (3)



Location: Chisholm-Hibbing Airport, Minnesota (6)

Wind Data Collected: January 1953 - January 1956

Figure 26 Source (3)

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to draw solid conclusions. Furthermore, the average velocity over the whole 24 hours tends to raise the minimums and lowers the maximums. The distribution of these hour by hour fluctuations within a day-night cycle can be seen in Figure 27 by the number of days per year, at various hours in the day, that wind speeds greater than 20 miles per houf are recorded. At 2 P.M. winds of 20 mi./hr. or greater will occur on the average, once every 10 days.

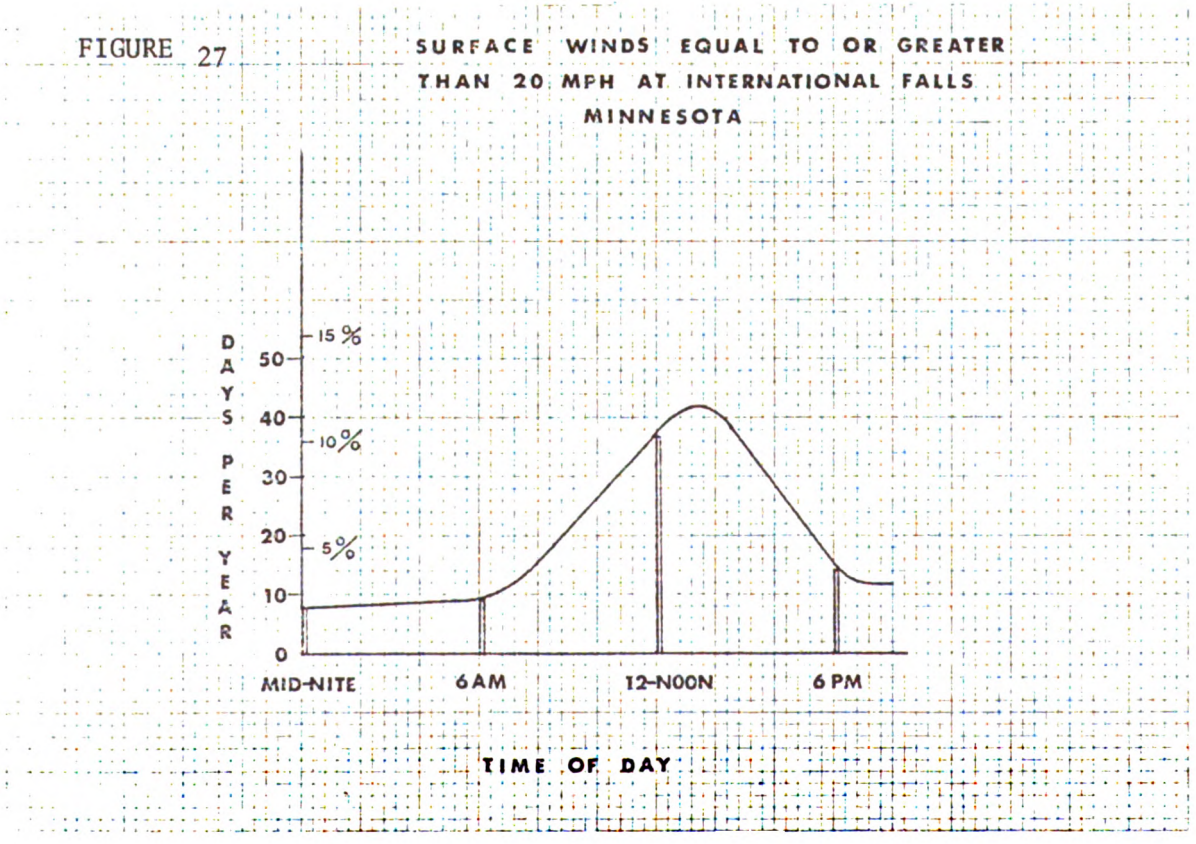
References - Climate

1. U. S. Department of Commerce, Weather Bureau in cooperation with Oliver Iron Mining Division of U. S. Steel Corporation, "Climatography of the United States No. 20-21," Station - Virginia, MN.

2. U. S. Weather Bureau Technical Papger No. 37, "Evaporation Maps of the United States."

3. Brice, W. C. "Possible Environmental Impact of Base Metal Mining in Minnesota". Minnesota Department of Natural Resources June 1972.

FIGURE 27



Topography

The Iron Range lies just south of a range of hills known as Giants Range which runs from Pokegama Lake west of Grand Rapids to Birch Lake east of Aurora. Near Grand Rapids the Giants Range merges into the level of the surrounding country which is about 1,400 feet above sea level. From Virginia to Eveleth eastward to Aurora the elevation increases to 1,800 and 1,900 feet above sea level, or 400 to 500 feet above the level of the surrounding country. For many miles both north and south of the range there is a comparatively low, flat area. The Giants Range, particularly its eastern portion, is, therefore, a conspicuous feature of the landscape.

While the general trend of the range is east-northeast, there are many gentle bends in the crest line and at Virginia a large bend known locally as the "Horn" projects if a south-southwesterly direction for six miles to a point just east of Eveleth before resuming its east-northeasterly trend. The crest of the range is in places broad and flat, in others comparatively narrow and sharp. The southern slope is very gentle; the northern slope is somewhat less so. At short intervals both crest and slopes are notched by drainage channels. Although several of these drainage channels cross the Giants Range, it, for the most part, forms the Continental or Laurentian Divide that apportions the runoff in northeastern Minnesota to Hudson Bay, St. Lawrence River and Gulf of Mexico Drainage Basins.

Glacial History

As can be seen on the regional soils landscape and geomorphic map Figure 28 , the whole region has been glaciated. The U. S. Geological Survey has mapped glacial material from three distinct glaciations*. The lower most basal till which is not encountered at the surface in this area is probably early to middle Wisconsin in age but could be pre-Wisconsin (approximately 40,000 to 60,000 years ago). The middle till unit was deposited from the Northeast by the Rainy Lake. This episode is responsible for much of the basic land forms in the present day physiography. The giants ridge was scrapped clean by this glacier 16,000 to 35,000 years ago and the Aurora till plain was formed during its retreat 14,000 to 16,000 years ago. In this area, glacial deposits formed hills and depressions mark the location of former ice blocks. The uppermost tills were deposited by the St. Louis sublobe of the Des Moines lobe about 12,000 years ago. This lobe came from the Northwest and did not significantly change the physiography of the region.

During the waning stages of the last glaciation, most of the lowlands were filled with glacial melt waters forming very large lakes. The Upham Lacustrian Plain is a remnant of one of these lakes. As these shallow lakes filled with sediment they evolved into peat bogs. Today these peat bogs cover a large portion of the Upham Lake bed as can be seen on Figure 29 .

*The following soils information was taken principally from Reference 1, augmented by 2 and 3.

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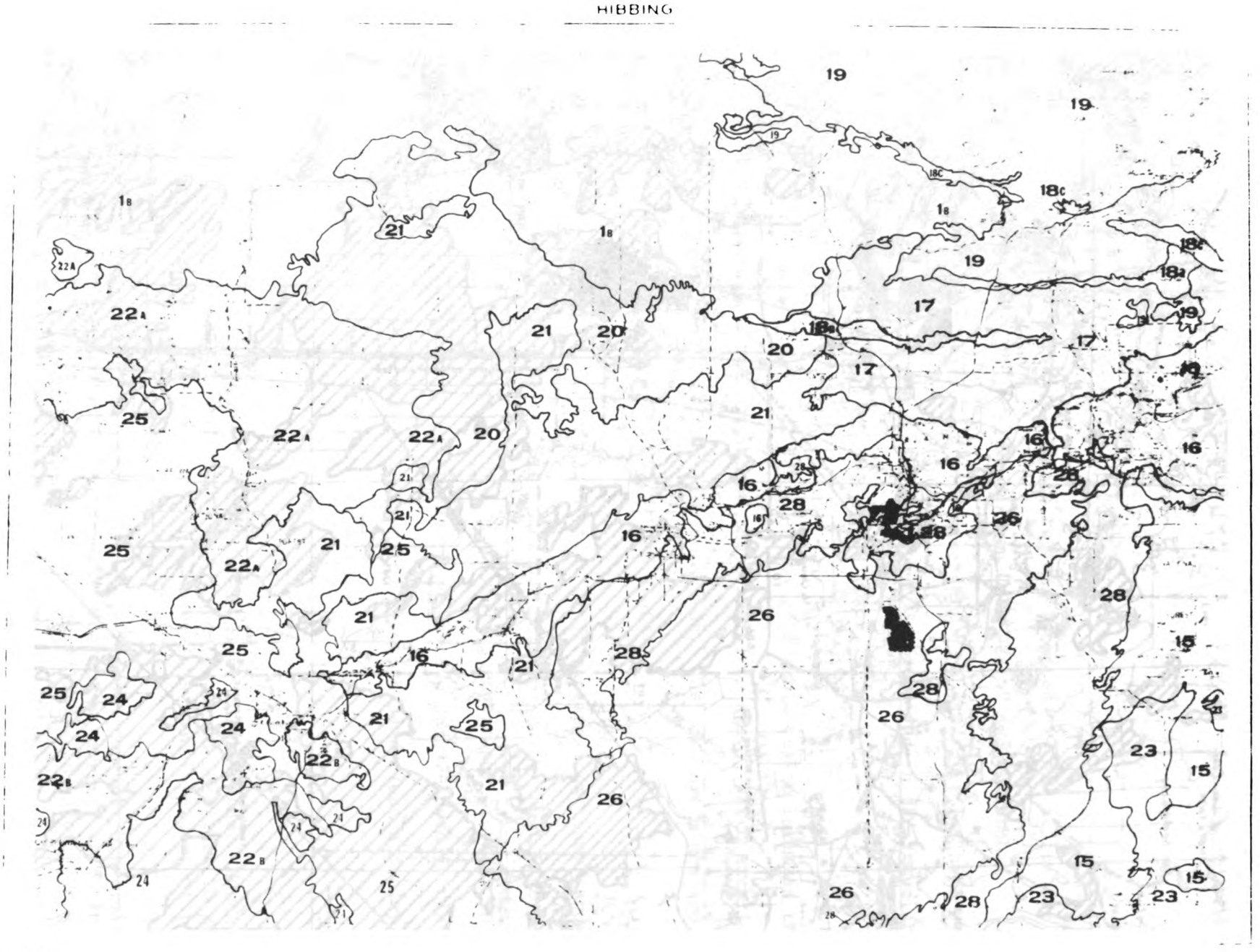


Figure 28

Regional soils, landscape and geomorphic map

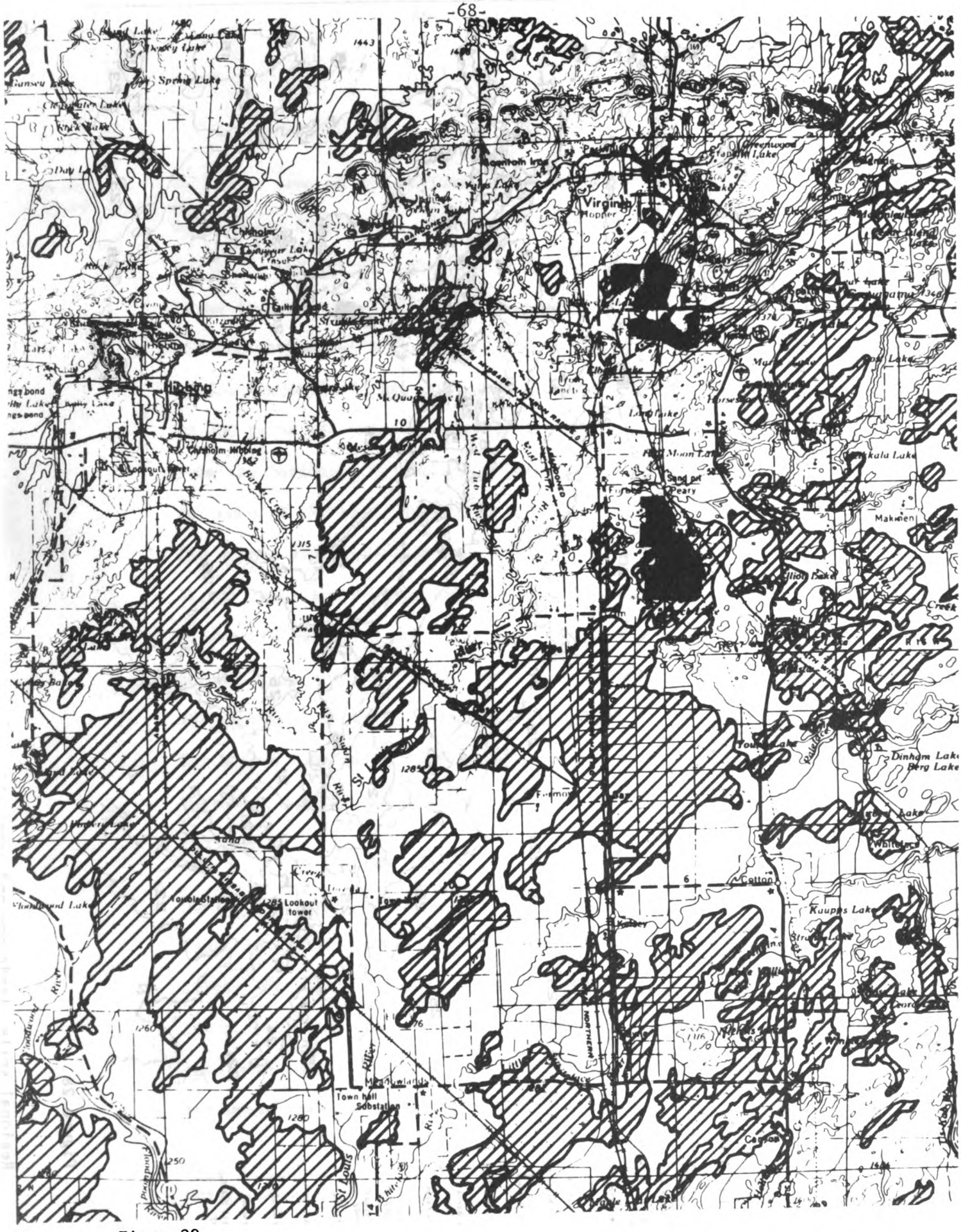


Figure29

Peat deposits in the Eveleth area

Geomorphology and Soil Descriptions

The three major geomorphic regions impacted by this action are the "Mesabi Range", the "Aurora Till Plain" and the "Upham Lacustrian Plain." A soil description of each unit followed by a description of each of its subunits encountered in the immediate area as defined by Figure 30 follows:

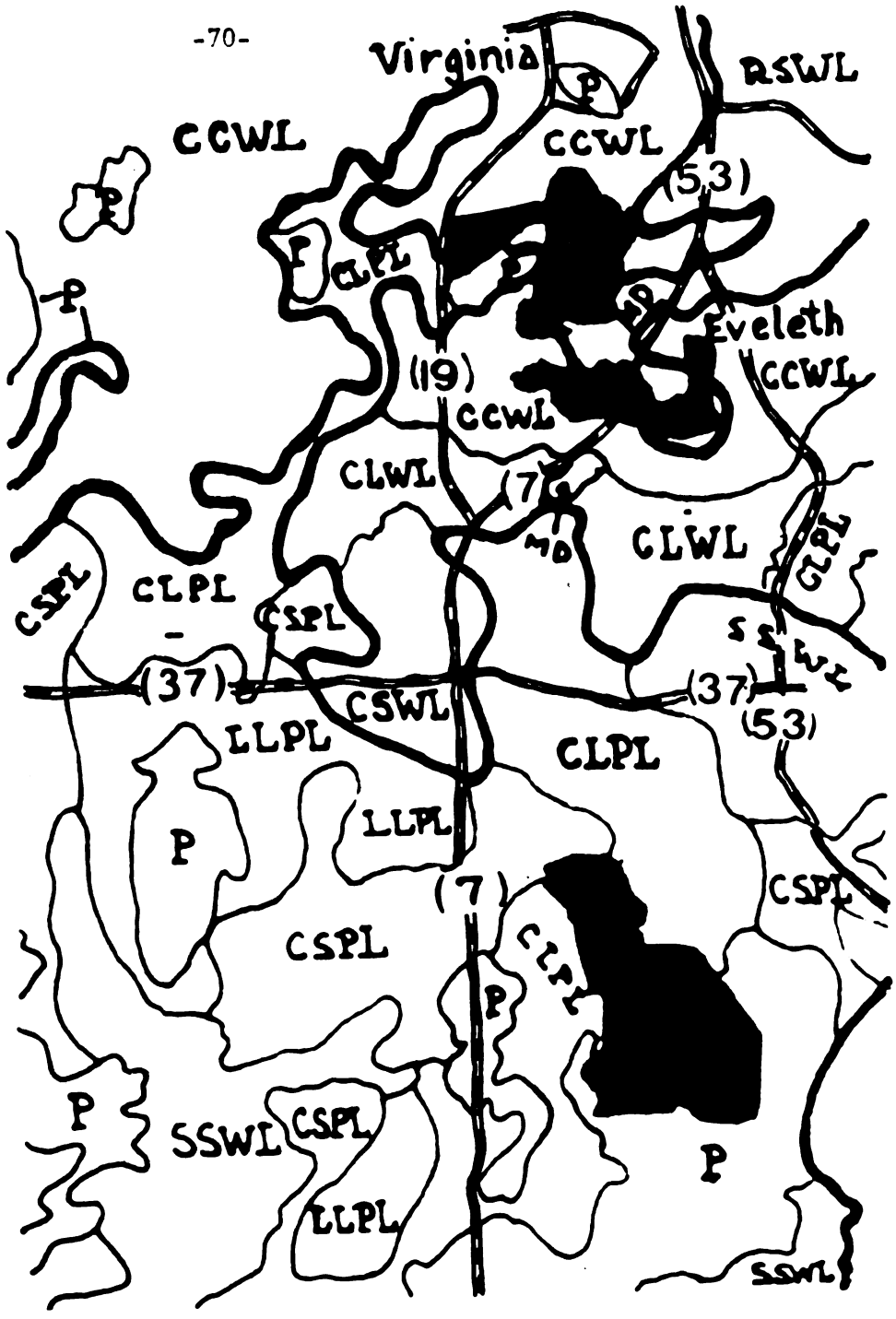
Unit 16: The Mesabi Range - This geomorphic region includes the prominent Giants Range and the Mesabi Iron Range, which parallels the Giants Range along the south side. The iron ore mines and mine dumps are located in the Mesabi Range.

The region is covered with stony drift ranging from loamy sand to sandy loam in texture. Bedrock outcrops cover about 5 percent of the area. Gently rolling to rolling topography prevails in this area where not disturbed by mines and dumps. Reddish clayey till dominates with inclusions of brownish sandy loam and clay loam till.

Sub Units

RSWL-Sandy over rock, well-drained, light colored sand. Most of the unit is cobbly and stony. Sandy loams occur in less than 20 percent of the unit. Bedrock is exposed over less than 5 percent of the surface.

M-D-The mine dumps are high and very steep. Considerable erosion occurs in places. The material is coarse, moderately acid, and infertile. A few abandoned mines are filled with water.



LEGEND

Major soil division

Minor soil division

Highway

Proposed action areas

Figure 30

Soil subunits in the immediate area

Unit 26: The Upham Lacustrine Plain - The plain is a large nearly level basin formerly occupied by glacial Lake Upham. Extensive peat bogs are located in the region (see Figure 29). Other features are occasional, discontinuous beach ridges, ice contact deposits, and a few gently rolling areas. The plain is 50 to 60 feet lower elevation than the Agassiz Lacustrine Plain. There is some evidence that water spilled over from Lake Agassiz into Lake Upham.

The mineral soils are dominantly somewhat poorly to poorly drained. Along the west side, the soils developed largely in fine and very fine sand. Along the east, soils have developed mainly in silts. There are some clays and shallow silts over clays.

The water table is normally 2 to 6 feet below the surface.

The bogs consist mostly of sedge and woody peats. Seven raised bogs of sphagnum moss peat have been observed on some of the larger bogs. The thickness of the sphagnum moss peat varies from 1 to 10 feet. Slope gradients in the raised bogs are relatively high for peat bogs, in places being 5 feet to the mile. Peat in the bogs, ranges from 3 to 20 feet thick overlying lake-laid sediments consisting of clay, silt, and fine sand. The water table is generally near the surface.

Sub Units

CLPL-The silt covering is generally 1 to 2 feet thick over the clay. It overlays clays, is poorly drained, and light colored.

SSWL-Sandy over sandy, well-drained light colored soil. Small areas of loamy very fine sands and somewhat poorly drained soils are included.

CSPL-Fine and very fine sands overlying the clays are generally 1 to 3 feet thick. The soil is poorly drained and light colored.

LLPL-Deep silty or loamy, poorly drained, light colored soils. Clays generally occur 3 to 6 feet below the surface.

P-Organic soils.

Unit 28: The Aurora Till Plain - Most is rolling to hilly topography characterized by short irregular slopes and numerous potholes and small peat bogs. Two areas of less rolling topography occur. One of these, located southwest of Virginia, is gently rolling. The other has drumlin-like topography and occurs southwest of Eveleth. Inter-drumlin areas are poorly drained.

The till is reddish-brown calcareous silty clay. In some localities, it is capped with silt loam or loam 6 to 12 inches thick and, in places, up to 24 inches.

Sub Units:

CCWL-Clayey over clayey, well-drained, light colored soils. The surface 6 to 10 is generally loam or silt loam. Several small depressions are located in the area.

P-This organic soils unit includes about 5 percent mineral soils.

CLWL-Silty or loamy over clayey, well drained, light colored soil. The upper 12 to 20 inches is a silt loam or loam texture. Small poorly drained depressions are quite common.

XCWL-Clayey over mixed sandy and loamy, well drained, light colored soils.

CSWL-The soils consist of loamy very fine sand to fine sand 15 to 30 inches thick over reddish-brown silty clay till. Small inclusions of moderately well to poorly drained soils occur. It is a sandy over clayey, well drained, light colored soil.

Also CLPL, P, and SSWL as described in Unit 26.

Soil at the Site

The overburden at the north pit area is shallow to non-existent at the eastern end, but has as much as 90 feet of red clayey till at the western ultimate limit. As you traverse south, away from Giant's Ridge across the south pit the red clayey till increases in depth from 25 feet at the north pit limit to 60 feet at the south pit limit.

The plant is located on clean sands and gravels, probably originating from an ice contact zone modified by beach action of Upham Lake. To the east and south of the plant, where the tailings will be deposited, is a large peat bog underlain by Lacustrian clays. The bog is basically composed of two types of peat, sedge-reed and sphagnum moss. Of these, the sphagnum peat is the most significant.

The expanded tailings basin will cover a major portion of Sections 17, 18, 19, 20, of T56N, R17W. The sphagnum deposit is located in the lower part of Section 17, all of Section 19 and 20 and in portions of Section 29 and 30. (See Map Figure 31). Sphagnum peat forms when a moss, called sphagnum, dies and decomposes to form an organic soil. Living moss covers the decomposed material and continues the thickening of the deposit. Because the moss prefers an acid environment it is usually found in stagnant spruce swamps and raised bogs where pH values range from 3.0 to 4.5. Sphagnum peat is fibrous, though not woody, and is often light tan to reddish in color. (6) Sphagnum peat is used as a soil conditioner

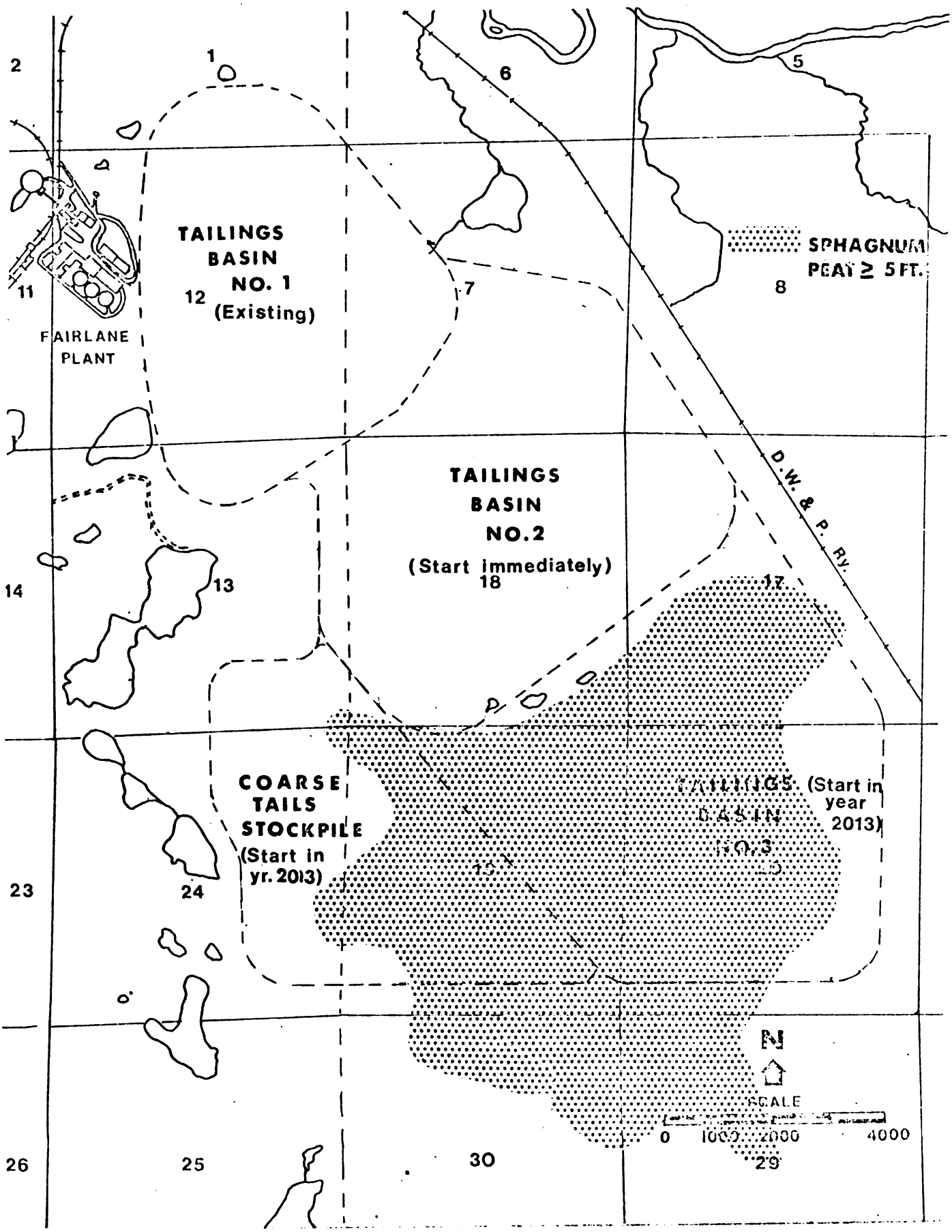


Figure 31

Tailings basins and sphagnum peat deposit location

for gardening and house plants. Therefore, it is commercially desirable.

An adequate inventory of peat in the State of Minnesota does not presently exist. However, estimates of Minnesota's peat resources puts the total acreage at 7.5 million acres. (4) Of this, only about 50,000 acres are sphagnum peat, and most of this is not even accessible. (7) In 1963, a survey of the bog on which Oglebay Norton proposes to place the tailings basin was conducted by the State's Iron Range Resources and Rehabilitation. Commission. The results of this survey indicate that 900 acres of sphagnum peat, 5 to 8 feet thick exist in the area. This equals about 7,200,000 cubic yards. In addition, there are 400 acres over 8 feet thick equalling 5,120,000 cubic yards. The total peat reserve is estimated to be in excess of 12,000,000 cubic yards. (5) This represents approximately 10% of the state's resource of high quality accessible sphagnum peat, and is equivalent to 6 times the total annual consumption of sphagnum peat for the entire United States. (7).

A commercial peat deposit, as defined by the Department of Natural Resources, must be a minimum of 5 feet thick and cover an area of at least 40 acres. (6) However, other factors such as drainage, accessibility, ground cover, distance to market and marketability, also affect the feasibility of developing a peat deposit. Using standard peat production rates (500,000 to 1,000,000 six cubic foot bales per year) the reserves within the tailings area could be

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depleted within 24 to 48 years. (5) However, since production limits are mainly established by demand and not by the rate at which the reserves can be removed, the time required to deplete the peat could be significantly different.

The land on which the peat rests is owned by Oglebay Norton. It was acquired from the state in a land exchange which took place in 1963 (Figure 32). In granting the exchange, the State of Minnesota reserved the mineral rights which specifically included the peat. Because of this reservation clause, the state is free to lease the peat to any responsible peat developer. However, an agreement to obtain access to the site must be made between Oglebay Norton and the peat producer. In the past, Oglebay Norton has been agreeable to the idea of commercial peat development provided the lease protects Eveleth "against interference with its operations by the activities of the lessee and also against any liability as a result of activities by the lessee." (8)

If the peat within the basin area, were to be totally developed by a peat producer the state could receive about $1.2 million in the form of royalties (based on the present royalty rate of $.05 per six cubic foot bale). The retail value, depending on packaging and the outlet, could be $200 million.

Sedge-reed peat is also very abundant in the area. This form, however, is not favored for use as a soil conditioner. Instead the sedge-reed form of peat is expected to find use as an energy source. Currently, studies are being conducted to evaluate the

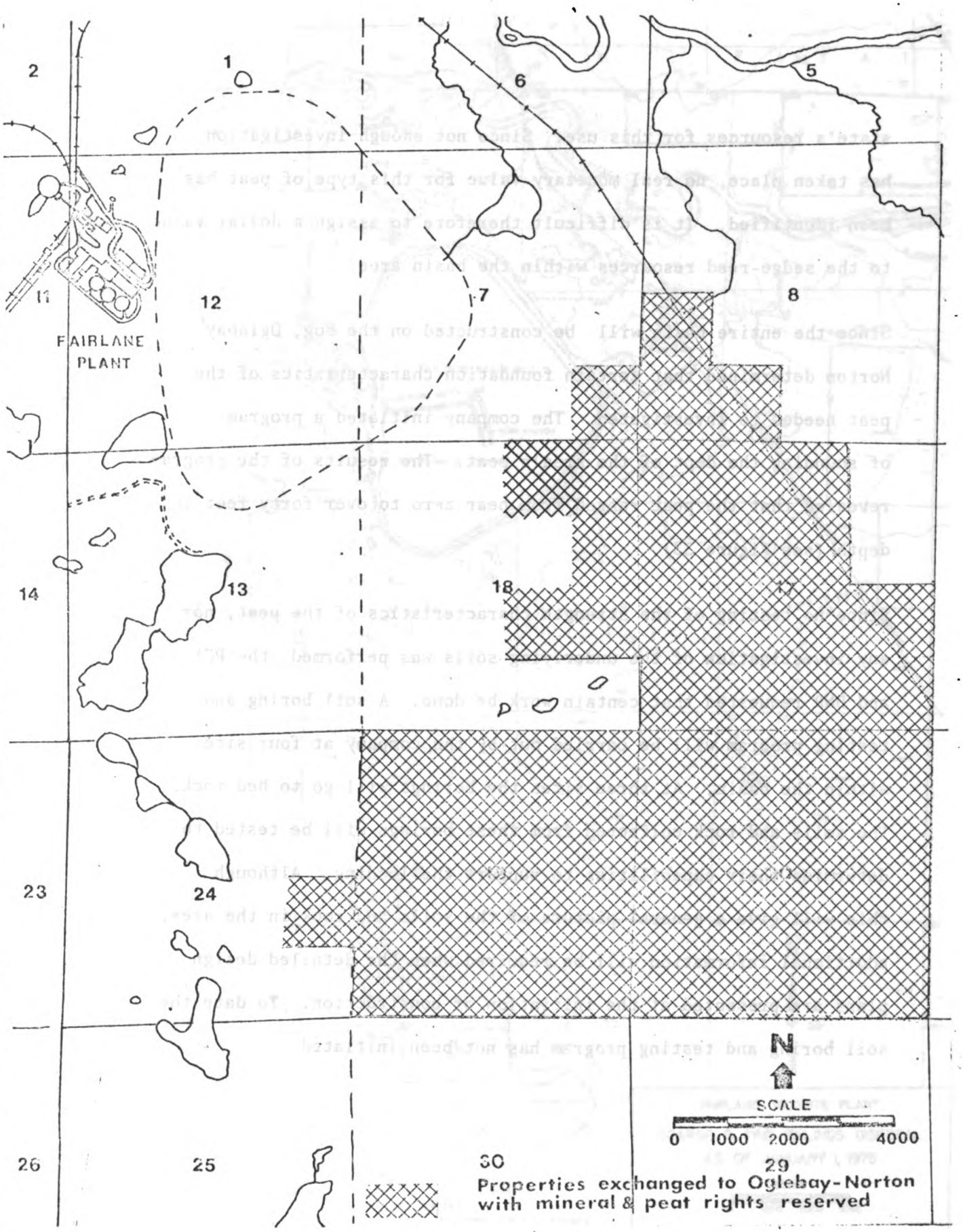

Figure 32

1963 Exchanged Lands

state's resources for this use. Since not enough investigation has taken place, no real monetary value for this type of peat has been identified. It is difficult therefore to assign a dollar value to the sedge-reed resources within the basin area.

Since the entire basin will be constructed on the bog, Oglebay Norton determined that certain foundation characteristics of the peat needed to investigated. The company initiated a program of sounding the dept of the area's peat. The results of the program revealed that the peat ranged from near zero to over forty feet in depth (see Figure 33).

Since no testing of the strength characteristics of the peat, nor any investigation of the underlying soils was performed, the PCA and DNR requested that centain work be done. A soil boring and testing program will be carried out by the company at four sites within the basin. At three sites the borings will go to bed rock. The soils and rock collected from these borings will be tested to determine their capabilities to support the loading. Although this will give a general picture of the soils and rock in the area, additional information will be required when the detailed design plans are presented at the initiation of construction. To date the soil boring and testing program has not been initiated.

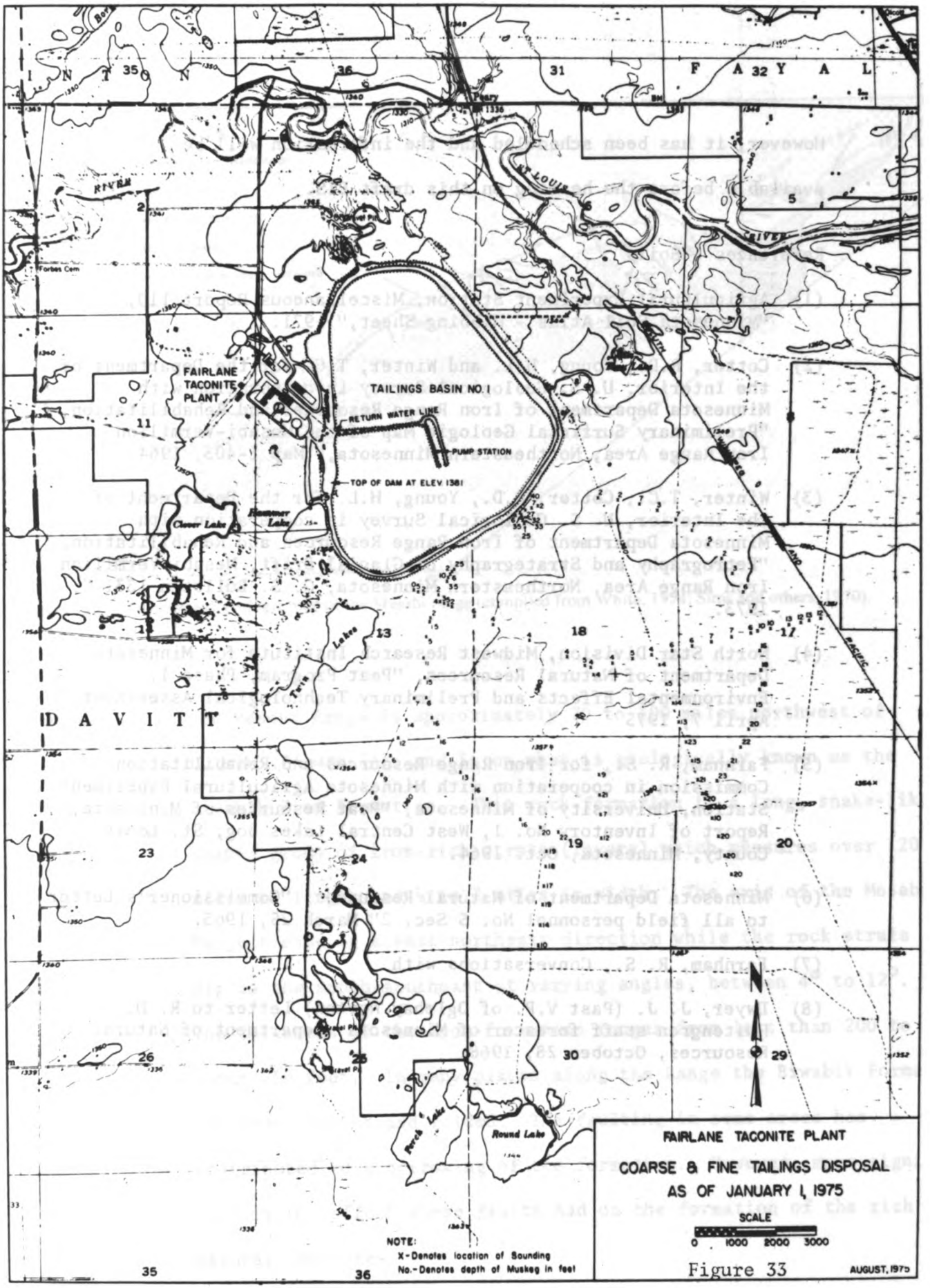

Figure 33

Peat Depth - Expansion Tailings Basin

However, it has been scheduled and the information will be available before the hearing on this draft EIS.

References - Soils

(1) Agricultural Experiment Station, Miscellaneous Report 110, "Minnesota Soil Atlas - Hibbing Sheet," 1971.

(2) Cotter, R.D., Young, H.L. and Winter, T.C. for the Department of the Interior, U. S. Geological Survey in cooperation with Minnesota Department of Iron Range Resources and Rehabilitation, "Preliminary Surficial Geologic Map of the Mesabi-Vermilion Iron Range Area, Northeastern Minnesota," Map I-403, 1964.

(3) Winter, T.C., Cotter, R.D., Young, H.L. for the Department of the Interior, U. S. Geological Survey in cooperation with Minnesota Department of Iron Range Resources and Rehabilitation, "Petrography and Strategraphy of Glacial Drift, Mesabi-Vermilion Iron Range Area, Northeastern Minnesota, G. S. Bulletin 1331-C, 1973.

(4) North Star Division, Midwest Research Institute for Minnesota Department of Natural Resources, "Peat Program, Phase 1, Environmental Effects and Preliminary Technological Assessment," April 7, 1975

(5) Farnham, R. S., for Iron Range Resources and Rehabilitation Commission in cooperation with Minnesota Agricultural Experiment Station, University of Minnesota, "Peat Resources of Minnesota, Report of Inventory No. 1, West Central Lakes Bog, St. Louis County, Minnesota, Oct. 1964.

(6) Minnesota Department of Natural Resources, "Commissioner's Letter to all field personnel No. 5 Sec. 2" March 25, 1963.

(7) Farnham, R. S., Conversations with

(8) Dwyer, J. J. (Past V.P. of Oglebay Norton) Letter to R. D. Hultengren staff forester of Minnesota Department of Natural Resources, October 28, 1968.

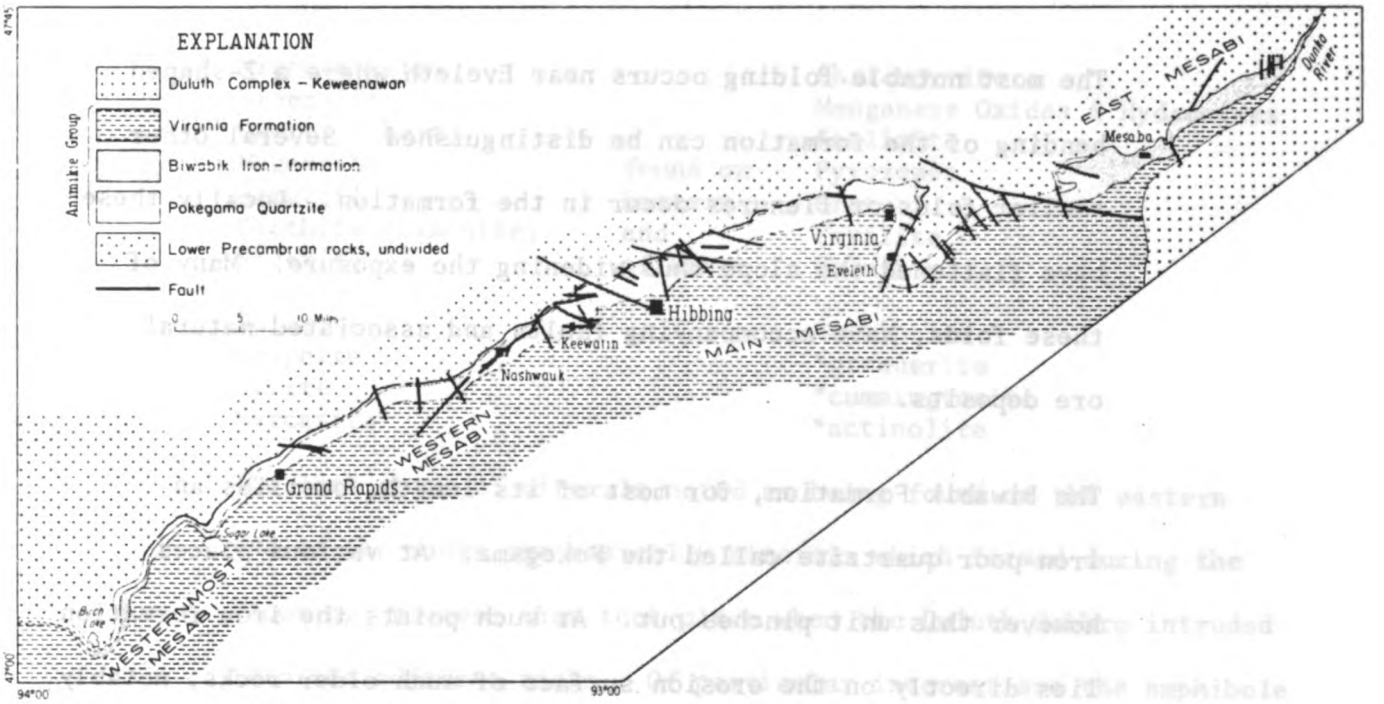

Figure 34 Generalized geologic map of the Mesabi range (compiled from White, 1954; Sims and others, 1970).

Regional Geology

The Mesabi Range is approximately 70 to 100 miles northwest of Duluth (Figure 34), and is on what is geologically known as the Biwabik Iron Formation. This rock formation is a long, snake-like shaped group of iron-rich strata (layers) which measures over 120 miles in length and ¼ to 3 miles in width. The axis of the Mesabi Range trends in a east-northeast direction while the rock strata dip to the south-southeast at varying angles, between 4° to 12°. The thickness of the iron-formation ranges from less than 200 to about 750 feet. In many places along the Range the Biwabik Formation has been faulted and folded. The faulting in some areas has contributed to a narrowing of the formation. However, more significant is the effect these faults had on the formation of the rich natural iron ores.

The most notable folding occurs near Eveleth where a Z-shaped bending of the formation can be distinguished. Several other smaller folds or flexures occur in the formation. Locally these have flattened the slope thus widening the exposure. Many of these folds, have accompanying faults and associated natural ore deposits.

The Biwabik Formation, for most of its length, overlies an iron-poor quartzite called the Pokegama. At various places however this unit pinches out. At such points the iron formation lies directly on the erosion surface of much older rocks; notably the Giants Range Granite. The rock unit which overlies the Biwabik is the Virginia Slate. Like the Pokegama Quartzite and the Giant's Ridge Granite, the Virginia Slate is relatively iron-free. The slate is found along most of the Range except in the far east end. In that area the slate has been overridden and consumed by a later igneous intrusive, the Duluth Gabbro. The gabbro in addition to affecting the Virginia Slate also affected the iron formation by metamorphasing the far east end and finally truncating it.

Mineralogy

The Biwabik Formation is composed of an extremely hard rock which is locally called taconite, a name which is used interchangebly with "iron formation". The minerals found in the taconite include:

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Minnesotaite		Chalcopyrite
Greenalite		Manganese Oxides & Hydroxides
Quartz (Chert)		Kaolinite
Magnetite	found on	Pyroxenes
Hematite	Eastern	Granet
Goethite (Limonite)	end	Fayalite
Siderite	of Range	Chlorite
Calcite		
Dolomite		Amphiboles
Graphite		*greenerite
Pyrite		*cummingtonite
Marcasite		*actinolite

The last group of minerals noted as being found on the eastern end of the range are basically minerals which formed during the "cooking" process that took place when the Duluth Gabbro intruded into the adjacent rocks. Of particular interest are the amphibole series. These minerals are often fibrous and have recently been deemed in court decisions to be health hazards when inhaled and potentially hazardous if ingested.

Stratigraphy

The taconite is a sedimentary rock which formed in a sea that at times varied in depth. It is thought that these variations in depth caused the development of four distinguishable units within the formation these subdivisions include:

--the upper slaty
--the upper cherty
--the lower slaty and
--the lower cherty.

These are described in Table 8 .

TABLE 8 .

Generalized Section of Subdivisions of the Biwabik Formation

	Thickness in feet
Upper Slaty Division	
Limy carbonate with silicates and slaty taconite	0 to 25
Slaty and cherty taconite, silicate taconite and slate On East Mesabi white quartz septaria and some beds rich in magnetite in lower 40 feet	0 to 145
Upper Cherty Division	
Cherty, banded slaty and silicate taconite with layers of conglomerate and algal structures. Some beds rich in magnetite. On East Mesabi many rich magnetite beds	80 to 250
Lower Slaty Division	
Slaty and silicate taconite, Slate, banded and some cherty taconite. Considerable carbonate and scattered conglomerate in upper part. On East Mesabi largely recrystallized to amphibolitc taconite with some fayalite	0 to 250
"Intermediate Slate". Black slate, silicate slate and paint rock	1 to 40
Lower Cherty Division	
Lean member. White cherty and silicate taconite	10 to 52
Member rich in magnetite. Irregularly banded, mottled, cherty and silicate taconite	2 to 250
On East Mesabi 2 to 70 feet thick.	
Member with iron in ferric state.	
Beds of cherty and banded taconite with slaty taconite on top. Largely absent on East Mesabi	8 to 70
Red basal taconite. Absent on East Mesabi	0 to 40
Basal conglomerate and algal structures	0 to 15
Total	350 to 755

Economic Mineral Potential

The most significant characteristic of the iron formation is its value as an iron resource. With regard to its potential use as ore, the taconite has been loosely divided into the following:

Natural Ore
- direct shipping
- wash
- heavy media

Magnetic taconite

Non-magnetic taconite

Natural ores were the main iron resource of the range from the first shipment in 1892 until about 1968. Natural ores formed when either ground water or hydrothermal fluids flowed through the taconite, oxidizing the minerals and leaching out the silica. Any faulted or jointed zones within the taconite provided prime areas where natural ores could form. This was apparently due to the easier access which the fluids had in moving through the taconite at these points. The minerals which formed were mainly Hematite, Goethite and Limonite. Through the years these iron oxides have proved to be highly acceptable for steel making. The natural ores are usually divided into groups depending on their iron content and need for artificial upgrading. These groups include:

- direct shipping
- wash ore, and
- heavy media ore.

.Direct Shipping Ore is one that has been oxidized and leached to such a point that it contains enough iron so that it can be used directly at the steel mills.

.Wash ore is a type of ore which naturally divides into coarse and fine fractions. The coarse particles are generally iron-rich while the fines are high in silica. To artificially upgrade the ore, this material is screened or washed to remove the fines, thus reducing the silica content and increasing the percentage of iron in the remaining ore.

.Heavy Media Ores require more processing than the wash ores. Basically, the process of heavy media separation relies on the differences in densities between the iron-rich, and silica portions of the ore. In the ore enrichment process of heavy media separation, screened uniformly sized pieces of ore are fed into a flowing stream of dense fluid. This fluid is generally a solution of fine ferrosilicate particles in water. The solution is very dense and only allows the heaviest, iron-rich particles to settle. The lighter particles which contain silica float to the top of the fluid and are skimmed off. The concentrated iron-rich particles are sreened to remove the ferrosilicate medium then are shipped to the steel mills.

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The amount of natural ore mined since the beginning of operations in the 1890's (over 2.65 billion tons) has substantially reduced this resource. As the resource has been diminished the tonnages being shipped have decreased. In 1973 about 18.6 million tons of natural ore was produced. Although this is a substantial tonnage, it does not compare to the peak shipments of 60 to 70 million tons per year, during the 1940's and 50's. Today the steel industry and the Mesabi Range are relying on a low grade material to provide the iron ore requirements. This material, which is being mined and beneficiated at several locations across the range is called magnetic taconite. It presently comprises about 2/3 of the iron ore shipments, however, this fraction is expected to increase as natural ore is phased out.

Magnetic taconite differs from the rest of the rocks in the iron formation in that it contains a higher percentage of magnetite. In certain horizons more than 3/4 of the iron may be present in the magnetic form. The horizons, or strata, which contain the greatest percentage of magnetite occur in the cherty layers of the formation.

The technology for utilizing this ore developed slowly, beginning in the early 1920's and advancing through the 1950's, when the first commercial full scale operation was constructed

(for a discussion of the processing steps refer to Appendix A). Magnetic taconite is presently being mined only by open pit methods, however future mining utilizing underground means is almost assured. The magnetic taconite reserves of the Mesabi have been estimated to contain between 8 and 15 billion tons of concentrate.

Non-magnetic taconite is that part of the formation which has not been oxidized and leached of silica to the point where natural ores have formed, nor does it contain enough magnetite to be currently profitably beneficiated by magnetic concentration, However, this material often contains iron minerals and therefore has potential for use.

The technology for treating non-magnetic taconite has been developing in areas where abundant resources are present, for example, Northern Michigan and the western end of the Mesabi Range. Apparently the physical and chemical characteristics, more than the iron content, determines whether non-magnetic taconite is amenable to processing. Factors such as iron particle size, type of iron minerals, grade or percentage of contained iron, plus the hardness and grindability of the rock determine the processability and the economics of beneficiation.

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Although non-magnetic taconite is mined every day at magnetic ore operations (the non-magnetic rock must be stripped and stockpiled in order to expose the underlying magnetic ores) it is presently not seriously considered as a viable source of iron by most operators. This attitude is kikely due to the fact that abundant magnetic ore resources exist. However, even though no plans might exist to utilize this resource, when encountered, it is usually prudently stockpiled. This is often done because of the mining company's mineral conservation policy or, more often, because of demands by the mineral's owner.

It is difficult to project the future of this resource, since so few attempts at developing beneficiation technology have occurred. However, there is little doubt that as magnetic ore reserves are depleted more emphasis will be placed on this resource. Ironically, since the cost of mining the non-magentic taconite that must be moved during magnetic ore mining operations is being absorbed by those operations, the stripped non-magnetic material might ultimately prove more economic than some in-place magnetic ores, and therefore, be processed before those ores are even mined.

Although not well defined, it is anticipated that a non-magnetic resource equal to the reserves of magnetic taconite (8-15 million tons of concentrate) could exist within the Biwabik Formation.

Local Geology

The Iron Formation in the vicinity of Eveleth is approximately 1½ miles wide and dips about 3° W at the Thunderbird mine steepens to about 9° SW at the west end of the Expansion pit then flattens to about 6° S at the east end of that pit. The thickness of the formation also varies between about 450 and 600 feet. Structural features in the area include a broad open fold between Virginia and Gilbert which has produced a few fractures, or faults, in the taconite.

Mineralogy

Minerals in the area of the mines include:

Magnetite	Minnesotaite
Martite	Stilpnomelene
Hematite	Greenalite
Goethite	Pyrite
Limonite	Graphite
Quartz (chert)	

These minerals were reported in a study of the mineralogy by a consultant to Oglebay Norton (see Appendix B). The purpose of the study was to investigate the possibility of any amphibale minerals, of the cummingtonite-grunerite series, being present in the ore. Because recent court decisions have concluded that fibrous forms of these minerals (the amphiboles) were potential health hazards, the company wanted assurance that none was present in its ore bodies. The report concluded that there was no evidence of any asbestos-like amphiboles in the Eveleth area. In order to substantiate these findings the state undertook two separate studies.

1) Staff of the PCA and DNR collected water samples from the Fairlane Plant tailings basin, from Little Tony Lake (east of the basin) and from four natural ore pits within the Eveleth area. These samples were sent to the Environmental

Protection Agency's National Water Quality Laboratory in Duluth for analysis. X-ray diffraction analyses were runs, with the conclusion that no cummingtonite-grunerite was detectable. In addition, an electron microscope scan of the samples showed no fibrous minerals present (see Appendix C).

2) A DNR geologist performed a microscopic analysis on samples supplied by Oglebay Norton, and on state drill core samples from the Eveleth area. The results of the studies indicate that the report by the consultant to Oglebay Norton was correct. No significant amounts of elongate, rod-like or asbestiform minerals were observed in any of the samples examined (see Appendix D).

Economic Mineral Potential

All of the various forms of actual and potential ores are, or have been, present in the iron formation near Eveleth. The city was founded and frew because of the natural ores in the formation. The mines west and south of Eveleth have, through the years, supplied the nation with over 165 million tons of ore (see Table 9).

TABLE 9 Eveleth Natural Ore Mines

Property or Mine	Tonnage Shipped	First Shipment
Alice Mine	1,097,144	1928
Cloquet Annex (Spruce Mine)	49,975	1943
Fayal Mine	37,055,594	1897
Gross-Nelson Mine	2,694,205	1944
Hull-Nelson Mine	18,690,507	1901
Leonidos Mine	23,685,341	1906
Pearsall Mine	464,991	1958
Security Mine (South Fayal)	218,411	1961
Spruce Mine	79,439,561	1894
Troy Mine	2,091,584	1903
Total	165,487,313	

The many years of mining natural ores has diminished, and even exhausted the reserves. Today, only one of the mines listed is operating. The others have been closed because the easily mined ores are gone. Today, the City of Eveleth, as well as the rest of the range, relies on magnetic taconite.

To date, the only magnetic taconite that has been produced near Eveleth has come from the Thunderbird mine. From its initiation in 1965 until January 1, 1975, this mine has produced over 50 million tons of ore from which 17 million tons of concentrates were processed. Current plans by the manager of the Thunderbird mine, Oglebay Norton, calls for expansion of the Thunderbird and the development of a second pit south of Eveleth. These two mines have been planned by the company to produce 6 million tons of concentrate per year for 60 years. Therefore, 360 million tons of pellets will be produced.

Although these tonnages are substantial neither the company nor the DNR feel that this constitutes the entire amount of magnetic taconite which these mines could eventually produce. For example, the company has set an ultimate open pit mining limit in the Thunderbird area which would allow mining to continue beyond the designed 60 year life. Future economics could move that limit to coincide with the one which the state projects, and which approaches the east shore of Lake Manganika. If these limits

are accurate, the mine life might ultimately approach 80 to 100 years (providing the present mining rates remain unchanged).

In addition, if technology is developed for the non-magnetic taconites in the area, iron ore producing might continue well beyond the years already mentioned.

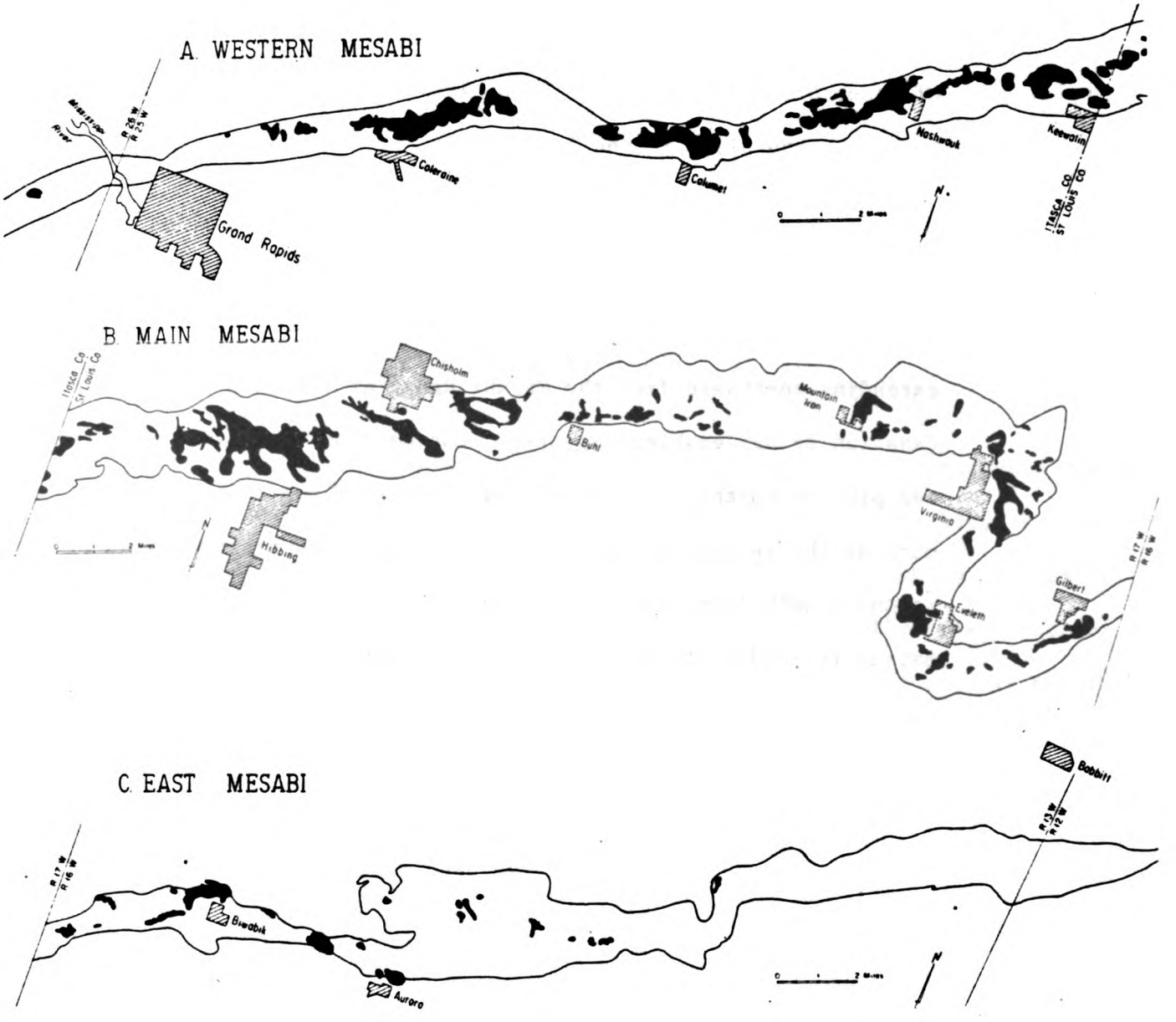

Figure 35 General map of the Mesabi range showing location, distribution, and shape of natural ore bodies in the Biwabik Iron-formation (modified from U.S. Steel map of 1956).

Vegetation

The lands in the vicinity are generally unsuitable for agriculture but do have fair to good timber development potential. In the late 1800's when iron ore was first discovered in northeastern Minnesota, the upland areas were covered with vast stands of white and red pine with lesser amounts of jackpine, white spruce and balsam fir. Lowlands were covered with dense stands of black spruce, tamarack, and white cedar. Interspersed among stands of conifers were areas of paper birch, aspen, maple, and basswood in the upland areas and black ash and alder in the lowlands.

Development of railroads to serve the newly developed mines of the central Mesabi Range also served to open the area to extensive logging. Construction of an interconnecting logging railroad extending northward from the Mesabi Range at Virginia to the Canadian Border enabled loggers to cut most of the virgin white and red pine in northeastern Minnesota. Forest fires then destroyed much of the remaining timber and the area is now characterized by a second growth forest with aspen and paper birch predominating. Balsam fir and white spruce are interspersed in the forest as are remnants of the three native pines. Less abundant species such as maple, basswood and yellow birch also persist. The original vegetation of the area's peat bogs was largely white cedar, tamarack, black spruce and sedges, but have been reduced by recent logging operations.

Pit Areas

The north and south pit area is being invaded by aspen and woody shrubs following clearing for past mining activity.

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Plant Site & Tailings Area

Upland stands of aspen, birch, red pine, jackpine, white pine, and mixtures of these can be found adjacent to the plant area surrounding the main bog and on the mineral islands within the boundaries of the bog. The bog itself is dominated by black spruce and open berry bog. Some Christmas tree logging has been carried out in recent years. When a large portion of this bog land was exchanged to Oglebay Norton in 1963, (as described in Figure 36) a timber dollar value of $1265,000 for the entire 2,240 acres was established. This dollar value is distributed as depicted in Figure 36 . The stunted Spruce were not considered valuable timber.

Ecosystems Habitat

Wildlife associations are placed into three basic habitat groupings. These groupings are quite general and predator, prey and plant species may overlap between the different habitats.

Basic habitat groupings are: 1) timbered areas dominated by paper birch and aspen; 2) low lying wet areas containing black spruce or black ash; and 3) lowland brush and openings which consist of abandoned fields being invaded by willow and other plant species. Although there are three basic habitat types, the readily observable wildlife associations are dominated by species which thrive in the forested habitat. For example, whitetailed deer are primarily reliant on the dominant timbered habitat but use the low lying conifer areas during severe winter periods and are attracted to the openings for succulent foods in the spring. By contrast, species such as sharp-tailed grouse, which require large expanses of open areas and herons or

* Most of the information in this section was taken from Source (1)

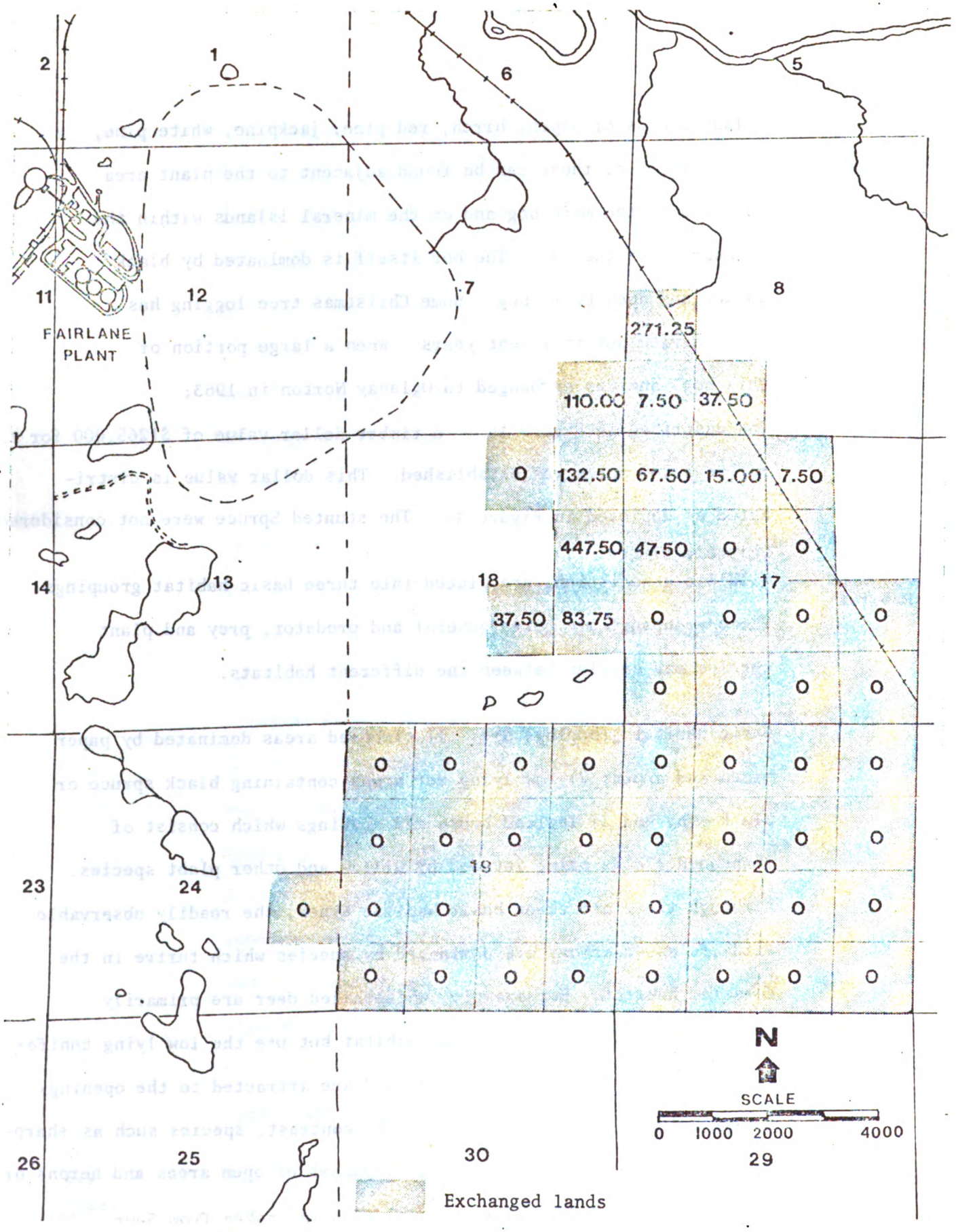

Figure 36

Dollar value of timber on land exchanged in 1963

mink, which require large amounts of wetlands and open water, are absent from the area or exist in low numbers. Song birds also are dominated by those species that thrive in wooded areas, including the least flycatcher, hairy and downy woodpeckers, chickadees, yellow warblers, etc. Species such as redwinged blackbirds, swamp sparrows, robins and cowbirds are absent or present in very low numbers. Table 10 describes the dominant species of flora and fauna present in the region.

TABLE 10 DOMINANT SPECIES OF THE REGION

Mammals	Birds
Coyote	Broad-winged Hawk
Timber Wolf	Cooper's Hawk
Red Fox	Great Horned Owl
Bobcat	Barred Owl
Whitetailed Deer	Goshawk
Snowshoe Hare	Ruffed Grouse
Small Rodents	Warblers
Red Squirrel	Jays
Flying Squirrel	Thrushes
	Sparrows
	Other Woodland Song Birds
	Grosbeaks

UPLAND PLANTS

Trees	Shrubs	Herbs
White Birch	Mountain Maple	Large-leaf Aster
Quaking Aspen	Round Dogwood	Bracken Fern
Large Toothed Aspen	Bush Honeysuckle	Violets
Balsam Poplar	Beaked Hazel	Anemone
Hard Maple	Juneberry	
Red Maple	Blueberry	
Balsam	Raspberry	
White Spruce		
Red Pine		
White Pine		
Jackpine		

TABLE 10 DOMINANT SPECIES OF THE REGION (cont.)

Trees	Shrub	Herbs
Black Spruce	Alder	Sphagnum Moss
Balsam	Willows	Pitcher Plant
Tamarack	Red-osier Dogwood	Cranberry
	Labrador Tea	

Game-Commercial and Recreational Values

Furbearers of commercial value include skunk, weasel and red fox. Mink, muskrat and beaver are of commercial value but occur in very low densities due to a shortage of either standing or flowing water. Game species providing significant hunting recreation are white-tailed deer, snowshoe hare, ruffed grouse, and woodcock. The waterfowl population of the project area is low due a shortage of habitat.

Terrestrial Ecosystems of the Proposed Project

Three broad areas exist within the proposed project that are terrestrial in nature:*

- -The land area between the mine site and processing plant.
- -The mine area to be dewatered and subsequently mined for crude taconite.
- -The bog area south of the processing plant to be used for a tailings disposal area.

These area will be discussed individually.

1. Mine Area

Presently the mine area consists of abandoned open pits and waste dumps typical of the Mesabi Range. Less severely disturbed areas are becoming revegetated by early invaders such as aspen, willow, hazel,

*Most of this description is taken from Source (2)

grasses, sedges and forbs such as strawberry. There is no specific or detailed information regarding wildlife in the area. The habitat is in an early successional stage and the wildlife populations are neither extensive nor complex. Resident mammals probably consist primarily of small rodents and shrews. Few larger mammals use the area. Many species of birds probably nest within the area and would include meadowlark, song sparrow, killdeer and other species associated with open or shrub vegetation types.

Aquatic life in the water-filled open pits undoubtedly consists of microscopic plants (algae) and animals (crustances) which quickly invade new waters. Fish are not present unless they have been introducted.

2. Upland Area South of Mine Site

The vegetation of large area between the mines and processing plant is typical of northeastern Minnesota. It consists of pole stage aspen, birch and hardwoods on the uplands with areas of spruce bog at lower, wetter elevations. Pines are present on lighter, sandy soils. Much of this area has been distrubed, first by logging then by fires and settlement. Many residences are scattered throughout the area, especially around larger lakes.

Variation in habitat probably contributes to a great variety of wildlife species. Upland timber types contain the usual complement of birds which nest in trees, shrubs or on the ground. Sparrows,

meadowlarks, and killdeer would utilize the nesting sites available in the open fields and specialized warblers and sparrows would be found in bog habitat. Hawks and owls would be found throughout the area. Important mammals in the timbered areas would be the red and flying squirrels, eastern chipmunk and deer mice. The meadow mouse would be the principal mammal in the fields and the bog lemming and redbacked vole in bogs. Mammalian predators such as red fox and weasels would be normal inhabitants of the entire area. Mink, beaver and possibly otter would be found along the stream courses. Deer, ruffed grouse and snowshoe hare would be the principal game species. Although groups of species are restricted to their favored habitats, considerable interchange between habitats undoubtedly takes place as larger, more mobile species such as deer, fox, hawks and owls are able to move about much of the area.

3. Bog Area

This area consists of twelve sections of a nearly monotypic vegetative type. Stunted black spruce comprises the overstory with leatherleaf, Labrador tea, and sphagnum moss making up the ground cover. Soils are peat ranging to a depth of over 20 feet. The upland surrounding the bog and the mineral soil islands within the bog support a growth of pole stage and larger aspen-birch with a few stands of pine. A number of small lakes are located between the bog and the high ground.

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Typical mammal species of the bog are the short-tailed and saddle-back shrews, bog lemming, redbacked vole, starnosed mole and snowshoe hare about the edges. Larger mammalian predators would include an occasional timber wolf or lynx. More common predators include bobcat, coyote and long and shorttailed weasels. Deer and possibly moose utilize the area on a temporary basis.

At one time the Itaska region may have supported a white-tailed deer population approaching 20 deer per square mile. DNR Game and Fish personnel estimate that presently, the population of this region (The Itasca Management Unit) approaches perhaps half of its carrying capacity. Successional changes have undoubtedly brought about deterioration of the habitat and relatively recent severe winters have contributed to a decrease in deer abundance. These population and habitat conditions are typical of this general area of northeastern Minnesota.

Birds which normally nest within bog habitat include the yellow-throat, palm, Nashville and myrtle warblers as well as the short-billed marsh wren, and teh song, white-throated and Lincoln's sparrows.

Three aquatic ecosystems can be found in the surface waters of the area:

-slow moving, warm water streams
-warm water lakes, and
-bog systems.

These systems will be described in the following section on water hydrology.

Hydrology
Streams
&
Fish

Five streams traverse the area between the mine area and the St. Louis River. Because they originate near the Continental Divide the streams are often no wider than 5 feet. They are listed from west to east:

1. The East Two River which flows from Manganika Lake in S24, 25 and 26, T58N, R18W, and joins the St. Louis River in S18, T56N, R18W.

2. The unnamed creek that originates in S6, T57N, R17W, and enters Elbow Lake from the east in S10, T57N, R18W.

3. Elbow Creek which originates in S15, T57N, R18W, and empties into the St. Louis River in S9, T56N, R18W. It receives an average of 600,000 gallons of treated sewage from the city of Eveleth daily.

4. An unnamed creek leading into Long Lake Creek and which originates in S7, T57N, R17W, and empties into the St. Louis River in S1, T56N, R17W. Nearly two miles of the central portion of the stream have been channeled.

5. An unnamed creek which originates at Fayal Pond just southwest of Eveleth. It flows approximately two miles before emptying into Mud Lake in S17, T57N, R18W. From Mud Lake the stream flows into Horseshoe Lake, connects with Long Lake and eventually enters Long Lake Creek. Fayal Pond is one of the collection points for the Eveleth storm sewer system.

Information on flows is available only for Elbow Creek in the vicinity of Iron Junction. Flow ranged from a low of 1.02 cfs on August 2, 1959, to a high of 32.6 cfs on May 19, 1961. Dissolved solids range from 112 to 763 ppm and the hardness ranges from 76 to 414 ppm.

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All of the above streams contain warm water fish populations. They appear capable of supporting populations of minnows throughout most of their length and probably have limited populations of game and rough fish in their lower reaches. Undoubtedly all the streams support spawning runs of suckers and northern pike.

Flowage from these streams is received by the St. Louis River, which flows into Lake Superior and through the St. Lawrence River to the Atlantic Ocean, Long Lake Creek and the unnamed creek originating at the Fayal Pond reach the St. Louis above the Fairlane Plant dam. The others meet the St. Louis downstream from the dam.

Lakes & Fish

Seven lakes lie within the broad zone of influence of the mine dewatering: These are:

1. Manganika Lake has an area of 181 acres and a maximum depth of 24 feet. It receives treated sewage from the Virginia disposal system which at the present time is being converted from secondary to tertiary treatment. Dissolved oxygen determinations made by Minnesota fisheries personnel in March 1957 indicate a strong probability of periodic winterkill. For this reason fish populations, if they exist at all, are composed of a few species highly tolerant to low dissolved oxygen levels.

2. Elbow Lake has an area of 171 acres and a maximum depth of 18 feet. It receives sewage from the secondary and phosphate treatment plant at Eveleth. In 1970, seine hauls made by fisheries personnel revealed a population of largemouth bass, pumpkinseed and perch. Although several species of minnows are undoubtedly present, they were not reported. In March, 1962, dissolved oxygen levels became very low and Elbow Lake was opened to promiscuous fishing. A fish kill also was reported in late May, 1967. Black crappies, sunfish, largemouth bass and common sucker were the affected species. The cause of the kill was diagnosed as an infestation of the parasitic protozoan Columnaris sp. It is also a winterkill lake.

3. Mud Lake covers 22 acres, it is susceptible to winterkill and is the first lake in the Long Lake chain.

4. Horseshoe Lake has an area of 95 acres and a maximum depth of 13 feet. A fishery survey was conducted by the state in August, 1957. Game fish included northern pike, largemouth bass, pumpkinseed, bluegill, rock bass and black crappie. Rough fish present were common sucker, black and brown bullhead and yellow perch. Other species were the bluntnose minnow and the Johnny and Iowa Darters. At the time of the survey there was no flow coming into the lake from Mud Lake. The outflow was significant, indicating Horseshoe Lake does not depend on the flow of tributary streams for lake level maintenance. Although Horseshoe receives no direct municipal sewage, it receives large amounts of nutrients from the disposal systems of the numerous dwellings along the shores.

5. Long Lake, lying below Horseshoe Lake on the Long Lake Chain, has an area of 140 acres and a maximum depth of 33 feet. It was surveyed by state fisheries personnel in 1955. At that time the inlet flow from Horseshoe Lake was estimated to be 8.5 cfs and an outlet flow of 14.5 cfs. A thermocline existed from 10 to 20 feet and dissolved oxygen below the thermocline was rather low. Fish populations were similar to those of Horseshoe Lake. Game fish included northern pike, walleye, largemouth bass, pumpkinseed, bluegill, rock bass and black crappie. Other species included common sucker, fathead minnow bluntnose minnow, brown bullhead, madtom, Johnny darter and Iowa darter. Long Lake has the same nutrient problem as Horseshoe Lake 6 & 7.

Other major lakes on the east side of the area between the mines and the taconite plant (St. Mary's & Ely Lakes) have fish populations similar to those in Long and Horseshoe Lakes. Like Long Lake, their shorelines are heavily developed with summer and permanent homes. Fishing, boating, waterskiing and swimming are importnat recreation pursuits on these lakes. A summary of these streams and lakes, their location, size and fish population is presented in the following table 11:

Table 11

Name	Location	DNR Inventory Number	PCA Class	Size	Fish Potential
Long Lake Creek	T.57,R.17,18,S.30,31; 25, 36		2B		Warm Water Stream
Long Lake	T.57,R.17S.19,30	69-635	2B	140 A.	Centrarchid Lake, (LM Bass)
Horseshoe Lake	T.57,R.17,S.20	69-654	2B	95 A.	Centrarchid (LM Bass)lake, marginal fish lake
Mud Lake	T.57, R.17.S.17	69-652	2B	22 A.	Periodic winterkill lake Warm water stream
Unnamed Construction Channel from Fayal Pond	T.57,R.17,S.5,7,8,17,18		2B		Warm water stream
Elbow Creek	T.57,R.18,S.15,22,27,33 34,39		2B		Warm water stream
Elbow Lake	T.57,R.18,S.10,15,16	69-717	2B	171 A.	Winterkill Lake
Unnamed Creek	T.57,R.17,18,S.6;1,2,3,				Mine drainage
Entering Elbow	10,11,12				
Lake from East			2B		
East Two Rivers	T.57,58,R.18S.26,27,33, 34;3,4		2B		Warm water stream
Manganika Lake	T.58,R.18,S.24-26	69-726	2B	181 A.	Periodic winterkill lake

*2 (Fisheries and Recreation)
Class B The quality of this class of the intrastate waters of the state shall be such as to permit the propagation and maintenance of cool or warm water sport or commercial fishes and be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be useble.

A discontinuous chain of 14 lakes surrounds the area of the proposed tailings basin on three sides, while the St. Louis River Reservoir completes the circle.

A table describing the location, size and fish potential of these lakes are listed in table 12:

Table 12

Name	Location	DNR Inventory Number	PCA* Class	Size	Fish Potential
Anchor Lake	T.56,R.17,S.21-23	69-641	2B	316 A.	Winterkill lake
Crystal Lake	T.56,R.17,S.27	69-645	2B	34	Potential stream trout lake
Murphy Lake	T.56,R.17,S.27,28, 33, 34	69-646	2B	356 A.	Centrarchid (LM Bass) Lake
Kiekkila Lake	T.56,R.17,S.28,29 32,33	69-648	2B	64 A.	Winterkill Lake
Stone Lake	T.55,56,R.17,18,S.6; 31;1;36	69-686	2B	160 A.	Winterkill Lake
Round Lake	T.56,R.17,S.30,31	69-649	2B	57 A.	Winterkill Lake
Perch Lake	T.56,R.17,18,S.30; 25;36	69-688	2B	79 A.	Winterkill Lake
Bluebill Lake	T.56,R.18,S.24,25	69-713	2B	21 A.	Periodic winterkill Lake
Mallard Lake	T.56,R.18,S.24	69-712	2B	16 A.	Periodic winterkill lake
Twin Lakes	T.56,R.18,S.13	69-708	2B	69 A.	Centrarchid (LM Bass) Lake
Hammer Lake	T.56,R.18,S.13	69-707	2B		Lake being pumped and tailings being deposited
Clover Lake	T.56,R.18,S.11,14	69-706	2B		Periodic winteskill lake
Little Tony Lake	T.56,R.17,S.7.	69-639	2B		Part of tailing basin
Unnamed Lake	T.56,R.17,S.10	69-640	2B	12 A.	Winterkill Lake

*See description on bottom of page____.

Bog Area

While the bog has been described as a terrestrial habitat it also contains an important aquatic ecosystem. The sphagnum that makes up the floor of the bog is actually emergent vegetation. Aqueous organisms are the decomposers who slowly break down the sphagnum plant into sphagnum peat in the acidic environment below the water table in the bog ecosystems.

Bog areas store large volumes of water. Only about 80% of the bog volume is taken up by peat and plants. One-sixth of it is water. The gradient of the bog in the tailings area is 7 feet in 5.75 miles.

Because of this flat gradient, the water is always no more than a foot down from the surface. The permeability and porosity of peat is decreased dramatically by compaction. This bog is in hydrologic contact with the lakes surrounding it.

Watersheds for the areas of the proposed action are presented in Figure 37. This information was developed from the 10 ft. topographical contour lines on the U. S. Geological Survey 7½ minute Quadrangle Map. Watershed boundaries in flat terrain are difficult to define and should not be considered fixed or precise.

Ground Water

In the area of both of the pits, ground water moves through the glacial drift along the basal contact with bedrock. It may be anticipated from the bedrock contours on Figure 38, that the flow of ground waters at the surface-to-formation contact would be due westerly north of Eveleth, southwesterly south of Eveleth, and southeasterly east of Eveleth, or, in effect, the direction of flow would be down grade approximately normal to the strike of the Biwabik Iron Formation. In addition, since the formation dips from 6 to 10° downward from its north limit of the outcrop area, any flow of water within or immediately under the iron formation would be down-dip normal to the strike. (3). However, as may be noted from the map, the chain of natural ore mines extend from the Fayal #3 on the east to the Leonidas on the west serves as an interceptor ditch to divert a substantial portion of the ground water to a northwesterly flowage through the open pit and their interconnecting underground work or oxidized iron formation. It would

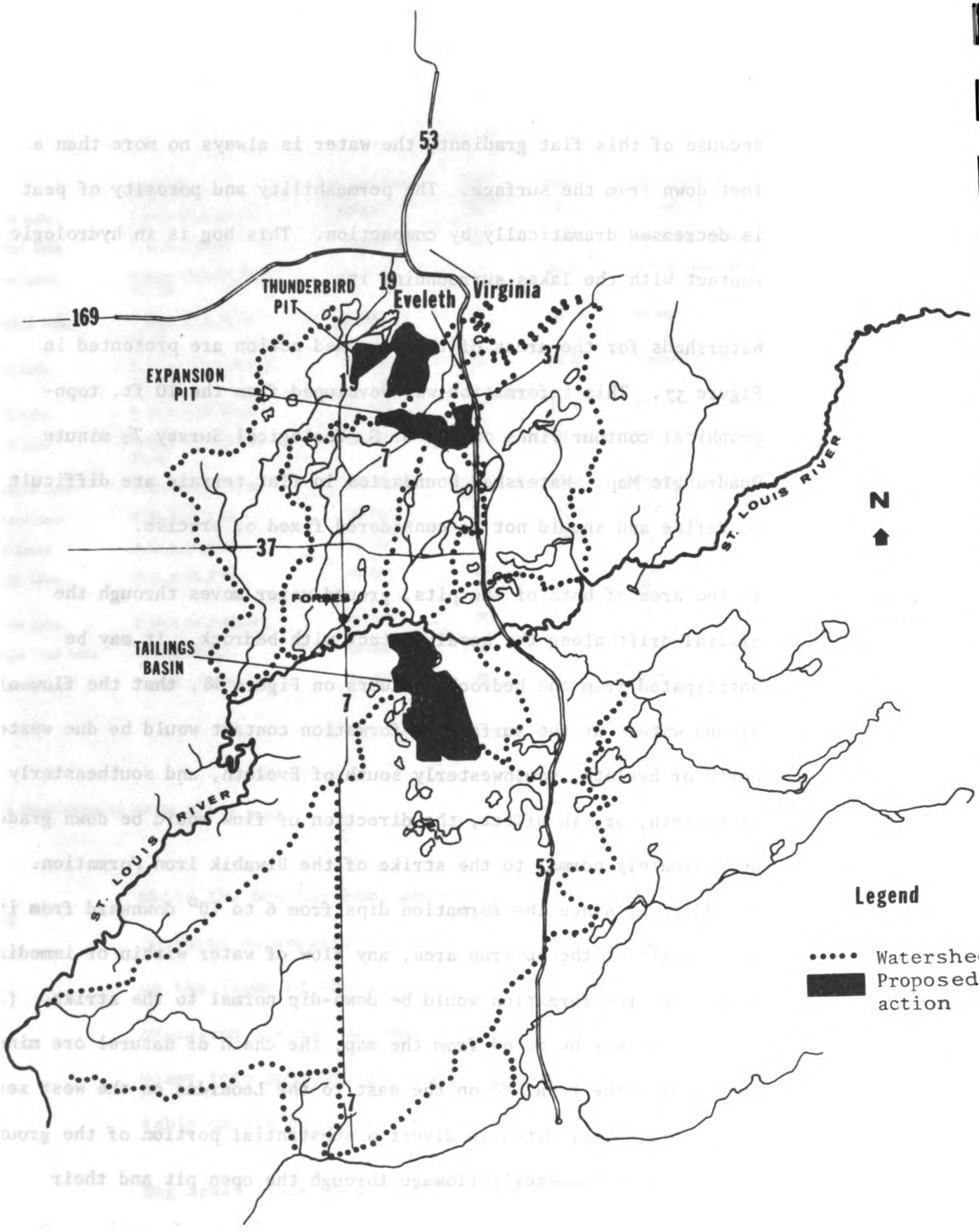


Figure 37

Watersheds in the area of the proposed action

BEDROCK TOPOGRAPHY
BIWABIK IRON FORMATION OUTCROP
VIRGINIA - EVELETH AREA
Figure 38
JULY, 1975
North Limit of Biwabik Iron-Formation
LAURENTIAN DIVIDE
VIRGINIA
THUNDERBIRD MINE
VIRGINIA MINE
GROSS-NELSON
LEONIDAS
HULL-NELSON
SPRUCE
ALICE
FAYAL NO. 2
FAYAL NO. 3
FAYAL PIT EXT.
TROY
PEARSALL
EVELETH
PROPOSED LIMIT OF OPEN PIT
M
M'
N

appear that the Fayal Extension pit is not hydraulicly connected to the other pits in the system. Longitudinal Section, M-M' (Figure 39) substantiates these premises in that the elevation of the impounded water indicates that the hydraulic gradient slopes off to the northwest (4), and in that the Fayal Extension water elevation is perched.

It is also anticipated that the only ground water flowage down-dip from the natural ore mines would be flowage in porous layers under the open pits or along faults extending southwesterly from the north edge of the formation. It would appear by the drop in water elevation from the Troy to the Pearsall Mine as shown on Section N-N' (Figure 40) that there is a poor to non-existent hydraulic connection in this down-dip direction even though the Pearsall, Troy and Fayal No. 3 mines all lie along a major fault running north-south which extends completely across the outcrop of the Biwabik Formation.

Section L-L' (Figure 41) shows the significance of the Laurentian Divide on the watershed of St. Mary's Lake.

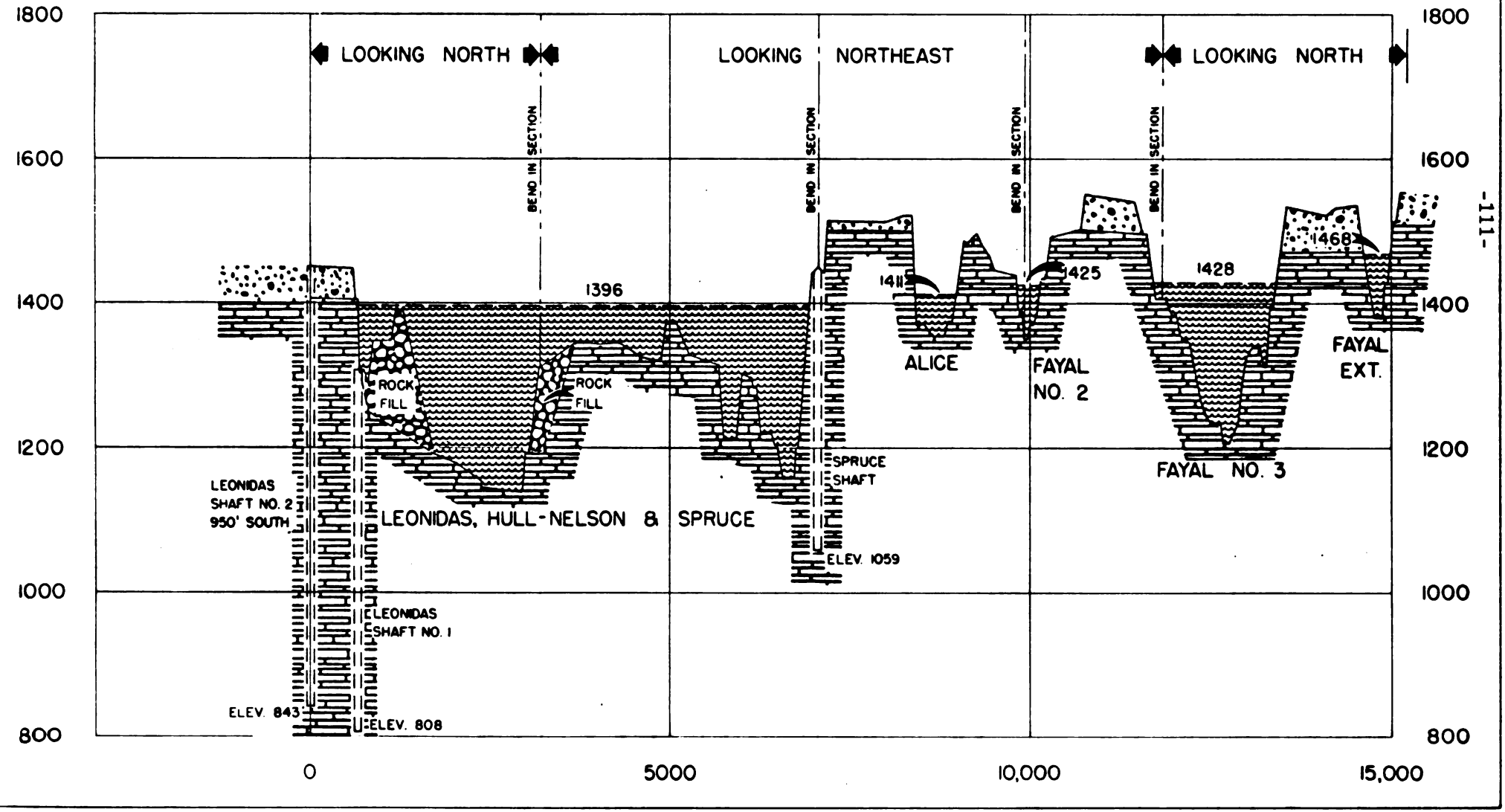
References - Ecosystems & Hydrology

1. Minnesota Department of Natural Resources "Final Environmental Impact Statement - Proposed Inland Steel Taconite Operation. St. Louis County, Minnesota." March 22, 1974.

2. Shields, J. T., Applegate, J., a working paper prepared for H. A. Axelson and Associates (consultants to Oglebay Norton).

SECTION M-M'

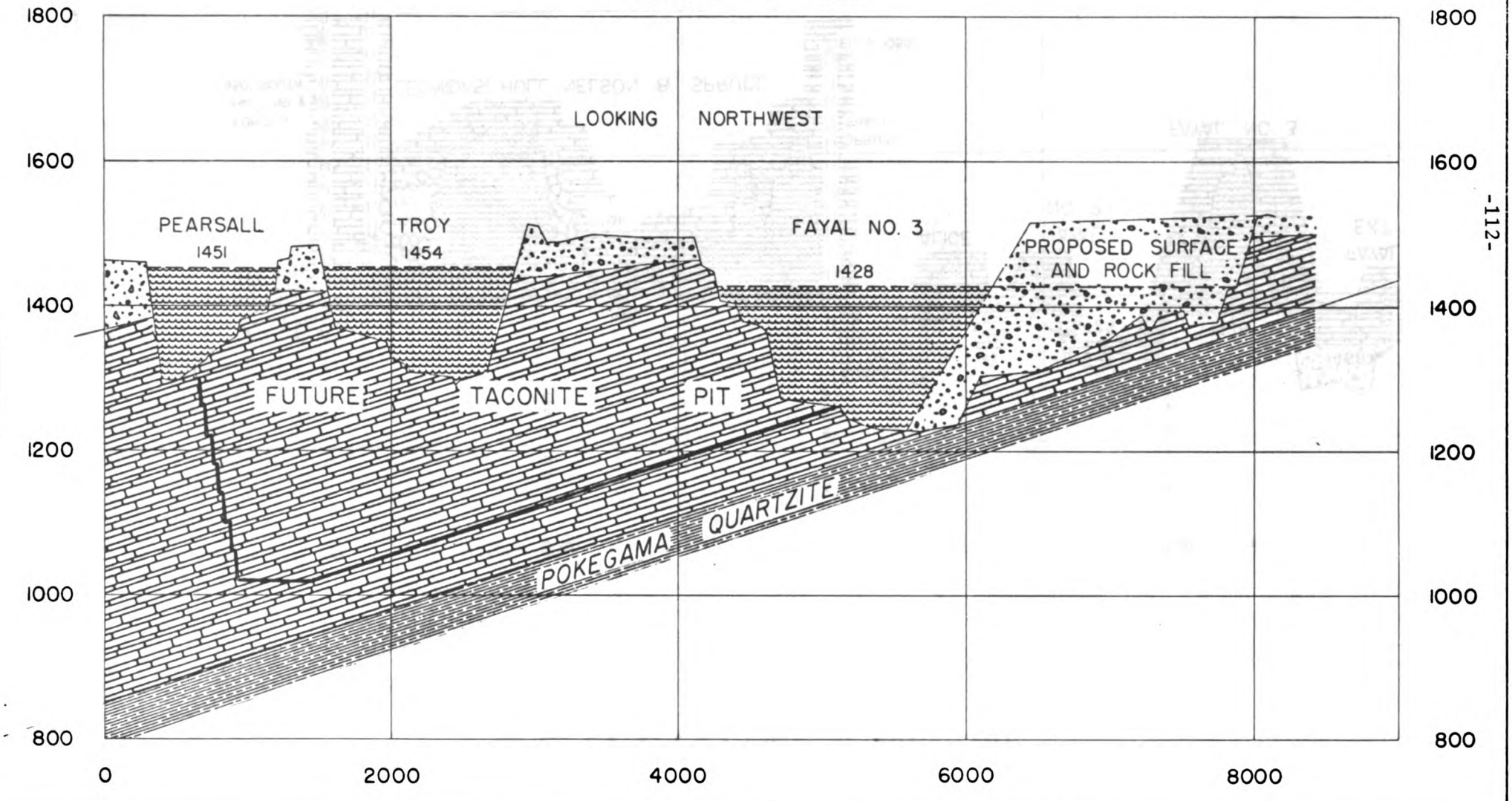
Figure: 39
SCALE
HORIZONTAL 1" = 2000'
VERTICAL 1" = 200'



SECTION N-N'

Figure: 40

SCALE
HORIZONTAL 1" = 1000'
VERTICAL 1" = 200'



SECTION L-L'

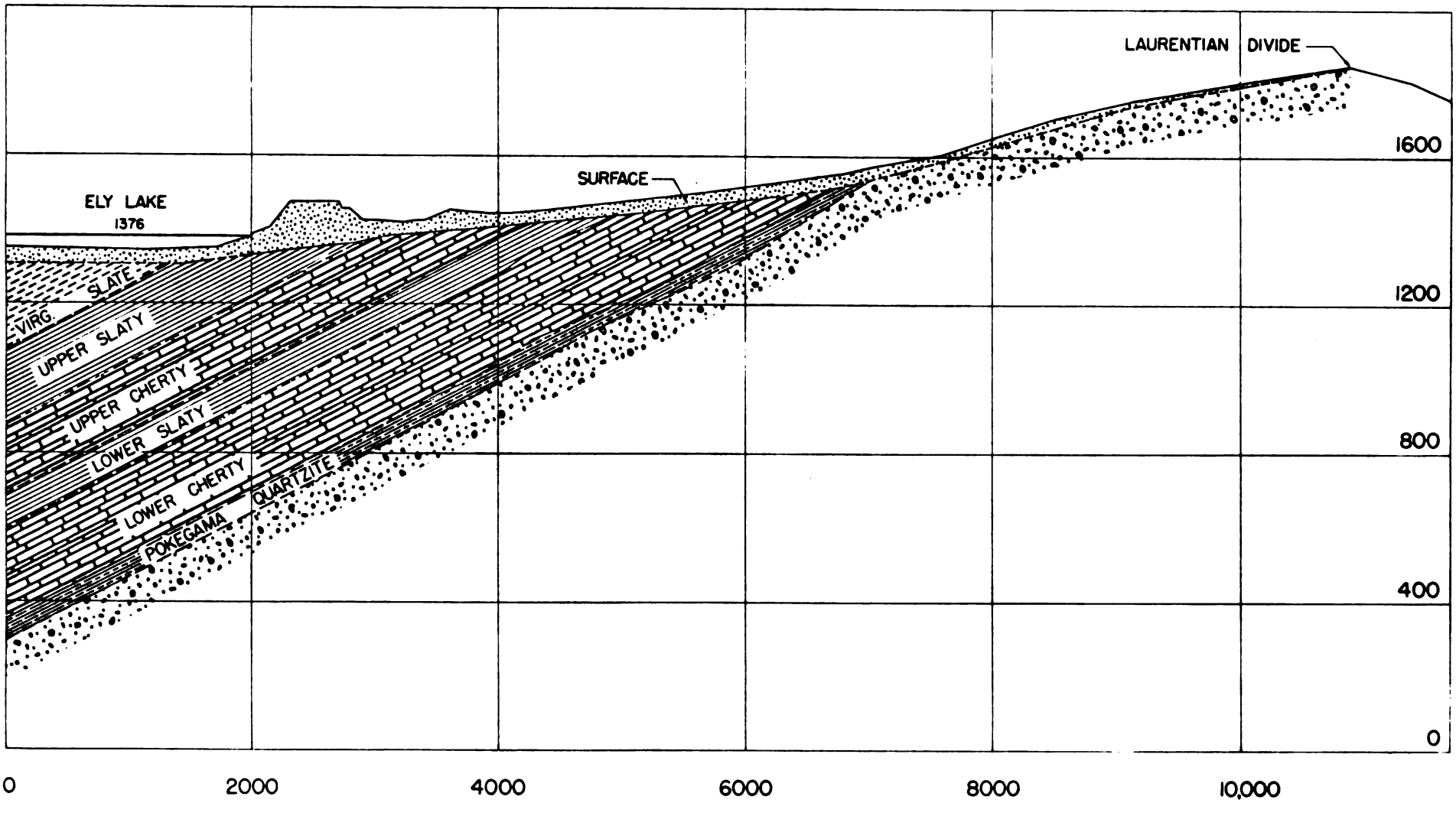
Figure: 41

LOOKING SOUTHWEST

SCALE

HORIZONTAL 1" = 1200'

VERTICAL 1" = 400'



Ecosystems & Hydrology Continued

3. Oakes, E.L., for the U. S. Geological Survey in cooperation with the Division of Waters, Minnesota Department of Natural Resources and the Department of Iron Range Resources Rehabilitation, "Bedrock Topography of the Eastern and Central Mesabi Range, Northeastern Minnesota," Miscellaneous Geologic Investigations Map I-389, 1964.

4. "Application for Permits for the Appropriation, Use & Diversion of Water" submitted by Oglebay Norton Company.

propriations The town of Eveleth which also supplied the Village of Leonidas and the Eveleth Taconite Co. may appropriate 3,000 gpm from the north end of St. Mary's Lake, and actually consumed an estimated 528 gpm in 1973. Eveleth Taconite Co. consumes 57 gpm of that 528 gpm total. Virginia appropriates water from the Messabe Mountain mine and maintains one well located in town for emergency water. They consumed an average of 1,669 gpm in 1970. Gilbert and Sparta may appropriate as much as 417 gpm from their wells located in S36, T58N, R17W. In 1970 they consumed 240 gpm.

ischarges Quality Gilbert discharges its effluent into Lost Lake which is hydrologically remote from the project area.

Eveleth has two discharge points. One discharges to Manganika Lake. The disposal system was built in 1935 and no design data is on file with the Minnesota Pollution Control Agency. City records show the facility is designed to treat 50,000 gallons of waste water per day. It consists of an Imhoff tank and a sludge drying bed. The yearly average 5-day B.O.D. is 170 milligrams/liter (mg/l) and total suspended solids is 85 mg/l.

The main Eveleth sewage system flows through Elbow Lake via an unnamed creek and Elbow Creek. The disposal system is designed for an average daily flow of up to 800,000 gallons per day and consists of bar screen, grit chamber, aeration tank using complete mix modification of the activated sludge process, final settling tank, an aerobic digester, a retention tank, chemical feed equipment, chlorine contact tank, and control building. The facilities are designed to treat sewage and industrial waste constituting a total 5-day biochemical oxygen demand (BOD_5) load of 1,300 pounds per day. The average yearly 5-day BOD is 31 mg/l and total suspended solids is 12 mg/l.

Virginia discharges their effluent into an unnamed creek which flows to Manganika Lake. The existing disposal system is designed for an average discharge of up to 1,500,000 gallons per day and consists of a mechanically cleaned bar screen and screenings grinder with an alternate manually cleaned bar screen control house containing equipment and facilities, venturi meter, manually cleaned grit chamber, two primary clarifiers, dosing tank, standard rate trickling filter, two final clarifiers, chlorination contact tank, primary and secondary heated sludge digesters, sludge storage tanks, and sludge drying beds. The plant is designed to treat sewage with a 5-day biochemical oxygen demand (BOD_5) of 270 parts per million. Beginning on July 1, 1975, Virginia planned to put additional facilities for their existing treatment facilities, on line. The additions and capacities follow.

Modifications and addition to the existing disposal system will provide for an average discharge of up to 2,000,000 gallons per day and consists of a control building containing auxiliary equipment and facilities, manually cleaned bar screen, aerated grit chamber, three 0 to 1,500 gallon per minute variable speed raw waste water pumps, lime storage facilities with 500 gallons per hour feed equipment, high-rate chemical solids contact unit, natural of LP gas recarbination unit, two aeration tanks for the activated sludge process, two final settling tanks, polymer feed system, mixing tank, floculation tank, two dual media filters, chlorine contact tanks, lime sludge beds, gravity sludge concentrator, and a stand-by diesel engine driven generator. The plant is designed to treat 2,550 pounds of 5-day biochemical oxygen demand (BOD_5) daily.

In order to establish baseline water quality for the taconite expansion, water samples were taken from all of the waters that will be involved in the dewatering and from the Little Tony drainage of the tailings basin. Sampling locations are represented on Figure: 42. A summary of these samples is presented in table 62 (next page).

Upon review of these results, PCA, DNR and Oglebay Norton met to discuss the monitoring program. It was requested that Oglebay Norton analyze 33 parameters on a new sampling point above Horseshoe Lake (Location Q on Figure 42) & another station be set up to monitor the flow from Elbow Lake (Station P). It was further requested that routine samples should be analyzed for the following parameters:

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Table 62

Chemical analysis, summary of all stations

Location	Fayal Extension Pit	Fayal No. 3 Pit	Fayal No.2 Pit	Alice Pit	Leonidas Spruce Pit	Unnamed Creek	Thunderbird mine drainage	Unnamed Creek	Manganika Outflow	Unnamed Creek	Troy Pit	Pearsall Pit	Unnamed Creek	Long Lake Outflow	St. Louis	St. Louis	St. Louis Little Tony Outflow	Tailings Seepage
Station	A	B	C-1	C-2	D	E	F	G	H	I	J-1	J-2	J-3	K	L	M	N	O
Date	5/24/74	5/24/74	5/24/74	5/24/74	5/24/74	7/17/74	5/24/74	5/24/74	5/24/74	7/17/74	5/24/74	5/24/74	7/17/74	7/17/74	7/28/74	7/24/74	7/24/74	7/24/74
pH	8.2	7.9	7.9	7.8	7.6	7.6	8.4	8.0	9.1	7.2	8.1	8.1	6.9	8.4				
Total Alkalinity, mg/l (as $CaCO_3$)	101	139	267	271	175	328	213	144	111	90	138	130	133	52				
Ca Hardness, mg/l (as $CaCO_3$)	74	134	174	166	394	416	44	138	90	100	194	130	90	41				
Total Hardness, mg/l (as $CaCO_3$)	142	298	424	434	1044	964	267	334	176	188	414	270	152	89				
Sulfide, mg/l (S)	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	.1	.1				
Sulfate, mg/l (SO_4)	30	195	145	180	710	467	195	174	65	90	385	170	68	10				
Chloride, mg/l	16	10	7	7	13	9	38	19	45	20	5	3	1	8				
Bromide, mg/l	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	.1	.1				
Fluoride, mg/l	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	.1	.1				
Nitrate, mg/l (NO_3 as N)	.01	.04	<.01	.07	.59	.21	23.0	2.30	1.17	1.10	<.01	.02	.11	.02				
Nitrite, mg/l (NO_2 as N)	<.01	<.01	<.01	<.01	<.01	.06	<.01	<.01	.04	.06	<.01	<.02	.01	.01				
Ammonia, mg/l (NH_3 as N)	<.1	<.1	<.1	<.1	<.1	.96	<.1	<.1	<.1	5.05	<.1	<.1	.20	.03				
Oil & Grease, mg/l	<10	<10	<10	<10	<10	<5	<10	<10	<10	5	<10	<10	5	5				
Color, Fe-Co units	15	5	10	5	<5	80	5	50	60	45	5	<5	200	20				
Turbidity, J.T.U.	4	3	5	3	4	4	2	3	5	14	5	3	19	2				
B.O.D., mg/l	3	2	2	2	<1	2	<1	1	9	9	<1	<1	1	2				
Dissolved Oxygen, mg/l	10.2	10.3	9.9	9.8	9.6	7.2	9.4	9.8	11.7	6.8	10.0	10.1	4.7	8.0				
Total Bacteria, per ml	62	71	53	61	4	944	31	11	32	688	45	10	736	628				
Total Coliform, MFN/100 ml	38	38	8.8	8.8	2.2	38	38	15	38	38	15	5	38	38				
Suspended Solids, mg/l	9	5	4	2	8	16	7	2	13	15	8	10	10	4	32	16	8	13
Total Solids, mg/l	186	423	496	491	433	1520	554	510	300	345	607	354	206	116				
Dissolved Solids, mg/l	177	418	492	489	425	1504	547	508	287	330	599	344	196	112	238		442	763
Phosphate, mg/l	.02	<.01	<.01	.02	<.01	2.5	<.01	.11	.40	3.0	<.01	<.01	.09	.05				
Mercury, ug/l (total)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1				
Aluminum, ug/l "	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	100	100				
Chromium, ug/l "	<100	<100	<100	<100	<100	<1	<100	<100	<100	<1	<100	<100	1	1				
Copper, ug/l "	3	2	3	4	3	5	3	3	5	8	3	3	20	6	10	5	4	2
Iron, ug/l "	33	40	79	121	30	600	24	163	119	900	33	31	6100	18	211	102	122	101
Lead, ug/l "	6	5	5	5	5	<1	6	6	6	1	5	6	1	1				
Manganese, ug/l "	15	122	2600	2700	400	8400	3	400	180	600	28	10	3800	100	8	4	65	500
Nickel, ug/l "	7	10	12	11	11	3	10	10	10	4	6	6	4	1	11	9	9	8
Zinc, ug/l "	8	6	8	8	8	5	8	8	12	11	6	7	6	3				

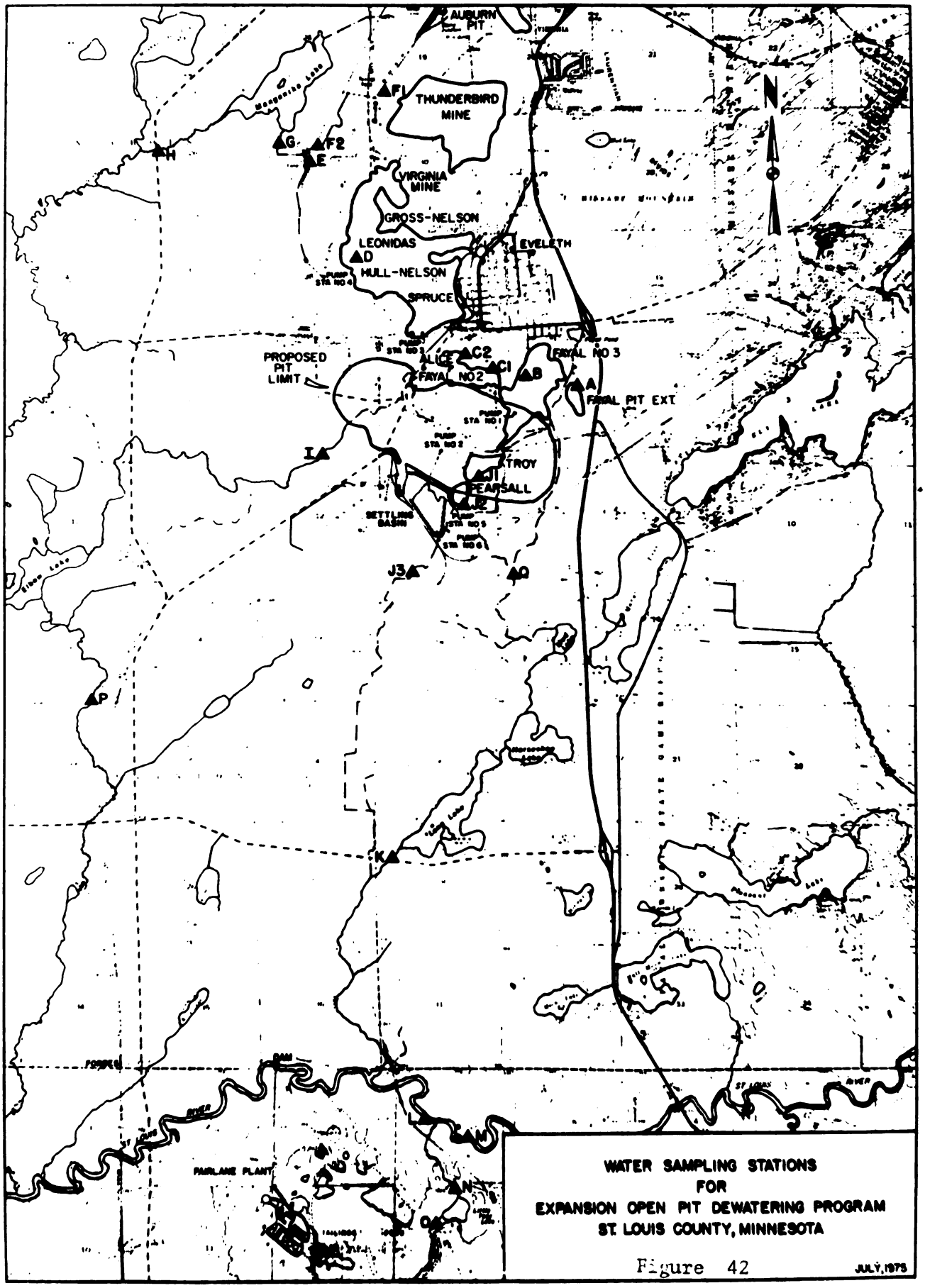
AUBURN PIT
THUNDERBIRD MINE
VIRGINIA MINE
GROSS-NELSON
LEONIDAS
HULL-NELSON
EVELETH
SPRUCE
PROPOSED PIT LIMIT
ALICE
FAYAL NO 2
FAYAL NO 3
FAYAL PIT EXT
TROY
PEARSALL
SETTLING BASIN
PUMP STA NO 1
PUMP STA NO 2
PUMP STA NO 3
PUMP STA NO 5
PUMP STA NO 6
F1
F2
G
E
H
D
AC2
AC1
B
A
I
J3
Q
P
K
M
N
O
FAIRLANE PLANT
WATER SAMPLING STATIONS
FOR
EXPANSION OPEN PIT DEWATERING PROGRAM
ST. LOUIS COUNTY, MINNESOTA
JULY, 1975

Figure 42

pH	Turbidity
Total Suspended Solids	Sulfate
Total Solids	Hardness
Total Dissolved Solids	Flow

In addition to the parameters requested for routine sampling, it was requested that sample stations J3, E, G and the tailings basin runoff be sampled and analyzed for dissolved iron.

Because Oglebay Norton now intends to develop another basin immediately, additional monitoring of surrounding lakes will be initiated. Water quality samples will be taken and lake level fluctuations will be measured. A more complete discussion of water quality with additional monitoring recommendations is presented on pp. 242 through 268 .

Asbestos

Finally, water samples were taken by Oglebay Norton and DNR for asbestos analysis from the active tailings basin, the Fayal #3, Troy and Pearsall pits. The samples were run at the National Water Quality Lab of the Environmental Protection Agency in Duluth. An x-ray diffraction test to detect amphiboles was run which showed that less than .009 mg/l (the detection limit of the equipment) was present. This compares with samples of Lake Superior water which have reached .2 mg/l. Therefore, the samples from the basin would indicate that very little or no amphiboles are present.

Further analysis was done by a qualitative transmission electron microscope examination of the suspended solids filtered from water samples described above. This analysis revealed platy mineral

particles (probably talc and Minnesotaite) and diatom fragments, were the constituents of the suspended load of those waters. No amphibole fibers were observed.

Archeological and Historical Sites

The St. Louis Historical Society publication "Exploring St. Louis County Historical Sites" shows no historical sites as being in the proposed project area. There is no known archeological significance that is presently listed in, or candidated for the National Register of Historical Places.

There are two historic sites located in the MDNR Project 80 report "Natural and Historic Areas of Minnesota" in the vicinity, but not in the immediate area of the action. There is what is called a prehistoric site on the west shore of Long Lake in S19, T57N, R17W, and an Indian cultural site on the northwest shore of Murphy Lake in S28, T56N, R17W. These sites have not been verified by field inspection. Because they are outside of the probable area of influence of this action, no more investigation is planned. But if the lakes described should rise, the Minnesota Historical Soceity should be notified immediately so that they may investigate further.

SOCIO-ECONOMIC SETTING OVERVIEW

HISTORY

Mining of the ore deposits in northeastern Minnesota started at Soudan on the Vermillion Range in the 1880's. The first mine on the Mesabi Range was opened at Mountain Iron in the 1890's. There was a continuous and rapid expansion in the number of mining operations, employment and ore shipments until the 1920's. Growth in the overall population of the Range corresponded with growth in the mining industry. Demand for natural ore was again high between the period immediately preceding World War II and the period through the Korean conflict. "As the deposits of natural iron ore were being depleted in the mid-1950's, the industry began switching to the concentration of the lower grade taconite ore. Estimates of the untapped deposits of the taconite ore resource run as high as fifty billion tons."[1]

The conversion to taconite mining and beneficiation resulted in considerable growth and investment on the Mesabi Iron Range. Before the recently announced industry-wide expansion across the Range, the total investment in taconite plants alone was estimated at more than one billion dollars. As of 1969, the impact included more than $130 million in wages, $15.2 million in state and $18.3 million in local taxes, and income taxes to the federal government of some $33 million.[2]

1. Population, Economy, Land Use, Lake Superior Basin Water Quality Management Plan, Non-Metro Minnesota Portion. Arrowhead Regional Development Commission, June 1974, p. 26.
2. ARDC, loc cit

In addition to the Eveleth Taconite Company's Fairlane Plant at Forbes, plants for the beneficiation and pelletizing of taconite have been established at Mountain Iron, Hoyt Lakes, Silver Bay in Lake County and Coleraine and Keewatin in Itasca County. New plants to be constructed in the next few years will be located north of Virginia and in the Hibbing-Chisholm area. All of the existing plants have announced expansion plans that will bring new plant investment on the Range close to an additional billion dollars.[1]

In addition to its financial impact, the taconite industry has had a substantial impact on employment, population and development patterns in the immediate past. In 1970 approximately 12,200 workers were directly employed in mining out of a total employed labor force of 110,300 workers in the seven county Arrowhead Region.[2] Almost all of these were employed in taconite operations. New planned communities were established at the Hoyt Lakes and Babbitt mine sites and at the Silver Bay plant in the late 1950's. These new communities were among the few in the Arrowhead Region to show growth in the past decade.

SOCIO-ECONOMIC STUDY AREA

The industry-wide expansion now underway can be expected to stimulate additional change in the area. Because construction on the major plants is proceeding concurrently and all will start operations within a relatively short time of one another,

1. ARDC, loc cit
2. Ibid.

it will be difficult to isolate geographically the effects on populations, employment, land use or other socio-economic considerations that any single project will generate. Improved transportation facilities, varying preferences for housing accommodations and life styles and a demonstrated willingness of Range residents to commute comparatively long distances to work are other factors that prevent relating impacts to a specific location of project influence.

The geographical setting for much of the inventory and analysis that follows then is that part of the Mesabi Iron Range lying within St. Louis County. This area, which extends from Range 16 on the east to Range 21 on the west and includes townships 56 through 59, encompasses most of the area from which the bulk of workers could be expected to commute. It does not include the east range communities of Aurora, Babbitt and Hoyt Lakes which are relatively self-contained and removed in terms of time-distance from the site of the expansion project. Figure 43, which shows this principal area of analysis, indicates the driving times between the various communities and taconite facilities.

LAND-USE

This area has been intensively inventoried by the Arrowhead Regional Development Commission in studies done as part of The Water Quality Management Plan for the Lake Superior Basin and for the Areawide Planning Jurisdiction studies done as part of ARDC's contracts with the Department

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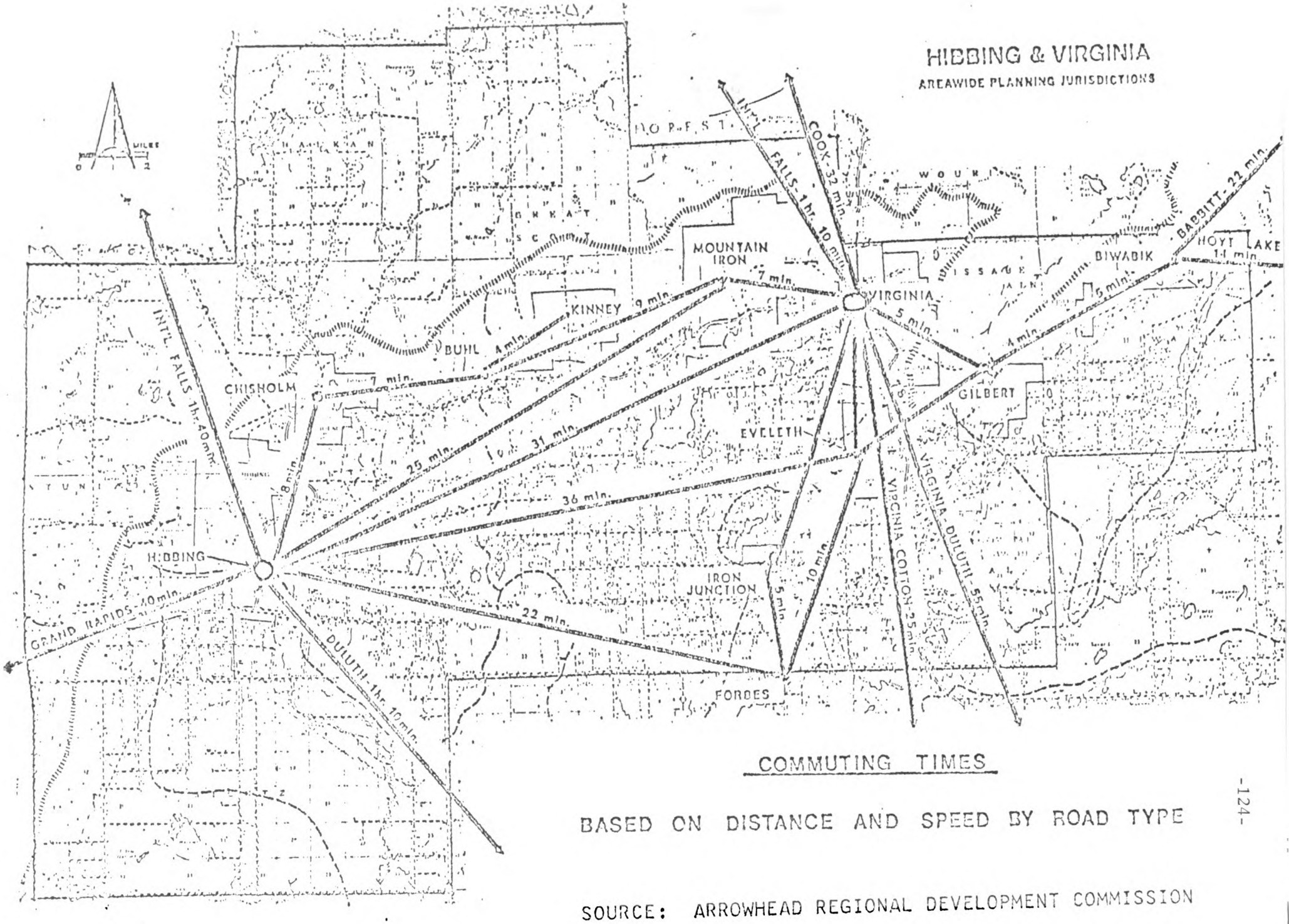

COMMUTING TIMES

BASED ON DISTANCE AND SPEED BY ROAD TYPE

SOURCE: ARROWHEAD REGIONAL DEVELOPMENT COMMISSION

FIGURE 43

of Housing and Urban Development. This same area is also included in the Regional Development Plan, previously cited, which provides a broad framework for evaluating long range impacts on the Range.

The St. Louis County part of the Range, referred to as the APJ in the studies by the Arrowhead Commission, includes thirteen incorporated communities and eight unincorporated townships. The incorporated areas include Hibbing, Chisholm, Buhl, Kinney, Gilbert, Virginia, Eveleth, Mountain Iron, Franklin, Leonidas, McKinley, Biwabik and Iron Junction. The unincorporated townships are Balkan, Cherry, Great Scott, Stuntz, Biwabik, Clinton, Fayal and Missabe Mountain. Nichols township was recently merged with Mountain Iron which makes that community the largest in area of the Range cities.

Prior to the Mountain Iron - Nichols Township merger, the incorporated places made up about 11 percent of the total land area, with a total of 41,000 acres. The entire area covers about 610 square miles. With the exception of Mountain Iron, Virginia and Gilbert, all of the incorporated communities lie entirely within the Lake Superior Basin. The portions of those communities named which fall in the Rainy River Basin are sparsely populated.

The ARDC study broke down the area into forty-acre cells for purposes of inventory and analysis. The area has a total of 9784 such cells. Table $_{13,}$ which gives the number of forty-acre cells in each land use category within incorporated limits

shows the importance of mining and mine-related activities. There were 816 cells out of the total 1054, or 77 percent classed as being in mining use. This includes 311 forty-acre cells in active mine, mine dump and tailings pond use, 306 in inactive or exhausted mines, and 199 in mining company control but not in active use at this time.[1]

TABLE 13:

Land Use - Mesabi Range, St. Louis County

Category		
Mining		816
Active mine use	311	
Inactive mines	306	
Mining controlled	199	
Cemetaries, parks, open space		4
Railroad siding, sewage disposal, etc.		31
Urban Activities		203
TOTAL		1054

Less than 20 percent of the incorporated area is presently used for urban activities including residential, commercial and related uses. Little land is available that is not in mining activity or control, or public ownership for the expansion of urban activities. Only one of the incorporated communities on the Range, Iron Junction, is located completely off the ore formation.

This lack of area for urban expansion was also documented earlier in the Regional Development Plan.[2] This report noted

1. Development Plans for Hibbing and Virginia Areawide Planning Jurisdiction, Arrowhead Regional Development Commission, October 1973.
2. Land Use Survey and Analysis, Aquar, Jyring, Whitman and Moser, 1967, p. 4.

that the existing pattern has been dictated by mining activity, highway development, lakes and other natural and man-made features. The report, which covered a wider area including both the Vermillion Range and parts of Itasca County, again demonstrated the importance of mining as a land use activity with about 30 percent of the developed area of this much larger study area classified in this category. Although the data in Table14 was developed in 1962, it does indicate the relative importance of the various activities. In addition to the 184,000 acres considered as developed this earlier inventory of the much larger study area showed more than 1.1 million acres in forest, 284,000 acres in wetlands, and 123,000 acres in lakes.

TABLE 14:

Developed Land Use, Mesabi and Vermillion Ranges 1962

Category	Acres	Percent of Developed Area
Urban Places & Non-Farm Settlements	18,164	9.8
Seasonal Homes, Resorts	14,749	8.0
Mining (Open Pits, Stockpits, Etc.)	53,274	28.9
Parks & Recreation	5,715	3.2
Public Open Space	2,176	1.2
Agriculture	89,919	48.9
TOTAL	183,997	100.0

Source: Land Use Survey and Analysis, Aquar, Jyring, Whitman and Moser, 1967, page 4.

The St. Louis County Land Use Survey and Analysis conducted by the same firm in 1965 gave a more detailed breakdown by land use activity for the townships and incorporated areas on the Range. Although the data is several years old, it does indicate

the relative importance of the various land uses and the importance of mining in the overall pattern. The acreage for selected land use categories is given in Table 15:

At the time of the inventory there were 42,647 developed acres in the study area. In addition to those categories shown in the table this developed acreage included land in seasonal and active and inactive agricultural uses. Mining was by far the single most important land use even in most of the incorporated cities. Hibbing was the only city without some mining land use in its limits at that time. Mining use accounted for 60 percent of the developed land acreage in the area as a whole.

Residential use was the second largest consumer of land with more than 3431 acres. This was 13 percent of the developed land. Public and semi-public uses also accounted for substantial acreage. There were more than 1360 acres in this use.

The most revealing fact about the land use inventory is the vast amount of undeveloped or vacant land in the area. This is represented by the difference between the total and developed acres. More than 696,000 acres, or almost 95 percent of the area, was undeveloped. Few of the incorporated areas were even close to utilizing all of the land within their limits. For the incorporated areas as a whole, undeveloped land amounted to 95 percent of the total acreage while in the unincorporated areas the figure was 92.8 percent. However, as noted earlier, much of this vacant or undeveloped land is in mining ownership.

TABLE 15 : Land Use, Iron Range, 1965

	Acres Of Land					Total	Grand
	Resid.	Comm.	Indus.	Public	Mining	Devel.	Total
Balkan	136.8	0.9	6.8	39.3	1,980.0	2,578	42,680
Biwabik	78.7	1.5	4.5	9.3	332.0	515	19,400
Cherry	95.3	1.0	1.7	8.5	21.0	1,251	23,040
Clinton	123.9	0.9	2.8	2.4	79.0	2,352	22,560
Fayal	216.7	5.4	5.5	112.6	385.0	848	19,960
Great Scott	25.1	0.0	1.9	10.7	1,223.0	1,631	42,163
Missabe Mtn.	17.3	0.3	1.9	0.2	1,422.0	1,443	13,944
Nichols	250.7	3.0	10.8	10.5	236.0	796	36,400
Stuntz	527.4	11.4	21.2	3.8	6,363.0	12,183	106,569
Sub-Total	1,471.9	24.4	57.1	197.3	12,041.0	23,597	326,716
Biwabik	71.0	2.1	4.0	11.0	1,056.0	1,195	3,120
Buhl	51.4	3.6	1.1	3.9	980.0	1,076	1,640
Chisholm	293.5	16.3	13.9	91.3	936.4	1,557	2,760
Eveleth	193.0	12.4	16.0	58.7	1,032.0	1,462	3,080
Franklin	1.4	0.1	0.8	0.7	960.0	967	1,320
Gilbert	94.3	5.2	7.2	27.6	696.0	900	2,400
Hibbing	770.5	135.3	14.2	435.7	4,272.0	6,223	8,631
Iron Junction	7.4	0.2	0.4	2.6	0.0	31	480
Kinney	12.6	0.6	0.2	5.4	932.0	963	2,277
Leonidas	3.8	0.0	2.9	4.1	580.0	599	881
McKinley	18.5	0.5	0.1	5.3	80.0	131	520
Mtn. Iron	41.3	1.7	5.6	16.9	1,692.0	1,798	8,800
Virginia	400.6	40.1	43.4	500.9	702.5	2,148	5,376
Sub-Total	1,959.3	218.1	109.8	1,164.1	13,918.9	19,050	412,850
GRAND TOTAL	3,431.2	242.5	166.9	1,361.4	25,959.9	42,647	739,566

SOURCE: Land Use Survey and Analysis, Aguar, Jyring, Whitman and Moser, 1967.

Outside the incorporated communities residential land use is widely dispersed. The ARDC study indicated that only 1798 of the 8192 forty-acre cells in the unincorporated part of the Range contained residential units. Over half of these contained a single dwelling unit. There were 62 forties with 11-30 dwelling units and only 11 with 31-80 residences.[1]

Suburbanization of residential developments has been occurring on the Range with most of the new units constructed in the unincorporated area in the time period analyzed. St. Louis County Zoning and Planning Department permits showed that most of this unincorporated development was clustered in seven distinct localities in the 1968-1972 period. Four of these development clusters were on or adjacent to lakeshore. The greatest building activity in these lakeshore areas was in Fayal Township in the Ely Lake area east of US 53. The other three development clusters were in the Clinton, Mountain Iron and Stuntz areas.

TABLE 16: Residential Building Starts in the Unincorporated APJ Area by Township and Soil Conditions, 1968-1972.

Township	Total Dwelling Units	Added Units 1968-1972	Added Units On Severe Soil
Balkan	363	17	3
Biwabik	319	28	9
Cherry	205	18	18
Clinton	292	35	38
Fayal	898	65	24
Great Scott	117	9	9
Missabe Mountain	281	1	0
Nichols*	447	46	46
Stuntz	1664	91	91
TOTAL	4616	310	235

*Now included in Mountain Iron

Source: ARDC, Population, Economy, Land Use, p. 118

1. ARDC, Population, Economy, Land Use, p. 118

A tabulation of dwelling units in the unincorporated area of the Range showed the importance of amenity lakeshore locations to this suburbanizing trend in certain townships. In Fayal Township, for example, half of the residential units were on lakeshore, and of these, another half were permanent residences. As indicated on Table 17, there were more than 4600 dwelling units in the unincorporated area with Stuntz having the largest number. Almost 700 of the total were lakeshore units with two-thirds of these in Fayal Township. Most of these were around Ely Lake. Not quite half of the lakeshore units were permanent residences.

TABLE 17:

Total and Lakeshore Homes in Unincorporated APJ Area, 1973

Township	Total D,U.	Lakeshore		
		Total	Permanent	Seasonal
Balkan	363	31	9	22
Biwabik	319	129	51	78
Cherry	208	5	3	2
Clinton	292	6	3	3
Fayal	898	463	233	230
Great Scott	117	16	14	2
Missabe Mountain	281	12	7	5
Nichols*	477	10	1	9
Stuntz	1664	25	9	16
TOTAL	4616	697	330	367

*Now included in Mountain Iron

Source: ARDC, op. cit., p. 21

The analysis was aimed at identifying potential areas for future residential development. The forty-acre analysis units were each rated on the basis of their suitability for future residential use. The weighing factors used included

existing land use, land ownership, zoning classification, soils ratings and the presence of swamps. Those areas which had the highest rating and which were considered the most suitable for development included the south part of Fayal Township east of US 53, the east side of Biwabik Township, and two areas in southern Stuntz Township. Those areas are indicated in Figure 44.

TRANSPORTATION

The present transportation network on the Range connects the string of incorporated cities and settlements generally following along the ore formation. The principal east-west route is US 169 which provides a continuous link from Grand Rapids, through Hibbing and Virginia to the Tower area where it becomes Minnesota 1 and continues to Ely. The entire route is to be upgraded to expressway standards in the future. Sections have been completed including the link between the Itasca County line through Hibbing to Chisholm and the stretch from Kinney through Virginia. The other major east-west route is Minnesota 37 which runs south of the ore formation from Hibbing to US 53, passing between the planned Oglebay Norton Mining activities and the Forbes plant. A short spur of Highway 37 runs from US 53 east, connecting Gilbert and McKinley. This spur also connects to Minnesota 135 which serves the east Range communities of Biwabik and Aurora.

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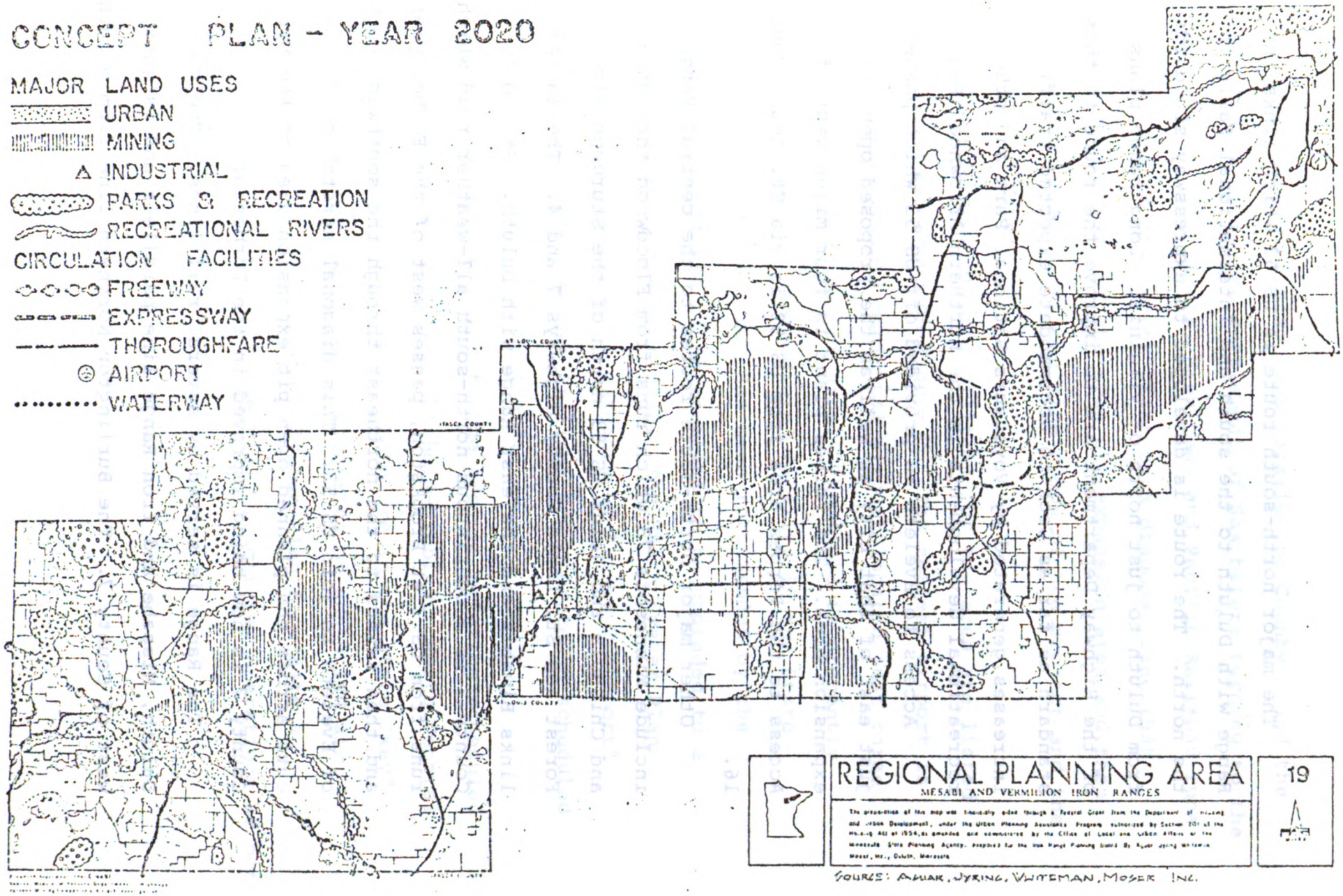

SOURCE: AHLAR, JYRING, WHITEMAN, MOSER INC.

FIGURE 44

The major north-south route is US 53 which links the Range with Duluth to the south and International Falls in the north. The route is developed to expressway standards from Duluth to just north of Virginia. Long range plans of the Highway Department are to improve the route to this standard as far as Cook to accommodate expected traffic increases generated by Voyageurs National Park and other recreational developments in the northern Arrowhead Region.

Access to Eveleth is provided off US 53 which passes just east of that city as well as the proposed open pit expansion area. The Forbes plant is four miles west of US 53. Access to the Forbes area from US 53 is via St. Louis County 16.

Other major north-south routes to the central Range include Minnesota 73 which runs from Floodwood through Hibbing and Chisholm and joins US 53 north of the Sturgeon River Forest and St. Louis County Highways 7 and 4. The latter links Biwabik and the east Range with Duluth. St. Louis County 7 is a continuous north-south all-weather road which runs from US 2 at Brookston, passes west of the Forbes plant and then swings to the northeast through the southwest corner of Eveleth to join US 53. This diagonal stretch of County 7 cuts across the planned open pit expansion area of the project. County 7 is now being improved in the Forbes area.

The Range is served by several rail lines. The main Duluth, Missabe and Iron Range line parallels and is just west of County 7. The Burlington Northern line from Duluth

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to the Hibbing area also runs parallel to County 7 and the DMIR tracks up to the settlement of Sax before turning to the northwest. The Duluth, Winnipeg, and Pacific Railroad runs to the east of the Forbes plant on a diagonal line that passes to the west of the open pit expansion area and then swings northeast along the mine dumps of the project and the Thunderbird Mine.

Air transportation facilities for the area are listed in Table 18 and shown on Figure 45. The nearest airport is the Eveleth-Virginia municipal airport located just three miles east of the project area. The field is presently classified as an "intermediate" facility in the State Aviation System Plan, but has been recommended by the Minnesota Department of Aeronautics to be upgraded to a "key" airport by the year 2000. The State System Plan recommends an operational category of "Basic Transport" by the year 2000. Mesabi Airlines now operates a scheduled commutor service from the field.

The nearest airports to the project offering scheduled air service are Duluth and Chisholm-Hibbing. North Central Airlines serves both fields. Both are in the state "key" system and have operational categories of scheduled air transport (AT). The Aviation System Plan forecasts a substantial increase in commercial air carrier operations at both fields by the year 2000.

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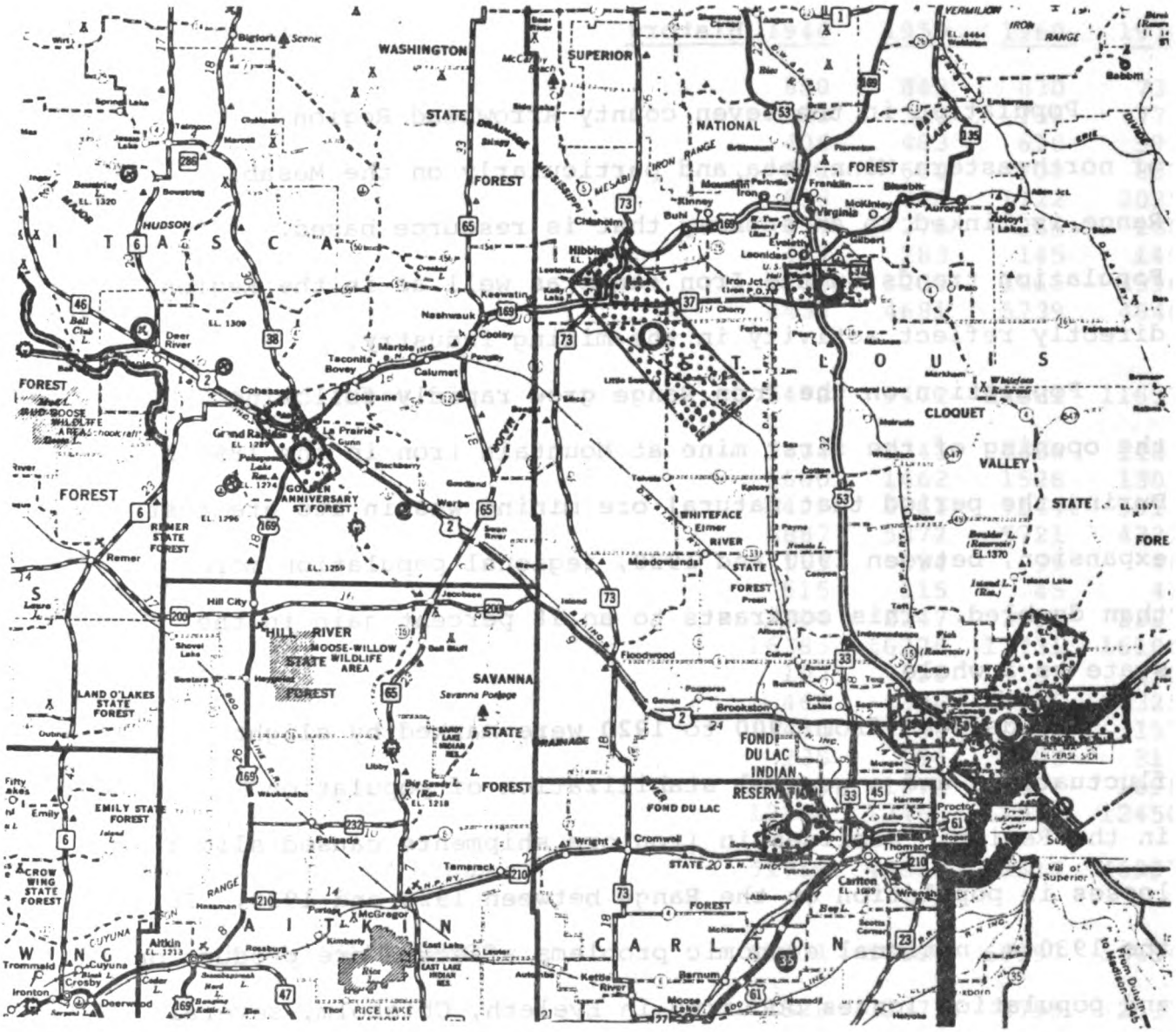
TABLE 18:

Existing Airport Summary

Location	Type	Runways	Lighted	Fuel	Storage	Repairs	24 hr. phone	Daily Attendance	Radio	Taxi or Car Rental	Recommended Operational Category
Duluth	International	E/W 10,150'paved	x	x	x	x	x	x	x	x	Key-International Scheduled Air Transport
		NW/SE 4000'paved	x								
		NE/SW 5700'paved	x								
Hibbing-Chisholm	Municipal	NW/SE 6500'paved	x	x	x	x	x	x	x	x	Key-Scheduled Air Transport
		SW/NE 4000'paved									
Cloquet	Municipal	N/S 3200'paved	x	x	x	x	x	x	x	x	Intermediate-General Utility
		E/W 2000'sod									
Grand Rapids	Municipal	NW/SE 4100'paved	x	x	x	x	x	x	x	x	Key-Basic Utility
		NE/SW 3050'sod									
		E/W 2470'sod									
Eveleth-Virginia	Municipal	E/W 4200'paved	x	x	x	x	x	x	x	x	Key-Basic Utility
		NE/SW 3050'paved									
		NW/SE 3200'paved									
Deer River	Municipal	SW/NE 2400'sod	0	0	x	0	0	0	0	0	Landing Strip/Basic Utility
		NW/SE 2000'sod									
Cohasset	Private	NW/SE 2470'sod	0	0	x	0	0	0	0	0	Landing Strip
Eveleth Sea-plane Base	Private	----------	0	x	x	x	0	x	x	x	----------
Bud's Ranch	Private	NW/SE 2750'sod	0	x	x	0	x	0	0	0	Landing Strip

x - Yes
0 - No

Source: Minnesota Aviation System Plan and Minnesota Airport Directory.


WASHINGTON
SUPERIOR
STATE
FOREST
NATIONAL
FOREST
HUBBARD
A I T A S C A
Hibbing
Nashwauk
Keewatin
Cooley
Calumet
Coleraine
Cohasset
Grand Rapids
La Prairie
Pokegama Lake Rec. Area
GOLDEN ANNIVERSARY ST. FOREST
Warba
Marble
Taconite
Bovey
Deer River
Bell Club
FOREST
FOREST
REMER STATE FOREST
Remer
Hill City
HILL RIVER
MOOSE-WILLOW STATE WILDLIFE AREA
FOREST
SAVANNA
Savanna Portage
STATE
FOREST
LAND O'LAKES STATE FOREST
EMILY STATE FOREST
CROW WING STATE FOREST
Emily
Fifty Lakes
Palisade
Tamarack
Wright
Cromwell
Aitkin
McGregor
Rosabud
Kimberly
Lost Lake
Lauder
Rice
RICE LAKE INDIAN RES.
Ironton
Crosby
Deerwood
Cuyuna
Trommald
W I N G
A I T K I N
C A R L T O N
Barnum
Moose Lake
Kettle River
Carlton
Thomson
Floodwood
Brookston
FOND DU LAC INDIAN RESERVATION
FOND DU LAC
Meadowlands
WHITEFACE
Elmer
RIVER
STATE
FOREST
Proctor
Superior
Duluth
Virginia
Mountain Iron
Buhl
Chisholm
Hibbing
Leonidas
Iron Jct.
Gilbert
Eveleth
Franklin
McKinley
Aurora
Biwabik
Babbitt
Hoyt Lakes
Embarrass
Bay Lake
Central Lakes
Markham
Whiteface Reservoir
CLOQUET
VALLEY
STATE
FORE
Boulder L. (Reservoir) EL.1370
Island L. (Res.)
Talon Lake
Indianadance
Fish L. (Reservoir)
Bartlett
Burnett
Grand Lakes
Harney
Munger
Esko
Scotts Corner
Wrenshall
Hermantown
Midway
Willow River
Sturgeon Lake
Pine City
Hinckley
Askov
Sandstone
Moose Horn River
Kettle River
Sandstone
Mission Creek
Willow River

POPULATION

History

Population in the seven county Arrowhead Region of northeastern Minnesota, and particularly on the Mesabi Range, is linked to an economy that is resource based. Population trends on the Iron Range, as well as in the Region, directly reflect activity in the mining industry.

Population on the Iron Range grew rapidly following the opening of the first mine at Mountain Iron in the 1890's. During the period that natural ore mining was in its greatest expansion, between 1900 and 1920, regional population more than doubled. This contrasts to an 18 percent gain in the state as a whole.

The decades from 1900 to 1920 were marked by slight fluctuations and a general stabilization of population in the Region. Declines in iron ore shipments caused slight losses in population on the Range between 1920 and 1930. In the 1930's, national economic problems affected ore production and population losses occurred in Eveleth, Chisholm, several of the smaller Range communities and Duluth. A rising demand for steel in the years immediately preceding World War II probably lessened the out-migration trend that had started during the "Depression" years.

The decline of ore production following the war saw the renewed out-migration from the Range and from the Region generally. Table 19, which gives the population figures for the various communities and unincorporated areas, including

TABLE 19:

Population Trends, 1940-1970

Minor Civil Division	1940	1950	1960	1970
Balkan	850	843	830	732
Biwabik	322	320	756	773
Cherry	406	483	610	593
Clinton	602	600	709	869
Fayal	818	780	1722	2025
Great Scott	377	276	255	280
Missabe Mtn.	427	283	145	149
*Nichols	1233	1205	1815	1596
Stuntz	4437	4681	5739	4640
All Unincorporated Areas	9472	9471	12581	11657
Biwabik	1304	1245	1836	1483
Buhl	1600	1462	1526	1303
Chisholm	7409	6861	7144	5913
Eveleth	6887	5872	5721	4721
Fraser	155	134	95	48
Franklin	515	115	45	41
Gilbert	2504	2247	2591	2287
Hibbing	16385	16276	17731	16104
Iron Junction	107	128	187	150
Kinney	462	336	396	325
Leonidas	440	88	94	157
McKinley	235	196	408	317
Mountain Iron	1492	1377	1808	1698
Virginia	12264	12486	14034	12450
Main Range Incorporated Areas	51759	48823	53616	46997
TOTAL MAIN RANGE	61231	58294	66197	58654
Aurora	1528	1371	2799	2531
Babbitt	117	118	2587	3076
Hoyt Lakes	17	20	3186	3634
East Range Incorporated Areas	1662	1509	8572	9241
GRAND TOTAL	62892	59803	74769	67895

*Nichols Township has been merged with the Village of Mountain Iron

Source: U. S. Census

the east Range communities of Aurora, Babbitt and Hoyt Lakes, indicates that the loss in some communities was substantial in the 1940-1950 period. Those communities which showed the most noticeable losses included Chisholm, Eveleth, Buhl and Aurora. The unincorporated townships as a group and the two major service centers, Hibbing and Virginia, remained at essentially the same population level with Virginia showing a slight gain. Overall, the entire Range lost some 3000 persons in this decade with the loss occurring in incorporated area populations.

By the mid 1950's taconite production was a reality on the Range and the post-war "baby boom" was affecting the local as well as national trends. The population in the entire area, including the east Range communities shown, grew by almost 15,000 persons or almost 25 percent. Reflecting a national suburbanization trend, the unincorporated townships grew by 3100 persons, an increase of 32 percent. The incorporated places increased at a somewhat lesser rate of 10 percent. Major increases in the main Range area occurred in Fayal, Nichols and Stuntz Townships, as well as in the incorporated communities of Hibbing, Virginia, Mountain Iron and Gilbert. Eveleth and some of the very small natural ore settlements such as Fraser and Franklin, continued to show a population loss in this time. (See Figure 46 for location of townships.)

The most dramatic change in the 1950-1960 period occurred in the east Range cities of Aurora, Babbitt and Hoyt Lakes.

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NORTHEASTERN MINNESOTA

Counties, Cities, Villages and Townships

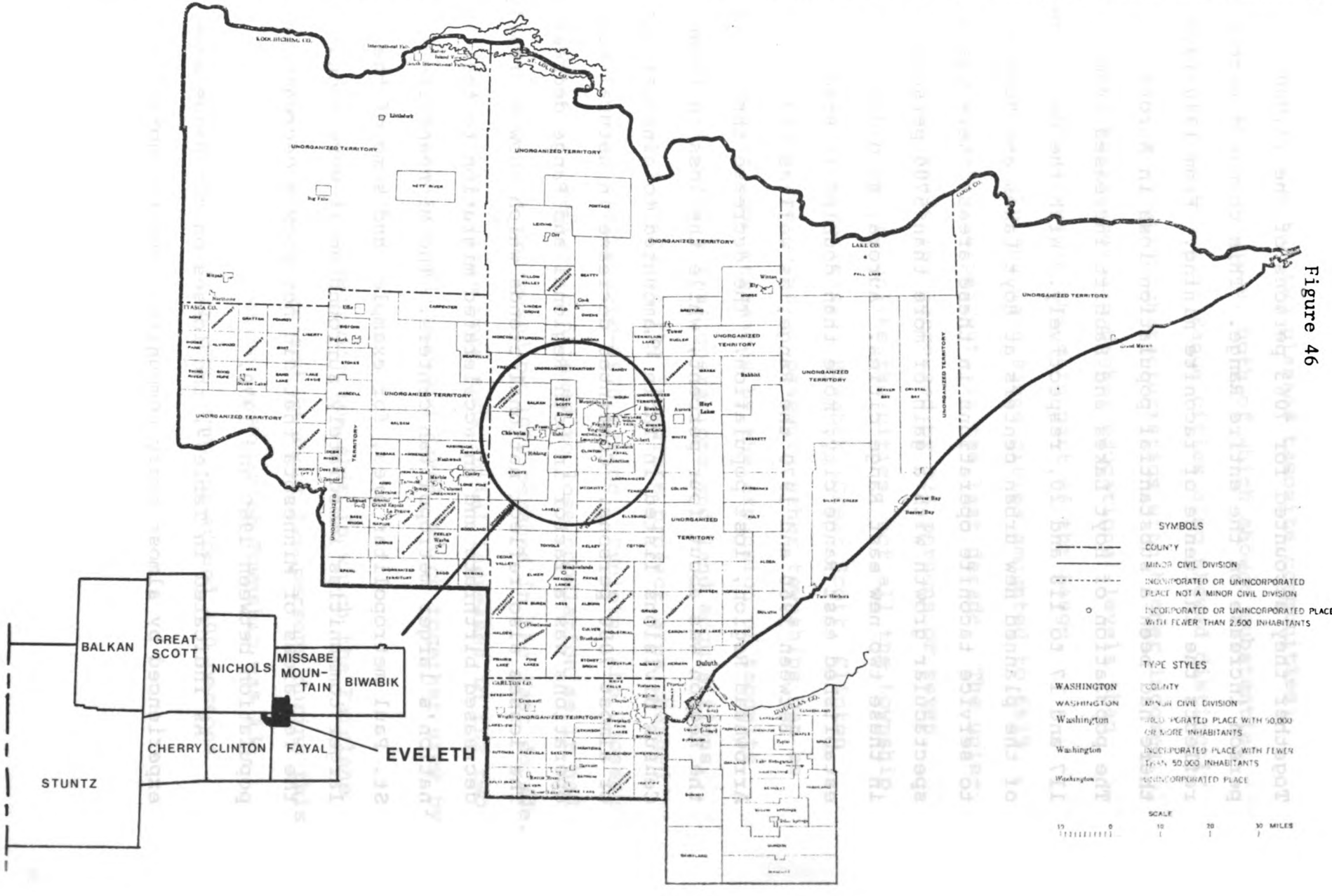

Figure 46

Together they accounted for 7063 persons of the 14,900 person increase on the entire Range. This change directly reflects the influence of taconite mining. From 1940-1950 there had been a substantial population loss in Aurora. The population of Hoyt Lakes and Babbitt increased from 117 and 17 to 118 and 20, respectively. With the development of the planned new urban centers at Hoyt Lakes and Babbitt to service taconite operations in these areas, there was a spectacular growth with a gain of more than 5700 persons in these two new east Range cities. Aurora, an older established east Range city, more than doubled in size.

Between 1960 and 1970 the Range, as well as the Arrowhead Region, lost population. The decrease throughout the Region was about four percent, while the loss in those Census divisions listed in Table 19, amounted to nine percent or almost 7000 persons. Continued decrease in natural ore operations was a factor in both Regional and Range decreases. The losses also reflect national trends which show a greatly decreased birthrate and an accelerated migration to the nation's larger metropolitan centers. The Minneapolis-St. Paul metropolitan area, for example, and some of the larger communities immediately surrounding it were among the few areas of Minnesota that did not show a decrease in population between 1960 and 1970.

As indicated in Table 19, the losses on the Range were experienced by almost every community. The two notable

exceptions were the two planned taconite communities, Babbitt and Hoyt Lakes, both of which showed substantial gains. These two east Range cities also showed distinctly different population characteristics with higher incomes, younger median ages and higher educational levels than other communities in the main part of the Range.

The loss in the main Range cities amounted to 6619 persons, or twelve percent, in the last decade. The unincorporated townships decreased by 924 persons or seven percent. However, unlike the cities, not all the township areas showed a decrease. Biwabik, Great Scott, Clinton and Fayal showed gains. Losses in other townships can be explained in some instances by the expansion of taconite activity such as actual operations and land acquisitions.

The population in the immediate project area changed considerably in the 1960-1970 period. Eveleth, the closest incorporated center, continued to lose population as it had since 1940. It decreased by 1000 persons in the last decade. As noted above, there were substantial increases in the two closest townships, Clinton and Fayal, which together grew by almost 500 persons.

Population in McDavitt Township, in which the Fairlane Plant is located, decreased by about ten persons during this time. The 1960 population in McDavitt Township was 435. The township population has remained around 400 persons since 1940.

Population is distributed unevenly across the Range with 80 percent of the total located in the 14 incorporated cities. About half of the population on the main part of the Range is located in the two largest cities, Hibbing and Virginia. About two-thirds of the total can be accounted for in these two, plus Chisholm and Eveleth. The balance is widely spread among the other small communities and unincorporated townships as noted earlier. The overall population density for the entire area from Grand Rapids to Ely is only 43 persons per square mile.

Density

Data developed by ARDC from aerial photographs, highway maps, and other sources giving the number of dwelling units for the APJ study area shows the wide variation in density on the Range Table 20. For the incorporated areas as a whole, the number of dwelling units per square mile is 192, while in the unincorporated portions the figure is 8 dwelling units by township and range--note that the overall density is 28 dwelling units per square mile, or approximately 84 persons per square mile, assuming a uniform occupancy of three persons per unit. The count of dwelling units in the table include those within the municipal areas so more detailed analysis of densities is not possible.

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TABLE 20

Dwelling Unit Density

Township Name	Township And Range	Number[1] Of DU's	DU's/ Square Mile
Biwabik	58-16	800	22
Fayal	57-17	930	26
Missabe Mtn.	58-17	4830	134
Clinton	57-18	460	13
Nichols[2]	58-18	937	26
	59-18	0	0
Cherry	57-19	205	6
Great Scott	58-19	486	14
	59-19	0	0
Balkan	58-20	2347	65
	59-20	226	6
Stuntz	56-20	141	4
	57-20	3521	98
	56-21	238	7
	57-21	1654	46
	58-21	156	4
TOTAL AREA		16,956	28

1 Includes municipal and unincorporated areas.

2. Nichols has been merged with Village of Mountain Iron

Source: ARDC, Development Plans for Hibbing and VIrginia, APJ

Population Forecasts

Estimates of current, 1974, population have been prepared by the Arrowhead Regional Development Commission. These were made for the entire Range area running from Ely through Grand Rapids. They are based on postal vacancy surveys and estimates of vacancies by local realtors and an assumed uniform factor for persons per occupied unit corresponding to the 1970 figure. The estimates are currently being revised with regard to the individual communities with the overall total for the entire area still considered valid.

These ARDC estimates place the 1974 population within the Main Range area at 63,100 persons as of May, 1974. This figure is some 1500 persons greater than the forecast figure for 1975 developed earlier in the ARDC Water Quality Management Plan with the difference most likely reflecting a faster build-up of workers on construction projects than anticipated.

Table 21 gives the current population estimates prepared by the ARDC. An increase of over 900 persons from 1970 to 1974 is shown in the unincorporated townships with almost all of this gain considered by ARDC to have occurred in Fayal Township. The increase in the incorporated communities in the four year period is estimated at 4460 persons. The most significant change was shown in Hibbing which increased by almost 3000 persons. The ARDC estimates also indicate a substantial gain on the East Range particularly in Aurora, which ARDC considers to have increased by 600 persons.

TABLE 21

Current Population Estimates

	1970	1974	Change	% Change
Balkan	732	737	5	0.0
Biwabik	773	773	0	0.0
Cherry	593	593	0	0.0
Clinton	809	874	5	0.0
Fayal	2025	2932	907	44.8
Great Scott	280	280	0	0.0
Missabe Mtn.	149	149	0	0.0
Stuntz	4640	4662	22	0.5
All Unincorporated Areas	10,061	11,000	939	9.3
Biwabik	1483	1502	19	1.3
Buhl	1303	1318	15	1.2
Chisholm	5913	5933	20	0.3
Eveleth	4721	4826	105	2.2
Gilbert	2287	2326	39	1.7
Hibbing	16,104	19,080	2976	18.5
Iron Junction-Leonidas	307	307	0	0.0
Kinney-Fraser	373	373	0	0.0
McKinley-Franklin	358	358	0	0.0
Mtn. Iron-Nichols	3294	3329	35	1.1
Virginia	12,450	12,760	310	2.5
Main Range Incorporated	48,593	52,112	3519	7.2
TOTAL MAIN RANGE	58,654	63,112	4458	7.6
Aurora	2531	3134	603	23.8
Babbitt	3076	3131	55	1.8
Hoyt Lakes	3634	3842	208	5.7
East Range Incorporated Areas	9241	10,107	866	9.4
GRAND TOTAL	67,895	73,219	5324	7.8

Sources: U. S. Census, 1970.
ARDC, Assessment of Growth Impacts on the Iron Range 1974 estimates.

In the immediate project area, Eveleth and Fayal Townships, the 1974 population represents an increase of just over 1000 persons from the 1970 figure. The total 1974 population of these two areas was estimated at 7758 persons. No estimate was made of McDavitt Township population.

The population forecasts mentioned above were prepared by the ARDC as part of the Lake Superior Basin Water Quality Management Plan. These were based on an earlier set of forecasts which were adjusted to reflect the population impact of these taconite plant expansions that had been announced as of May 1974. The earlier forecast was based primarily on State Health Department estimates of future county populations which, with adjustments for actual 1970 Census counts, were used as control totals from which the forecasts of individual minor civil divisions were prepared. Even with the later adjustments to take into account the expanded taconite operations on the Range, it is considered by ARDC staff that these estimates might be on the conservative side.

The population estimates for the Range from the ARDC Water Quality Management Plan are given in Table 22. These show the population in the unincorporated areas reading 11,620 by 1980 and 13,500 by 1990. The incorporated cities are expected to gain 4200 persons by 1990, and have a total population of some 53,000 by that date. The 1990 total population for the Main Range area is estimated at 66,340. With the East Range considered, the population for the entire area would be 82,000 persons, a gain of some 14,000 over the 1970 figure.

TABLE 22

Estimates of Future Population to 1990

	1970	1975	1980	1985	1990
Balkan	732	650	560	470	390
Biwabik	773	640	630	620	600
Cherry	593	520	450	380	310
Clinton	869	880	930	980	1020
Fayal	2025	2700	3380	4050	4730
Great Scott	280	250	210	180	150
Missable Mtn.	149	130	120	100	80
Stuntz	4640	5050	5460	5860	6270
All Unincorporated Areas	10,061	10,820	11,620	12,640	13,550
Biwabik	1483	1740	1830	1930	2030
Buhl	1303	1270	1240	1220	1190
Chisholm	5913	5900	5900	5900	5900
Eveleth	4721	4410	4100	3790	3480
Gilbert	2287	2680	3030	3410	3770
Hibbing	16,104	16,360	16,620	16,880	17,140
Iron Junct.-Leonidas	307	350	360	370	370
Kinney-Fraser	373	300	280	260	240
McKinley-Franklin	358	340	260	140	40
Mtn. Iron-Nichols	3294	3740	4190	4640	5090
Virginia	12,450	12,730	13,000	13,270	13,540
Main Range Incorporated	48,593	49,820	50,810	51,810	52,790
TOTAL MAIN RANGE	58,654	60,640	62,430	64,450	66,340
Aurora	2531	2950	3170	3390	3610
Babbitt	3076	3740	4310	4880	5440
Hoyt Lakes	3634	4380	5120	5870	6610
East Range Incorporated Areas	9241	11,070	12,600	14,140	15,660
GRAND TOTAL	67,895	71,710	75,030	78,590	82,000

Source: ARDC, Lake Superior Basin Water Quality Management Plan.

Population in the immediate project area, including Eveleth and Fayal Townships, according to this set of estimates, would increase by almost 1500 persons by 1990. Combined population of the two areas by 1990 would be 8210. The estimate assigns all of this increase to Fayal Township with Eveleth to continue to decrease. McDavitt Township, the site of the Fairlane plant, is also expected to continue to decline with a 1990 population of 220 forecasted.

More recent farecasts were prepared along with the 1974 estimates of population that were presented in Table 21. by ARDC. The ARDC report, Assessments of Growth Impacts on The Iron Range (revised in June 1975, which contains the population forecasts), shows a slightly higher total population for the Main and East Range areas in the future. The figure arrived at in this forecast is 84,660 or some 2,600 persons more than in the earlier estimates presented in Table 20. The later estimate places future population in the Main Range area at 71,740. This is some 5400 persons greater than the 1990 figure shown in Table 22 For planning purposes it seems likely then that the future population in the study area will fall within the range of the low estimate of 66,340 and the high of 71,740 persons. Table 23. compares the two projections.

TABLE 23:

Comparison of 1990 Population Forecasts

	W.Q.M. Plan	Range Impact Study
Main Range	66,340	71,743
East Range	15,660	12,917
TOTAL	82,000	84,660

Sources: ARDC, Water Quality Management Plan
ARDC, Assessments of Growth Impacts on the Iron Range

This later study estimates that the Eveleth population will increase by about 350 persons and Fayal Township by about 1025 persons over the 1974 numbers. This would mean a total 1990 population of 9130. No new figure was developed for McDavitt Township. For planning purposes, future population in the Eveleth-Fayal Township area will range between 8120 and 9130 persons by 1990.

Project-Related Population

The existing Eveleth Taconite operations, including the Thunderbird Mine and the Fairlane Plant, employ about 400 workers. Assuming an average family size of 3.0, the current population directly supported by these operations would be approximately 1200 persons.

As the basic industry on the Range, mining and ore processing generates and supports employment in the service or non-basic industries and, therefore, accounts for other population indirectly. The ARDC estimates of mining-related employment are based on a multiplier of .47. That is, for

100 jobs in the basic industry of mining an additional 47 jobs will be created in other sectors. Using this multiplier, Eveleth Taconite's existing employment supports another 190 employees in other categories and a related population of 570, again assuming a family size of three persons. Total population then related to the Eveleth Taconite operations amounts to 1800 persons at present or about three percent of the study area total.

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EMPLOYMENT AND ECONOMY

The economy of northeastern Minnesota is resource-based and mining is the major industry. In 1970 the three county study area of the ARDC Water Quality Management Plan contained a total employed labor force of some 42,000 people. Nearly 10,000 persons were employed in the mining industry. Mining was the second largest employer in this three county area, service industries being first, in 1970; however it had been largest since 1960.

The relationship between mining activity and the economy and employment is even more closely linked on the Range. In 1970 there were 4603 mining workers and they accounted for almost 23 percent of all Range employment. Table [24], which gives the number and percent of employment by major industry for that year, points out the dependence of the area on mining. More than 55 percent of all employment was in mining in the three East Range communities and in the immediate site area, Eveleth and Fayal Townships, more than 26 percent of total employment was in this category. Mining was by far the largest single employer in each of the areas shown.

Further evidence of the importance of mining to the local economy can be seen by dividing the percent of local employment by the corresponding percentage of national employment with the resultant figure called the location quotient. Where the location quotient is greater than 1.00 the particular industry is generally considered to be a "basic" industry producing more than is needed locally or, in other words, exporting to other areas.

TABLE 24: Employment By Major Industry, 1970

Number	Main Range Uninc.	Main Range Incorp.	Main Range Total	East Range	Site*
Agriculture	123	42	165	10	28
Mining	1,344	3,319	4,663	1,767	613
Construction	232	777	1,009	42	129
Mfg.-durables	211	483	694	27	50
Mfg.-non-durables	281	1,137	1,418	121	246
Transportation	264	1,022	1,286	146	119
Trade	779	3,229	4,008	340	371
**F.I.R.E.	55	435	490	43	36
Services	228	1,162	1,390	74	104
Professional Svcs.	613	3,371	3,984	440	466
Public Admin.	121	609	730	75	82
Not Reported	126	645	771	99	83
TOTAL	4,377	16,231	20,608	3,184	2,327
Percent					
Agriculture	2.8	0.2	0.8	0.4	1.5
Mining	30.7	20.4	22.6	55.5	26.3
Construction	5.3	4.8	4.9	1.3	5.5
Mfg.-durables	4.8	3.0	3.4	0.8	2.1
Mfg.-non-durables	6.4	7.0	6.9	3.8	10.6
Transportation	6.0	6.3	6.2	4.6	5.1
Trade	17.8	19.9	19.4	10.6	15.9
**F.I.R.E.	1.3	2.7	2.6	1.4	1.5
Services	5.2	7.2	6.7	2.3	4.5
Professional Svcs.	14.0	20.8	19.3	13.8	20.0
Public Admin.	2.8	3.7	3.5	2.4	3.5
Not Reported	2.9	4.0	3.7	3.1	3.5

*Eveleth and Fayal minor civil divisions

**Finance, Insurance and Real Estate

SOURCE: U.S. Census, 1970.

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A Profile of Labor Force Data

The labor force available in the Range in 1970 numbered 21,700 persons or about 34 percent of the population. Of this 20,100 persons were employed and about 1,000 unemployed. The unemployment rate was 7.4 percent with females making up about 44 of those out of work. Table 25 gives the labor force data for 1970.

Data on the labor force for earlier years is not readily available for the areas shown. However, it is believed that the same trends that are evident in the Region are affecting the Range as well. The three county area included in ARDC's Water Quality Management Plan indicated that the percentage of population in the labor force decreased between 1950 and 1970, the rate of increase in labor force was less than that of population and women accounted for most of the labor force increase, and that the female percentage of total labor force participants increased in this time.

On the basis of the 1970 factors shown in Table 25, the current labor force on the Main Range is estimated at 23,350, an increase of 1625 since 1970. For the entire area including the East Range it is estimated at 27,090.

Almost all of the employed labor force on the Range in 1970 worked in the area. Table 26, gives the place of work for residents and shows about 94 percent of those employed worked on the Standard Metropolitan Statistical Area, St. Louis County.[1] Only 612 persons had jobs out

1. Standard Metropolitan Statistical Area, Geographical Measurement used by U. S. Bureau of the Census.

TABLE 25: Labor Force, 1970

	Main Range			East	
	Uninc.	Incorp.	Total	Range	Site*
Employed	4,322	15,790	20,112	3,152	2,281
Male	3,159	10,252	13,411	2,373	1,508
Female	1,163	5,538	6,701	779	773
Unemployed	452	1,161	1,613	86	180
Male	305	596	901	33	124
Female	148	565	713	53	56
Total Labor Force	4,774	16,951	21,725	3,238	2,461
Total Population	11,657	46,997	58,654	9,241	6,746
LF-% Population	40.9	36.0	37.0	35.0	36.5
Emp.LF-% Total LF	90.5	93.2	92.6	97.3	92.7
Female-% Emp. LF	26.9	35.0	33.3	25.0	33.9
Female-% Unempl.	32.7	48.7	44.2	61.6	31.1

*Eveleth and Fayal minor civil divisions

SOURCE: U.S. Census, 1970.

TABLE 26:

Place of Work, 1970

	Main Range Uninc.	Incorp.	Total	East Range	Site*
In SMSA	4,033	14,587	18,620	2,918	2,148
Out of SMSA	100	452	612	10	24
Not Reported	132	519	651	77	58
TOTAL	4,325	15,558	19,883	3,005	2,230

* Eveleth and Fayal minor civil divisions

Source: U.S. Census, 1970.

TABLE 27:

Means of Travel to Work, 1970

	Main Range Uninc.	Incorp.	Total	East Range	Site*
Private Auto	3,177	9,475	12,652	1,500	1,389
Auto Passenger	539	2,056	2,595	895	211
Walk	179	3,423	3,602	252	552
Other	421	605	1,026	358	78
TOTAL	4,316	15,559	19,875	3,005	2,230

* Eveleth and Fayal minor civil divisions

Source: U.S. Census, 1970.

of the county. Most of the workers used their private automobiles as a means of travel to work. Along with auto passengers, drivers accounted for 76 percent of those responding to means of commution in 1970 as indicated in Table 27.

The occupational characteristics of the employed labor force are given in Table 28. While there are minor variations among the areas shown, craftsmen, operators and professional occupations make up the most important occupations numerically in each. All of those are associated in large measure with the mining industry. These same three occupational groups are the most predominant in the Arrowhead Region as a whole, where 16.7 percent of the employed labor force is in the operative occupations, 16.8 are craftsmen and 13.3 are professionals. The corresponding figures for the state in 1970 were 13.6, 11.9 and 15.0

Data on changes in the composition of the employed labor force for the aggregated areas shown in Table 26 are not readily available. In the seven county Region as a whole, there was a decrease in the percent of total employment in the operative and labor occupational categories between 1950 and 1970, and a marked increase in the professional, service and clerical occupations. The number of operators actually decreased by 5500 workers and laborers by 3600 region-wide in this period, while there was a gain of 5300 professionals and 4500 service workers. It is believed that this same general pattern holds in the Range study area with a greater proportion of workers in the relatively higher skilled occuptions.

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TABLE 28: Occupational Characteristics, 1970

Number	Main Range Uninc.	Main Range Incorp.	Main Range Total	East Range	Site Area*
Professional	406	2,432	2,838	454	332
Manager	261	1,298	1,559	91	185
Sales	201	1,190	1,391	126	146
Clerical	424	1,875	2,299	270	211
Craftsmen	1,092	2,619	3,711	333	436
Operative	731	2,109	2,840	503	394
Transp.Operator	319	622	941	188	142
Laborer,Non-Farm	218	689	907	111	71
Farmer	32	0	32	0	5
Farm Labor	14	15	29	4	18
Service	468	1,996	2,464	313	265
Private Hshld.	37	221	258	21	34
Not Reported	143	552	695	112	88
TOTAL	4,346	15,618	19,964	2,526	2,327
Percent					
Professional	9.3	15.6	14.2	17.9	14.3
Manager	6.0	8.3	7.8	3.6	7.9
Sales	4.6	7.6	7.0	5.0	6.3
Clerical	9.8	12.0	11.5	10.7	9.1
Craftsmen	25.2	16.8	18.6	13.2	18.7
Operative	16.8	18.5	14.3	19.9	16.9
Transp.Operator	7.3	4.0	4.7	7.4	6.1
Laborer,Non-Farm	5.0	4.4	4.5	4.4	3.0
Farmer	0.7	0.0	0.2	6.0	0.3
Farm Labor	0.3	1.0	0.1	0.3	0.7
Service	10.8	12.8	12.3	12.4	11.4
Private Hshld.	0.9	1.0	1.3	0.8	1.5
Not Reported	3.3	3.0	3.5	4.4	3.8

*Eveleth and Fayal minor civil division.

SOURCE: U.S. Census, 1970.

Some measure of current unemployment on the Range is available from the Minnesota Department of Employment Services. However, this data shows only those persons who have unemployment compensation benefits coming or who have registered with that office to seek employment. In May of this year, 1975, the Range offices of Hibbing and Virginia had 3292 applicants in their active application files. Of these, 2533 were experienced workers. The May 1975 figure was about 750 more than the figure for the corresponding month in 1974. As shown in Table 23 there was an increase in the number of active applicants at all the major offices with only Ely, Grand Rapids and International Falls showing fewer applicants in 1975. The increase over the past year may be due to such factors as new persons just entering the labor force or others reentering it because of greater job availability or simply persons coming to the area in search of work.

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TABLE 29:

Employment Applicants in the Active Application Files
In N.E. Minnesota

Total	May 1974	November 1974	May 1975	Change May '74 - May '75
Ely	453	298	425	-28
Grand Rapids	968	1276	673	-295
Hibbing	1059	806	1195	+136
Int'l. Falls	542	610	486	-56
Virginia	1486	624	2097	+611
Duluth	4295	3992	5490	+1195
Range Sub-Total	2545	1430	3292	+747
TOTAL	8803	7606	10336	+1533
Experienced				
Ely	432	293	425	-7
Grand Rapids	728	986	543	-185
Hibbing	847	651	1013	+166
Int'l. Falls	506	468	412	-94
Virginia	1013	475	1520	+507
Duluth	3914	3544	4835	+921
Range Sub-Total	1860	1126	2533	+673
TOTAL	7440	6417	8323	+883

SOURCE: Minnesota Department of Employment Services

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COMMUNITY FACILITIES AND UTILITIES

Sewer

Municipal sewage treatment facilities are maintained by those communities listed in Table 30. The Kelly Lake area in Stuntz Township and Nichols Township also had treatment facilities at the time the data in the table was compiled. With the merger of Nichols Township and Mountain Iron, the township's sewage lagoon will be abandoned and a new improved plant is to be constructed in Mountain Iron to handle the wastewater of the combined area. The Kelly Lake treatment plant is also to be abandoned with the wastewater to be treated at the Hibbing South Plant. This plant has been designed to serve most of the southern developed area of Stuntz Township as well as future growth in the south part of Hibbing. Stuntz has its own collection system, as does the small village of Franklin, which is connected to the Virginia system and treatment plant.

The Range communities fall within the St. Louis River sub-basin of the Lake Superior Basin. Because of the high water quality standards established by federal-state pollution conferences regarding Lake Superior, all of the communities on the Range have been under orders from the Minnesota Pollution Control Agency to upgrade their treatment plants. The ARDC Water Quality Management Plan estimated the cost of treatment plant improvements in the entire St. Louis River sub-basin at almost $5 million and the cost of collection system rehabilitation at $3.6 million.

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TABLE 30 Municipal Sewage Treatment Facilities

Community	Sewer Connections	Units Not Served	Existing Flow Rate (m.g.d.)
Biwabik	522	18	0.15
Buhl[1]	396	4	0.13
Chisholm	2050	25	0.67
Eveleth[2]	505	18	0.60
Franklin[3]	16	0	-
Gilbert	635	100	0.30
Hibbing[4]	4783	65	2.60
Iron Junction[5]	19	25	N.A.
Kinney[1]	95	10	0.03
McKinley	81	0	0.03
Mountain Iron	500	2	0.17
Virginia	4500	0	2.00
Kelly Lake	240	10	0.04

[1]Buhl treatment plant to serve Kinney in future.

[2]Eveleth treatment plant to serve West Eveleth and Leonidas in future.

[3]Franklin wastewater treated in Virginia.

[4]Hibbing has two plants. The new south plant was designed to serve that part of southern Stuntz Township which has a collection system. The treatment plant of Kelly Lake, a community within Stuntz, will be abandoned and sewage treated at the Hibbing South plant.

[5]Iron Junction has a community septic tank.

SOURCE: Wallace And Associates, Inventory of Wastewater Sources, June 1974. (A report to ARDC as part of Lake Superior Basin Water Quality Management Plan.)

Some of the PCA required treatment plant improvements have already been completed including those at Virginia, Hibbing and Eveleth. Most of the communities are awaiting funding assistance from the Environmental Protection Agency and the state grant program to complete the plant and collection system improvements. They are in various phases of the grant application process but all communities listed in Table 30 are high on the PCA's statewide priority list for funds. As part of the grant application procedure, engineering plans for treatment plant improvements have been, or are in the process of being, prepared. These plans are designed to accommodate expected population increases.

Water

Municipal water systems are in operation at all of the incorporated communities listed in Table 31. In addition, Kelly Lake, a built-up part of Stuntz Township, has a water distribution system that is supplied by Hibbing. The communities of Franklin and Leonidas also do not have their own sources of water or storage facilities and depend on the neighboring cities, Virginia and Eveleth, to provide these. All of the cities depend on wells as a source of supply except Eveleth, McKinley, Mountain Iron and Virginia. Eveleth obtains its supply from St. Mary's Lake while the others depend on water collected in old mine pits or shafts.

TABLE 31:

Municipal Water Supplies

	Connections	Avg.Use /Day (1000mgd)	No. Wells	Combined Pump Capacity (gpm)	Storage Capacity (1000 gal.)
Biwabik	540	170	2	625	250
Buhl	342	175	2	410	300
Chisholm	2064	500	4	1250	1800
Eveleth	1500	750	0[1]	3000	400
Franklin	Connected to Virginia System				
Gilbert	850	300	2	900	575
Hibbing	5220	2400	15	6350	4050
Iron Junction	20	6	1	N.A.	750
Kinney	106	10	1	125	200
Leonidas	Connected to Eveleth				
McKinley	112	5	0[2]	180	79
Mtn. Iron	400	225	0[2]	1100	200
Virginia	4184	2160	1[2]	6200	4050
Kelly Lake	338	Connected to Hibbing System			

[1] Eveleth's source of water is St. Mary's Lake.
[2] Mine pits or shafts are the source of water. Virginia also has a well for standby service.

Source: Minnesota Department of Health

The report Hydrology and Water Quality prepared as part of the ARDC Water Quality Management Plan for the Lake Superior Basin investigated the future supply and demand factors for water.[1] A special analysis was made of the Range which fell in planning areas 2, 3, 4 and 8. Those planning areas were groupings of major watersheds.

The reliable supply of water throughout this area was estimated at 191,946 acre feet per year. The demands by individual planning area were also estimated by type of

1. Borr Engineering. Hydrology and Water Quality, ARDC, June 1974, p. 27. (A part of the Lake Superior Basin Water Quality Management Plan.)

use including municipal, rural, livestock, natural ore processing, taconite processing and copper-nickel processing through 1990. Taconite processing alone consumes more water than all other uses combined and future demand estimates by planning area. This varied according to the expected level of taconite operations.

The report estimated that total consumption by all uses through 1990 for the Range would be less than half the reliable supply. However, it continued that localized supply problems might occur. The estimates of supply and demand are shown in Table 32.

TABLE 32:

Water Demand, Hibbing and Virginia. Area-Wide Planning Jurisdictions

Year	Municipal Population	Total Water Consumption Acre-Foot/Yr.	Reliable Supply Acre-Foot/Yr.
1970	46,997	28,781	191,946
1975	48,050	48,694	191,946
1980	48,860	70,284	191,946
1985	46,690	82,933	191,946
1990	50,490	94,622	191,946

Source: ARDC, Hydrology and Water Quality

An inventory of municipal water facilities was conducted by ARDC for the Comprehensive Areawide Sewer and Water Plan. This was funded by the Farmers Home Administration and limited to communities under 5,500 population. Data in the report is limited to Biwabik, Buhl and Kinney. The available data in the report does show that these communities do need improvements to their systems such as repair and renovation of lines,

new pumps or wells, and extension of distribution lines. None of the needed improvements were extensive for the communities reported on.

Police and Fire Protection

Among the Range cities, municipal police departments are maintained at Biwabik, Buhl, Chisholm, Eveleth, Gilbert Hibbing and Virginia. The Chisholm force is a combined police-fire department. The St. Louis County Sheriff's Department has contracts with Mountain Iron and the East Range city of Aurora to provide police protection and the personnel assigned at those locations are considered part of the Sheriff's staff. Law enforcement in the unincorporated portions of the area is under the jurisdiction of the St. Louis County Sheriff, who maintains offices and jail facilities at the courthouses in Virginia and Hibbing. The Hibbing office has eleven deputies, each of whom is assigned a patrol car, and seventeen deputies and patrol cars are stationed at Virginia. Table 33, which lists the number of police personnel and patrol cars, indicated that the size of the agencies meets the usual standard of one patrolman per thousand population.

Full time fire departments are maintained at Chisholm, Eveleth, Hibbing and Virginia. As noted, the Chisholm department is combined with the police force. Volunteer fire departments are located in Biwabik, Buhl, Gilbert and Kinney as well as in all the unincorporated townships. (Figure 47) & Table 34 gives the characteristics of the fire departments as well as

TABLE 33 Local Law Enforcement Personnel And Equipment

Community	Full-Time Patrolmen	Squad Cars	Patrolmen Per 1000 Population	Persons Per Patrolman
Biwabik	3	1	2.0	494
Buhl	4	1	3.1	326
Chisholm	20	3	3.4	296
Eveleth	9	2	1.9	525
Gilbert	5	1	2.2	457
Hibbing	28	3	1.7	575
Mountain Iron	5	2	3.5	283
Virginia	23	4	1.9	541
*Sheriff	28	28	2.1	453
Regional Average	-	-	1.6	631

*St. Louis County Sheriff has offices at Hibbing and Virginia.

SOURCE: ARDC Criminal Justice Plan, 1975.

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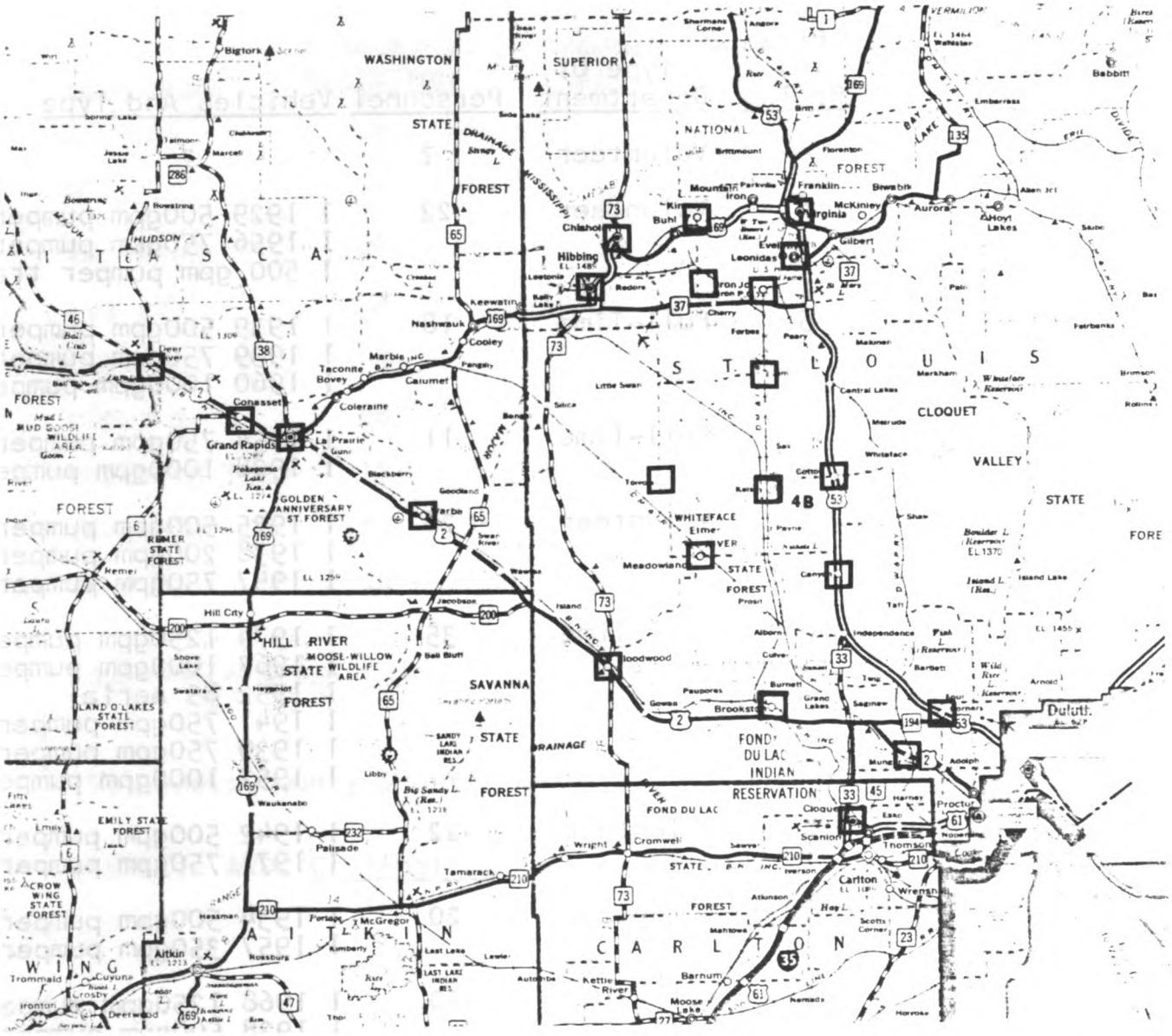
TABLE 34 Fire Protection

Community	Fire Ins. Rating	Type Of Department	Personnel	Vehicles And Type
Biwabik	-	Volunteer	?	?
Buhl	8	Volunteer	22	1 1929 500gpm pumper 1 1956 750gpm pumper 1 500 gpm pumper trailer
Chisholm	5	Full-Time	18	1 1939 500gpm pumper 1 1939 750gpm pumper 1 1960 1000gpm pumper
Eveleth	6	Full-Time	11	1 1954 750gpm pumper 1 1928 1000gpm pumper
Gilbert	7	Volunteer	26	1 1925 500gpm pumper 1 1938 200gpm pumper 1 1957 750gpm pumper
Hibbing	6	Full-Time	35	1 1974 1250gpm pumper 1 1967 1000gpm pumper 1 1952 85 aerial 1 1941 750gpm pumper 1 1939 750gpm pumper 1 1952 1000gpm pumper
Kinney	8	Volunteer	22	1 1942 500gpm pumper 1 1971 750gpm pumper
Mountain Iron	8	Volunteer	20	1 1934 500gpm pumper 1 1957 350gpm pumper
Virginia	5	Full-Time	30	1 1968 1250gpm pumper 1 1938 500gpm pumper 1 1942 700gpm pumper 1 1962 1000gpm pumper

SOURCE: Minnesota Insurance Services Office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FOREST
HUDSON
A I T A S C A
S T. L O U I S
CLOQUET
VALLEY
STATE
FOREST
FOREST
MUD GOOSE WILDLIFE AREA
GOLDEN ANNIVERSARY ST FOREST
REMER STATE FOREST
HILL RIVER MOOSE-WILLOW STATE WILDLIFE AREA
SAVANNA STATE FOREST
LAND O LAKES STATE FOREST
EMILY STATE FOREST
CROW WING STATE FOREST
FOND DU LAC INDIAN RESERVATION
A I T K I N
C A R L T O N
W I N G
Bigfork
Grand Rapids
Conasset
Hibbing
Virginia
Aurora
Hoyt Lakes
Babbitt
Duluth
Hill City
Waukenabo
Palisade
Tamarack
Aitkin
Deerwood
Carlton
Wrenshall
Scanlon
Cloquet
Brookston
Cromwell
Wright
Barnum
Moose Lake
WHITEFACE
Meadowlands
Independence
Woodwood
Nashwauk
Keewatin
Taconite
Bovey
Marble
Calumet
Coleraine
La Prairie
Goodland
Jacobson
Island
Swatara
Libby
Big Sandy L.
Sandy Lake Indian Res.
Hassman
Portage
McGregor
Rossburg
Kimberly
Last Lake
Last Lake Indian Res.
Kettle River
Automba
Lawler
Atkinson
Mahtowa
Scotts Corner
Thomson
Proctor
Harney
Munger
Adolph
Seagrave
Grand Lakes
Burnett
Paupores
Gowan
Prosit
Albora
Culver
Island Lake
Whiteface Reservoir
Colby Lake
Central Lakes
Marsham
Brimson
Fairbanks
Bonsor
Rollins
Bowstring
Jessie Lake
Spring Lake
Marcell
Chisholm
Kelly Lake
Leetonia
Redore
Cherry
Forbes
Peary
Little Swan
Silica
Sax
Payne
Elmer
Prosit
Island L. (Res.)
Boulder L.
Kearney
EL 1370
Whiteface Reservoir
Colby Lake
Central Lakes
Marsham
Brimson
Fairbanks
Bonsor
Rollins
Sherman Corner
Angora
Vermilion
Webster
Embarrass
Bay Lake
Florenton
Brittsmount
Franklin
Mountain Iron
Buhl
McKinley
Gilbert
Leonidas
Evelyn
Iron Junction
Iron Port
Aurora
Hoyt Lakes
Allen Jct
Fairbanks
Bonsor
Rollins
Brimson

the fire insurance rating of the area each serves. The ratings are based on a scale of one to ten, with the lower ratings being the better ones.

Recreation and Cultural Facilities

Because of the strong local interest in school athletics and outdoor recreation, the Range has numerous facilities for such activities. Even the smaller cities have municipal athletic fields, beaches, parks and playgrounds. Eveleth, Virginia and Hibbing all have municipal golf courses which supplement several private clubs in the area. Table 35, lists the municipal outdoor recreation facilities within the area.

Interest also is high in such indoor recreation activities as hockey and basketball, and the teams are strong contenders in the state high school tournaments. There are excellent large community buildings at Eveleth, Virginia and Hibbing for these indoor activities. The seating capacity of these facilities for indoor events is shown below. Both the Hibbing and Virginia buildings have dining facilities.

	Hockey	Basketball	Conventions
Eveleth	2000	4000	4000
Hibbing	3500	6500	7000
Virginia	2500	6000	6000

Other important indoor recreational and cultural features include the mining museum under construction in Chisholm and the United States Hockey Hall of Fame on US 53 at Eveleth. The Hockey Hall of Fame has exhibits and a museum on hockey.

TABLE 35

Municipal Recreation Facilities

Community	Facility	Capacity - Facilities				
		Acres	Picnic Table	Parking	Camp Sites	Other
Adams	Municipal Park	2				
Biwabik	Municipal Swimming Beach	15	8	20		
Burton	Burton Memorial Park		8	10		Playground
Cherry	Cherry School Athletic Field	6				
Chisholm	Campground					Fee
	Mun. Playground	8				
	Municipal Beach	5				Swimming-Play area
	Municipal Park					
	Memorial Park	8				Playground
Eveleth	City Park	3				
	Mun. Golf Course	60				18 hole
	Veterans Lake Mun. Park	66			20	
	Franklin Pub. School Ath. Fld.	3				
Forbes	El. School Ath. Field	3				
Gilbert	Sr. High Ath. Fld.	3				
	Mun. Ath. Fld.					
	Hopkins Mun. Park	6	6			Swimming
Hibbing	Mun.Golf Course	30	40		10	9 Holes

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TABLE 35 continued

Community	Facility	Acres	Picnic Table	Parking	Camp Sites	Other
Mountain Iron	Village Park	3	2			Playground
	W. Mun. Park	2				
	Sr. High Sch. Ath. Field	4				
	Elem. Sch. Ath. Field	3				
	Elem. Sch. Ath. Field	3				
Virginia	Mun. Golf Course	120				18 Hole
	Olcott Mun. Park	10				Playground
	S.Side Mun. Park	6				"
	S.20th St. Mun. Pk.	6				"
	Midway Mun. Park	2				"
	Midway Mun. Ath. Field	8				
	Hopkins Mun. Park	6				" Swimming
	Ely Lake Mun. Access	0.5	6	6		Beach

Source: Department of Natural Resources, Statewide Outdoor Recreation Plan (SCCRV)

The facility also has a small auditorium. The Chisholm facility will be an interpretive center containing exhibits which explain the Range's early history.

The outdoor activities range from downhill skiing at Giants Ridge, cross country skiing and snowmobiling in the winter to camping, fishing and hunting in the spring, summer and fall. People living in the project area may choose from many areas offering many of these activities. The state, primarily through the Department of Natural Resources, provides access facilities for boat launching and road end parking. There are large areas of state and county forest lands nearby which are also open to the public. Table 34, lists the recreation facilities provided by the state within the study area. Many others, including McCarthy Beach and Tower Sudan State Parks, are available within easy driving distance.

The project area is extremely wlll endowed with lakes, streams and rivers for boating and canoeing. Some of the largest lakes are listed in Table 37. In addition to public camping and launching sites, there are a number of resorts and summer home developments on these and other lakes. The St. Louis River from Forbes to Cloquet has recently been designated as a canoeing river by the Department of Natural Resources. This designation allows the state to provide access to the river from state-owned lands.

The project area lies within and adjacent to the boundaries of the Superior National Forest. This forest

TABLE 36 State Recreation Facilities

Management Or Ownership	Location Sec	T	R	Type	Capacity - Facilities Acres	Pic.	Tbls.	Pkg.	Other
MN DNR	16	60	19	Access, Boat	3.0				Portage
	19	59	21	" "	-				Portage
	25	58	19	" "	.5				Earth Ramp
	33	58	18	" "	1.0				Portage
	36	58	17	" "	1.0				Portage
	16	57	19	" "	1.5	2		4	Earth Ramp
	16	57	18	" "	1.0				Portage
	17	57	19		4.0			2	Earth Ramp
	36	58	16		1.0				Earth Ramp
MN Hwy.Dept.	27	60	18	Roadside Rest					
	4	57	20	" "					
	7	57	20	" "					
	17	57	17						

Source: DNR SCURP maps

TABLE 37 Major Outdoor Recreation Attractions

Attraction	Distance From Virginia	Size Acres	Facilities
Boundary Waters Canoe Area (BWCA) Superior National Forest	60	1,030,000 220,000	1700 primitive camp sites, managed for primitive recreatio
Superior National Forest	10+up	3,000,000[1]	33 camp or picnic areas, 470cp, 125pa
Voyageur's National Park	99		
Vermillion Lake	30		
Birch Lake	45		
Whiteface Reservoir	30		
Pelican Lake	45		

[1] This includes the BWCA above.

includes the one million acre Boundary Waters Canoe Area, which is managed for primitive type recreation experience. In addition the forest includes 33 camp and picnic areas for the use of the public.

The headquarters of the newest addition to the National Park system, the Voyageur's National Park, will be located at International Falls approximately one hundred miles from Virginia on US 53. Other entrance points will be nearer and within convenient driving range from Virginia. The plans that are now being prepared for this park will add greatly to outdoor recreation opportunities in the region.

A number of historical and archeological sites have been identified on the Range in the background reports to the previously cited "2020 Plan" as well as other sources. These include several "ghost towns," which were former lumbering or mining centers, historic homesites, mining sites and others. A prehistoric site has been identified in the project area north of Minnesota 37 between US 53 and the Duluth, Winnipeg and Pacific tracks in the vicinity of Long Lake. This is identified in the report Natural and Historic Areas of Minnesota prepared by the Department of Natural Resources in 1971. This site is the closest to, but not within the area for project expansion.

Medical Facilities

Mecical facilities in the study area include hospitals at Chisholm, Hibbing and Virginia. There is also a small 26 bed hospital in Eveleth which provides limited medical services.

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Any emergency cases in the area are usually taken to Virginia. As indicated in Table 38, the three Range hospitals provide most of the normal medical services. To supplement the Range facilities there is a 116 bed hospital in Grand Rapids as well as the extensive medical services offered in Duluth's three hospitals. These three have some 1080 beds and offer specialized medical serivces to a multi-state area.

TABLE 38:

Health Care Facilities and Services

Facility	Services	
Chisholm Hospital	Emergency Care	Extended Care
	Physical Therapy	Blood Bank
	X-Ray	Radiology
	Surgery	
Hibbing General Hospital	Medical Services	Surgery
	Pediatrics	Inhalation Therapy
	Pathology	Social Services
	Blood Bank	Radiology
	Physical Therapy	Occupational Therapy
	Speech Therapy	Emergency Services
	Dental Services	Pharmacy
Virginia Municipal Hospital	Medical Services	Surgery
	Pathology	Emergency Services
	Physical Therapy	Occupational Therapy
	Intensive Care	Radiology
	Blood Bank	Dental Services
	Extended Care	Pharmacy

Source: Arrowhead Regional Planning Council for Health Facilities and Services.

Operational data for the three large hospitals, as well as those in Duluth, are given in Table 39. The 1973 data shows that the Range hospitals had a total of 396 beds,

more than 11,870 admissions and 81,100 total patient days in that year. All three have space to handle increased patient loads.

Ambulances are based at the following locations on the Range: Babbit, Biwabik, Buhl, Chisholm, Eveleth, Hibbing, Hoyt Lakes and Virginia.

TABLE 39:

1973 Hospital Operational Data

Hospital	Beds	Total Staff	Admissions	Total Patient Days	% Occupying	Avg. Days of Stay
Chisholm	54	N.A.	840	8,011	40.6	9.0
Hibbing	177	159	6,076	42,553	65.8	7.0
*Virginia	165	173	4,907	30,572	68.1	6.0
St. Lukes	490	457	15,703	134,029	74.9	8.6
St. Mary's	419	436	15,177	121,015	79.2	7.9
Miller Dawn	172	178	3,027	42,636	67.9	14.1

*Nine months data only

Source: Arrowhead Regional Planning Council for Health Facilities and Services

Schools

The Main Range includes all or parts of nine public school districts. Those include independent school districts at Biwabik, Buhl, Chisholm, Eveleth, Gilbert, Hibbing, Mountain Iron and Virginia. All of these districts have service areas which extend beyond the municipal boundaries. The St. Louis County Unorganized District, #710, also serves the rural and suburbanizing area along the southern edge of the Range.

The complete list of school districts and the schools operated by each district are shown in Table 40. The table also gives information on the physical characteristics of each facility.

The existing public school facilities in the project area include 21 elementary, one combined elementary-secondary, two combined junior-senior high, four junior high, four senior high, and two grade 9-12 high school buildings. The combined elementary-secondary building is at Cherry. The two grade 9-12 high schools are located at Biwabik and Buhl and Gilbert and Mountain Iron operate the two combined junior and senior high schools. Chisholm, Eveleth, Hibbing and Virginia operate separate junior and senior high schools.

In addition to the public school facilities listed in Table 38, there are parochial schools at Hibbing and Eveleth. The two parochial elementary schools in Hibbing had a combined enrollment of 288 in 1973-74, while the parochial school in Virginia had an enrollment of 88. In the same school year the Eveleth Vo-tech had 274 day-time students and 20 teachers, and the Vo-tech at Hibbing had corresponding figures of 258 and 23.

The total number of classrooms in the nine districts is 706. This includes 332 classrooms in the junior and senior high school grade systems, 32 in 9-12 systems, and 342 in elementary grades. The total number of teachers in 1973-74 was 818. This included 48 in the 9-12 systems, 428 in the

TABLE 40. Existing Schools, Physical Characteristics

District	Location	School	Stories	Date Of Construction	Material	Condition
Unorg. #710	Cherry	E-S	NA	NA	NA	NA
	Forbes	E	NA	NA	NA	NA
0693	Biwabik	E	1	1956-60	Brick	Good
		S	2	1913-21,36,60	Brick	Good-Fair
0694	Buhl	E	2	1912	2	Good-Fair
		S	2			
0695	Chisholm					
		Lincoln E	2	1912	Brick	Fair-Poor
		Roosevelt E	2	1920	Brick	Fair-Good
		Vaug-S E	1	1958	Brick	Good
		Jr.	3	1923	Brick	Good-Fair
		Sr.	3	1913	Brick	Good-Fair
0697	Eveleth					
		Franklin E	3	1922	Brick	Good-Fair
		Jr.	2	1909	Brick	Good-Fair
		Sr.	3	1917-27	Brick	Good-Fair
0699	Gilbert					
		Nellie-Shean E Sig.Moe E Jr.-Sr.	2	1911-17,63	Brick	Good-Fair
0701	Hibbing					
		Alice E	3	1910-23	Brick on Wood	Fair-Poo
		Cobb E	2+1	1924-57	Brick	Good
		Greenhaven E	1	1954	Brick	Good
		Jefferson E	2	1958	Brick	Good
		Washington E	2	1955	Brick	Good
		Jr.	2	1957	Brick	Good
		Sr.	2	1922	Brick	Good
0703	Mtn.Iron					
		Mtn.Iron E	2	1911	Brick	Fair
		Parkville E	2½	1916-24	Brick	Fair
		W.Virginia E	1	1909	Brick	Fair
		Jr.-Sr.	2	1919-56	Brick	Good-Fair
0706	Virginia					
		Madison E	2	1926-54,56	Brick	Good
		Mann E	2	1914-24,41	Brick	Good
		Midway E	1	1958	Brick	Good
		Washington E	3	1921	Brick	Good
		Tech. Jr.	2	1910-18	Brick	Fair-Good
		Roosevelt Sr.	2	1930	Brick	Good

SOURCE: District offices, Minnesota Ed. Dir., 1974-75 and Augur & Associates, 1964, Public Facility Survey - Analysis Mesabi and Vermillion Range.

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junior and senior grades, and 342 in the elementary grades. Table 41 on page 182 indicates the number of students enrolled in 1973-74, the number of teachers and number of classrooms for each facility in the area. The table also notes the number of pupils per classroom and the capacity for each school. Although the capacity of some schools has been reached, other schools have room for growth in school-age population. Calculations using Table 39 indicate an average figure of 20.4 pupils per classroom for all grades. The accepted standard is 30 pupils per classroom in the elementary and 25 students per classroom in the junior and senior grades. The capacity of the combined schools is in excess of 17,900 students, while the 1973-74 enrollment in all grades was 14,469. Table 39 gives the figures for enrollment and capacity for each school.

Table 42 compares enrollment with school capacity for each facility to determine the extent of overcrowding or excess capacity. As noted, the capacity in all schools exceeded 1973-74 enrollment by more than 3,460 students. There was an excess capacity in all but one elementary school in the area. The Virginia system had room for more than 1000 elementary students, the Chisholm system for more than 600, and the Hibbing system for another 250 elementary students. Overcrowded conditions existed in the junior and senior grades in Virginia and Eveleth.

Trends in school enrollment are shown in Table 43. The table groups enrollment by elementary and secondary grades

TABLE 41: School Enrollment And Capacity, 1973-74

District	Location	School	* Enroll	** Teacher	Class-Rooms	Pupil/ Classroom	Capacity
0710	Cherry	E-S	476	23	16	30	325
	Forbes	E	97	6	5	19	125
0693	Biwabik	E	365	21	21	17	525
		Six	454	27	17	17	400
0694	Buhl	E	253	14	13	19	390
		S	246	21	15	16	375
0695	Chisholm						
		Lincoln E	148	8	16	9	390
		Roosevelt E	97	4	12	8	330
		Vaughn E	365	17	17	21	510
		Jr.	400	33	41	10	500
		Sr.	431	21	21	21	525
o697	Eveleth						
		Franklin E	741	37	26	29	800
		Jr.	496	24	20	25	450
		Sr.	488	32	25	20	430
0699	Gilbert						
		Nellie Shean E	308	19	14	22	420
		Sig.Moe E	66	4	4	16	120
		Jr. - Sr.	449	27	18	25	450
0701	Hibbing						
		Alice E	159	7	11	14	150
		Cobb E	544	23	24	23	690
		Greenhaven E	478	21	22	23	630
		Jefferson E	427	19	20	21	570
		Washington E	496	32	20	25	600
		Jr.	1364	69	34	40	850
		Sr.	1396	80	94	15	2350
0703	Mtn. Iron						
		Mtn. Iron E	212	17	15	14	450
		Parkville E	120	6	8	15	240
		W. Virginia E	38	2	4	10	120
		Jr. - Sr.	460	32	24	19	460
0706	Virginia						
		***Madison E	311	16	74	19	2220
		***Mann E	293	16			
		***Midway E	265	15			
		***Washington E	307	15			
		Tech. Jr.	831	50	30	28	760
		Roosevelt Sr.	888	60	25	33	780
	TOTAL		14,469	818	706		17,935

*Does not include Kindergarten
**Excluding Superintendent & Supervisors
***Combined Elementary Classrooms

SOURCE: Enrollment and teachers data from Minn. Ed. Dir. 1974-75.

Classrooms and School Capacity from Aguar & Associates, 1964 report, Public Facilities, Survey and Analysis Mesabi And Vermillion Ranges, Minnesota.

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TABLE 42 Capacity Analysis, Schools

District	Location	School	1973-74 Enrollment		Capacity		Excess Enroll.	Excess Capacity
Unorg. #710	Cherry	E-S	476		325		151	
	Forbes	E	97		125			28
0693	Biwabik	E	365		525			160
		S	454		400		54	
0694	Buhl	E	253		390			137
		S	246		375			129
0695	Chisholm							
		Lincoln E	148		390			248
		Roosevelt E	97		330			233
		Vaughn E	365		510			145
		Jr.	400		500			100
		Sr.	431		525			94
0697	Eveleth							
		Franklin E	741		800			59
		Jr.	496		450		46	
		Sr.	488		430		58	
0699	Gilbert							
		Nellie Shean E	308		420			136
		Sig.Moe E	66		120			54
		Jr.-Sr.	449		450			1
0701	Hibbing							
		Alice E	159		150		9	
		Cobb E	544		690			146
		Greenhaven E	478		630			152
		Jefferson E	427		570			143
		Washington E	496		600			104
		Jr.	1364	2760	850	3200		440
		Sr.	1396		2350			
0703	Mtn.Iron							
		Mtn.Iron E	212		450			238
		Parkville E	120		240			120
		W.Virginia E	38		120			82
		Jr.-Sr.	460		460			
0706	Virginia							
		Madison E	311					
		Mann E	293					
		Midway E	265	1176	2220			1044
		Washington E	307					
		Tech. Jr.	831		760		71	
		Roosevelt Sr.	888		780		108	

SOURCE: Minn. Ed. Dir., District Offices, and Augur & Associates, 1964 Publi
Facility Survey.

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TABLE 43. School Enrollment Trends, 1961 - 1974

District	School	1961-62 E	1961-62 S	1969-70 E	1969-70 S	1970-71 E	1970-71 S	1971-72 E	1971-72 S	1972-73 E	1972-73 S	1973-74 E	1973-74 S
710	Cherry E-S	162	213	229	260	221	260	224	263	215	253	209	267
	Forbes E	NA	-	124	-	114	-	113	-	135	-	97	-
693	Biwabik E	358	-	445	-	427	-	427	-	387	-	365	-
	S	-	294	-	367	-	395	-	436	-	437	-	454
694	Buhl E	317	-	256	-	250	-	254	-	250	-	253	-
	S	-	272	-	272	-	264	-	245	-	256	-	246
695	Chisholm E.*	1050	-	724	-	677	-	682	-	625	-	610	-
	Jr.High	-	540	-	464	-	431	-	384	-	407	-	400
	Sr.High	-	436	-	495	-	487	-	475	-	456	-	431
697	Eveleth E.*	1014	-	906	-	897	-	848	-	779	-	741	-
	Jr. High	-	430	-	590	-	577	-	553	-	518	-	496
	Sr. High	-	322	-	394	-	419	-	463	-	476	-	488
699	Gilbert E.*	495	-	463	-	450	-	461	-	417	-	374	-
	Jr.-Sr. High	-	385	-	484	-	477	-	472	-	494	-	449
701	Hibbing E.*	2823	-	2497	-	2403	-	2303	-	2195	-	2104	-
	Jr. High	-	728	-	825	-	825	-	827	-	1410	-	1364
	Sr. High	-	1798	-	2101	-	2134	-	2085	-	1416	-	1396
703	Mountain Iron E.*	507	-	446	-	421	-	408	-	384	-	370	-
	Jr.-Sr. High	-	419	-	484	-	495	-	499	-	482	-	460
706	Virginia E.*	1520	-	1428	-	1346	-	1321	-	1258	-	1176	-
	Jr. High.	-	779	-	917	-	924	-	899	-	872	-	831
	Sr. High.	-	582	-	917	-	982	-	952	-	919	-	888
	TOTALS	8254	6360	7518	8570	7206	8670	7041	8553	6645	8396	6299	8170

*Combined Elementary enrolled.

SOURCE: Minnesota Educational Directory.

even though two districts, Buhl and Biwabik, operate on a school system of grades one through eight. The table groups elementary enrollment for those districts which operate more than one elementary school.

In 1961-62 there were 8254 elementary and 6360 secondary pupils. In 1973-74, the total enrollment was a approximately the same with elementary enrollment being 6299 and secondary enrollment 8170. Elementary enrollment declined by about 2000 pupils in this time period, while the number of secondary students increased by about 1800.

Children born during the post-war "baby boom" reached elementary school age in the early 1960's with elementary enrollment peaking by the mid 1960's. Since 1969-70 there has been a steady decrease in elementary school enrollment for the area as a whole. The same pattern holds true for the individual districts although the amount of decrease varies.

Enrollment in the secondary grades appears to have peaked in the 1969-70 school year when there were 8570 students. Secondary school enrollment for 1973-74 was 8170, 400 lower than the 1969-70 figure. The Eveleth and Biwabik secondary schools appear to be the only ones which showed an opposite trend. In Eveleth, senior high enrollment has increased steadily since 1969-70. In Biwabik there has also been a steady increase. Most secondary schools appear to have reached their peak in the 1969-74 period.

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HOUSING

The Range has historically been an area of home ownership and single family homes. In 1970, more than seventy percent of all housing units in incorporated areas and ninety percent in the unincorporated areas consisted of single family homes. For the area as a whole, including the three East Range communities, more than three-fourths of all housing units were single family homes in 1970.

Table 44 gives the 1970 statistics for the type of structure by number of units. At the time of the Census more than 17,600 structures were one unit or single family structures. Only 21 percent of the housing units were in structures of two or more units, and the housing inventory included only 458 mobile homes.

About two-thirds of those residing on the Range in 1970 had lived in the same house since 1965. Eveleth and Fayal Township reported that 75 percent of their residents had lived in the same residence from 1965-70. As indicated in Table 45 there was little in-migration to the area either from Minnesota or from other states.

In 1970 there were almost 24,000 housing units in the entire area including the East Range municipalities. Table 46, which reports the figures from the 1970 Census of Housing, shows that there were some 5000 units in the unincorporated townships, almost 16,500 in the Main Range cities, and some 2300 in the East Range.

TABLE 44: Type of Structure, 1970

	One Unit	Two Plus Unit	Mobile Homes	Total
Balkan	284	4	3	291
Biwabik	602	44	36	682
Cherry	180	1	6	187
Clinton	278	7	33	318
Fayal	556	19	24	599
Great Scott	129	1	9	139
Missabe Mountain	45	1	1	47
Nichols	446	23	51	520
Stuntz	1,311	24	65	1,400
All Unincorporated	3,831	124	228	4,183
Buhl	374	41	3	418
Chisholm	1,738	432	10	2,180
Eveleth	1,207	660	0	1,867
Fraser	17	0	0	17
Franklin	13	0	0	13
Gilbert	655	97	9	761
Hibbing	4,137	1,446	81	5,664
Kinney	99	5	5	109
McKinley	78	5	7	90
Mountain Iron	487	54	8	549
Virginia	2,827	1,955	16	4,798
Main Range Incorporated	11,622	4,695	139	16,466
Total Main Range	15,453	4,819	367	20,649
Aurora	621	91	65	777
Babbitt	694	15	26	735
Hoyt Lakes	835	31	0	866
East Range Incorporated	2,150	137	91	2,378
GRAND TOTAL	17,603	4,956	458	23,027

SOURCE: U.S. Census, 1970.

TABLE 45: Place Of Residence, 1970*

Number	Main Range Uninc.	Main Range Incorp.	Main Range Total	East Range	Site**
Same House	8,512	27,687	36,199	5,526	4,848
Different House	3,943	14,787	18,718	2,845	1,573
Same County	2,662	9,680	12,342	1,529	876
Same State	499	1,902	2,401	572	186
Different State	478	1,862	2,340	558	151
Other	294	1,341	1,635	186	360
TOTAL	12,445	42,474	54,917	8,371	6,421
Percent					
Same House	68.3	65.2	65.9	66.0	75.5
Different House	29.2	31.6	30.9	31.8	18.8
Same County	21.4	22.7	22.4	18.3	13.6
Same State	4.0	4.5	4.3	6.8	2.9
Different State	3.8	4.4	4.2	6.7	2.3
Other	2.5	3.2	3.2	2.2	5.7

*Count of persons five years and older by residence in 1965.

**Eveleth and Fayal minor civil divisions.

SOURCE: U.S. Census, 1970.

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TABLE 46: Housing Units, 1970

	1970 Total	New D.U. 1960-70
Balkan	336	46
*Biwabik	810	75
Cherry	360	71
Clinton	319	71
Fayal	865	133
Great Scott	139	22
Missabe Mountain	52	0
**Nichols	526	100
Stuntz	1,602	150
All Unincorporated	5,009	668
Buhl	420	5
Chisholm	2,162	28
Eveleth	1,867	56
Fraser	17	0
Franklin	13	0
Gilbert	764	42
Hibbing	5,681	399
Kinney	109	0
McKinley	90	5
Mountain Iron	549	15
Virginia	4,805	317
Main Range Incorporated Area	16,477	867
Total Main Range	21,486	1,535
Aurora	780	87
Babbitt	691	6
Hoyt Lakes	872	169
East Range Incorporated Area	2,343	262
GRAND TOTAL	23,829	1,797

*Includes City of Biwabik.

**Nichols Township has been merged with Mountain Iron.

SOURCE: U.S. Census, 1970.

Table 46, also notes the number of new dwelling units built between 1960 and 1970. Eighteen hundred units were built for the entire area with 1538 being built on the Main Range. Almost 700 of these were constructed in the unincorporated areas. The suburbanizing trend was most evident in Stuntz, Fayal and Nichols Townships. Except for Hibbing and Virginia, none of the incorporated cities saw much new housing growth in the 1960-70 period. In Hibbing the average number of new units per year in the decade was 40 while in Virginia the figure was about 32 new units per year. The rate of increase in housing units was not substantial in either area.

As an area of predominantly single family homes, the Range has had a high proportion of its housing units owner occupied at least through 1970. Almost three-fourths of the occupied units on the Main Range in 1970 were occupied by owners. About 30 percent of the occupied units in the incorporated cities and 12 percent in the unincorporated parts of the Main Range were renter occupied in that year. For the area as a whole, including the East Range cities, less than a fourth of the occupied units were rentals. The figures for the various areas are shown in Table 45..

Table 47, also gives the number of vacancies and seasonal housing units by minor civil division. In 1970 the vacancy rate among year-round units was 7.5 percent for the entire area. On the East Range it was 2.4 percent, and in the Main Range incorporated areas it was 6.0 percent. In the

TABLE 47: Occupancy Characteristics, 1970

	Occupied			Total	Seasonal
	Owner	Renter	Vacant	Yr.Round	Units
Balkan	212	16	63	335	1
*Biwabik	566	86	30	682	128
Cherry	146	14	200	360	0
Clinton	285	16	17	318	1
Fayal	533	35	31	519	226
Great Scott	76	13	50	139	0
Missabe Mountain	35	5	7	47	5
**Nichols	438	60	22	520	6
Stuntz	1,082	201	297	1,580	22
All Unincorporated	3,373	446	717	4,580	389
Buhl	333	65	20	418	2
Chisholm	1,533	485	142	2,160	2
Eveleth	1,198	520	149	1,807	0
Fraser	0	12	5	17	0
Franklin	0	13	0	13	0
Gilbert	603	118	40	761	3
Hibbing	3,869	1,464	331	5,664	17
Kinney	82	18	9	109	0
McKinley	64	22	4	90	0
Mountain Iron	377	148	24	549	0
Virginia	2,771	1,761	266	4,798	7
Main Range Incorporated	10,830	4,626	990	16,446	32
Total Main Range	14,203	5,072	1,707	21,026	421
Aurora	678	120	29	777	0
Babbitt	638	38	14	690	3
Hoyt Lakes	817	35	14	866	1
East Range Incorporated	2,083	193	57	2,333	6
GRAND TOTAL	16,286	5,265	1,764	23,359	431

*Includes City of Biwabik.

**Nichols Township has been merged with Mountain Iron.

SOURCE: U.S. Census, 1970.

unincorporated areas it stood at 15.6 percent in that year. Among the incorporated areas, the highest vacancy rates were in Hibbing, 5.8 percent; Chisholm, 6.6 percent; and Eveleth, 8.2 percent.

The 1970 Census also revealed a total of 431 seasonal housing units in the entire area. More than half of these were in Fayal Township. The other area with a significant number was Biwabik Township which had almost 130 seasonal units.

The number of owner occupied structures in each value class is shown in Table 48 . In all areas shown, more than 83 percent of such structures were valued at less than $20,000. For the area as a whole some 31 percent were valued at less than $10,000. Those areas with a relatively high proportion of homes valued in excess of $25,000 included Fayal Township (14 percent) and Hibbing (9.6 percent).

The number of units by rent class is shown in Table 49. More than 90 percent of the rental stock in the entire area had reported rents of less than $100 per month in 1970 according to the U.S. Census. In the entire area there were only some 400 units with rents in excess of this amount. The only areas with any significant number of units with rents above $100 were Hibbing and Virginia, and here such units only made up 13 and 9 percent of all rental units respectively.

The housing supply problem on the Range pre-dates the current taconite expansion. The low rate of new home construction

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TABLE 48: Value Of Owner Occupied Structures, 1970

	Less Than 10,000	10,000-19,999	20,000-24,999	25,000-29,999	Over 30,000
Balkan	32	21	1	1	1
*Biwabik	183	208	13	13	3
Cherry	15	16	4	0	0
Clinton	56	34	3	0	0
Fayal	85	198	55	33	24
Great Scott	15	12	1	0	0
Missabe Mountain	13	13	4	0	0
**Nichols	140	166	26	7	2
Stuntz	412	226	24	10	4
All Unincorporated Areas	951	894	131	64	34
Buhl	179	116	4	1	0
Chisholm	201	568	48	23	5
Eveleth	521	403	40	12	7
Fraser	0	0	0	0	0
Franklin	0	0	0	0	0
Gilbert	117	193	15	4	1
Hibbing	966	1,771	451	253	80
Kinney	67	4	1	0	0
McKinley	25	28	3	3	0
Mountain Iron	181	147	11	6	2
Virginia	482	1,350	259	190	69
Main Range Incorporated Areas	2,739	4,577	832	492	164
Total Main Range	3,690	5,471	963	556	193
Aurora	95	265	47	15	3
Babbitt	36	533	31	15	0
Hoyt Lakes	130	621	25	10	0
East Range Incorporated Areas	261	1,419	103	40	3
GRAND TOTAL	3,951	6,890	1,066	596	201

*Includes City of Biwabik.

**Nichols Township was merged with Mountain Iron.

SOURCE: U.S. Census, 1970.

TABLE 49: Number of Units By Rent Class

	Less Than 60	60-99	100-149	150-199
*Biwabik	22	34	3	0
Fayal	8	10	6	0
**Nichols	17	26	4	0
Stuntz	79	43	8	3
All Unincorporated Areas	126	113	21	3
Buhl	33	20	0	0
Chisholm	223	191	14	0
Eveleth	257	184	24	1
Fraser	12	0	0	0
Franklin	12	0	0	0
Gilbert	35	51	5	1
Hibbing	559	657	136	29
Kinney	12	1	0	0
McKinley	10	10	1	0
Mountain Iron	63	72	9	0
Virginia	815	722	123	24
Main Range Incorporated Areas	2,031	1,898	312	55
Total Main Range	2,157	2,011	333	58
Aurora	29	64	12	0
Babbitt	6	13	3	4
Hoyt Lakes	0	32	1	0
East Range Incorporated Areas	35	109	16	4
GRAND TOTAL	2,192	2,120	349	62

*Includes City of Biwabik.

**Nichols Township was merged with Mountain Iron.

SOURCE: U.S. Census, 1970.

between 1960 and 1970, eight percent, was far below that needed for normal replacement of aging or dilapidated structures. Reasons for the lack of new home construction include an uncertain real estate market, high construction costs, and, in recent years, the credit pinch, the unavailability of mortgage money and a reduction in federal programs providing financial assistance to housing.

The ARDC report, Assessment of Growth Impacts on the Iron Range, June 1975, estimated that there were approximately 22,704 occupied housing units in the so-called growth areas on the Range in June 1974. At that time there were only 208 vacant habitable housing units in the same area. Table 50 shows those by the ARDC growth areas as well as that agency's estimates of future units needed.

According to this analysis, there were 20,140 occupied units in June of 1974 on the Main Range, and 22,700 such units in the entire area. Vacancies were extremely limited. There were 81 on the Main Range and 208 vacant units in the entire area. The vacancy figures were estabished through postal vacancy surveys and contacts with local realtors. The Table notes that mroe than 3000 housing units are needed in the Main Range.

Accurate data to document current vacancies is not readily available. According to informed sources, including local realtors and the St. Louis County Assessor, the current vacancy rate is negligible. The Assessor reported that many

TABLE 50: Occupied And Vacant And Needed Housing Unit Estimates, 1974

	1974 Occupied Units	Vacant Habitable Units	Projected Units Needed
Fayal	1,173	8	320
Stuntz	1,586	7	670
Main Range Unincorporated	2,759	15	990
Biwabik	462	9	80
Buhl	402	12	20
Chisholm	2,046	2	270
Eveleth	1,732	7	110
Gilbert	737	3	210
Hibbing	6,339	16	360
Mt.Iron-Nichols	1,006	5	340
Virginia	4,657	12	640
Main Range Incorporated	17,381	66	2,030
Total Main Range	20,140	81	3,020
Aurora	927	90	21
Babbitt	735	37	90
Hoyt Lakes	902	0	150
East Range Incorporated	2,564	127	180
GRAND TOTAL	22,704	208	3,200

SOURCE: ARDC, Assessments of Growth Impacts On The Iron Range.

NOTE: Other areas included on previous tables are considered by ARDC to be non-growth areas and no data is presented for them.

seasonal units are being acquired by construction workers and that there have been a number of conversions of single family homes.[1]

The County Assessor also stated that the lack of available homes has resulted in substantial price increases. As examples, he cited instances in both Eveleth and Chisholm of older homes that were on the market a few years ago for $10,000 to $12,000 and are now selling for twice that amount. He felt there was an areawide demand on the Range for lots of mobile homes particularly in areas with water and sewer nearby. The pressures on housing on the Range have resulted in increases in sales value as far south as Meadowlands.

Accurate data on new housing construction is also not readily available from secondary sources because of the variance among the communities in the procedures for issuing and keeping records of building permits. Table 51, which gives the number of building permits for the unincorporated area for the past few years, is intended to indicate general trends rather than to provide an accurate inventory of available housing resources.

1. Interview with St. Louis County Assessor, Peter Hamburg, July 8, 1975.

TABLE 51:

Number of Housing Units Authorized by Building Permits In Unincorporated Areas

Township	1968-72	1973	1974	1975*	Total
Balkan	17	10	7	6	40
Biwabik	28	13	12	11	64
Cherry	18	14	21	12	65
Clinton	35	12	30	15	92
Fayal	65	24	29	10	128
Great Scott	9	2	5	4	20
Missabe Mtn.	1	2	0	0	3
Nichols**	46	0	0	0	46
Stuntz	91	49	82	160	382
TOTAL	310	126	186	218	840

* Through June 1975
** Nichols merged with Mt. Iron in 1972

Source: 1968-1972 ARDC tabulations of St. Louis County Zoning and Planning Department

1973-75 St. Louis County Zoning and Planning Department

Because of changes in the system of record keeping, it is not possible to break down the combined figures for 1968-72 to provide an accurate count of units built since the 1970 Census. However, in the period shown there were permits issued by the St. Louis County Planning and Zoning Department for 840 housing units including those in multiple structures and mobile homes. Some 530 of these were built in the past two and one-half years. The largest number of permits were issued for housing units in Stuntz Township with Fayal and Clinton Townships following in that order. Stuntz accounted for more than 45 percent of the housing unit permits.

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According to the ARDC report, Proposed Housing Guide Plan for Iron Range Communities, June 1975, there are a number of projects in various stages of completion that will provide additional housing on the Range. Table 52 , which is from that report, notes that there are some 2300 units in proposed projects. The number in the "prospect" stage is 1900. The projected number of units by all housing types is 3420 by 1980. It should be noted that the data is for the area extending between Grand Rapids and Ely.

TABLE 52

Summary of Current and Proposed Housing Projects Throughout Iron Range Communities

Type	Const. In Place	Proposed Projects	Actual Pros-pects	Needed New Units	1980 Demand
Single family	22	200	162	238	400
Townhouse	-	-	-	300	300
Apartments	60	1169	1010	630	1640
Elderly Housing	-	812	290	230	520
Mobile Home Parks	20	420	440	120	560
TOTAL	102	2301	1902	1518	3420

Source: ARDC, Proposed Housing Guide Plan for Iron Range Communities, Page 11.

This same source identified a number of proposed multi-family projects, most of which were being financed with State and Federal assistance. The locations of these projects (which are listed in Table 53) are not identified for confidentiality reasons.

TABLE 53

Tabulation of Proposed Multi-Family Housing Projects As of June 12, 1975

Structure(s) Type	Efficiency	Number of Units 1-Bedroom	2-Bedroom	3-Bedroom
1 Apt. Bldg.	0	25	75	0
6 Apt. Bldgs.	0	72	72	0
4 Apt. Bldgs.	0	48	49	0
2 Apt. Bldgs.	0	6	36	18
4 Apt. Bldgs.	24	44	120	12
2 Apt. Bldgs.	0	20	32	8
1 Apt. Bldg	0	49	1	0
1 High Rise Apt.	0	156	1	0
2 High Rise Apt.	0	126	126	24
6 Walkup Apt. 3 Apt. Bldgs.	0	18	30	0
TOTAL	24	564	542	62

Source: ARDC, Proposed Housing Guide Plan for Iron Range Communities, Page 10.

The tabulation shows that there are 32 multi-family projects in the planning stage as of June of this year. Assuming financing and other factors let them move ahead, these projects would add 1224 new multi-family rental units to the existing inventory. Almost all of these would be in the one- and two-bedroom categories. The ARDC data gave the following monthly rental ranges for the proposed projects:

Efficiency	$150
One-Bedroom	$200-$238
Two-Bedroom	$240-$265
Three-Bedroom	$290-$400

The ARDC study of the Hibbing-Virginia APJ area noted especially the lack of suitable land for residential development on the Range itself.[1] Table 10showed that 816 of the 1054 forty-acre parcels in the incorporated areas were in actual mining use, inactive mines or held by mining companies.

1. Development Plans for Hibbing and Virginia Areawide Planning Jurisdictions, ARDC, Oct. 1973.

Another 35 forties were in such uses as railroad, sewage disposal plants, and permanent open spaces as cemetaries, leaving only 203 forties in urban use. Little land is available within the incorporated areas for residential development at existing single family low densities.

In the unincorporated areas ownership patterns and soil conditions also limit the availability of land suitable for residential development. There were 1823 forty-acre cells in the study area that were wholly or partially in public ownership. Mining controlled lands also occupied a sizeable area. The soil conditions were considered by ARDC to be particularly limiting conditions. More than 68 percent of the total acreage in the APJ area was considered to have soils with severe limitations for the use of on-site sewage disposal systems or was in actual mining use. Only 25,640 acres out of 367,360 acre total was considered to have soils with only slight limitations. Table 54 shows the acreage with severe soils by township.

TABLE 54

Severe Soils Acreage by Township

Township	Severe Soil Acreage
Balkan	12,400
Biwabik	11,120
Cherry	22,760
Clinton	23,040
Fayal	14,640
Great Scott	18,160
Missabe Mountain	7,280
Nichols	26,640
Stuntz	92,120
TOTAL	227,160

Source: ARDC, Population Economy and Land Use, Page 123.

This analysis identified areas for future residential development that were suitable from the standpoint of soils, ownership factors and others. These included the Ely Lake area, Fayal Township, the east side of Biwabik Township, and two areas in southern Stuntz Township. These are indicated in Figure 48. There are also a few undeveloped areas within or adjacent to the following municipalities which are suitable for residential development.[1] These include the following:

--Southwest Hibbing
--Chisholm (NW and NE)
--Mountain Iron (South of US 169 and West of West Virginia)
--Gilbert (SW)

The population and dwelling unit holding capacities of these areas identified as being suitable for residential development were calculated by ARDC. These estimated capacities were based on existing zoning density lot considerations and on a family size of three. Sewer and water could be extended to all of the areas. These holding capacities are shown in Table 55.

1. ARDC, Population Economy and Land Use, pages 127-134.

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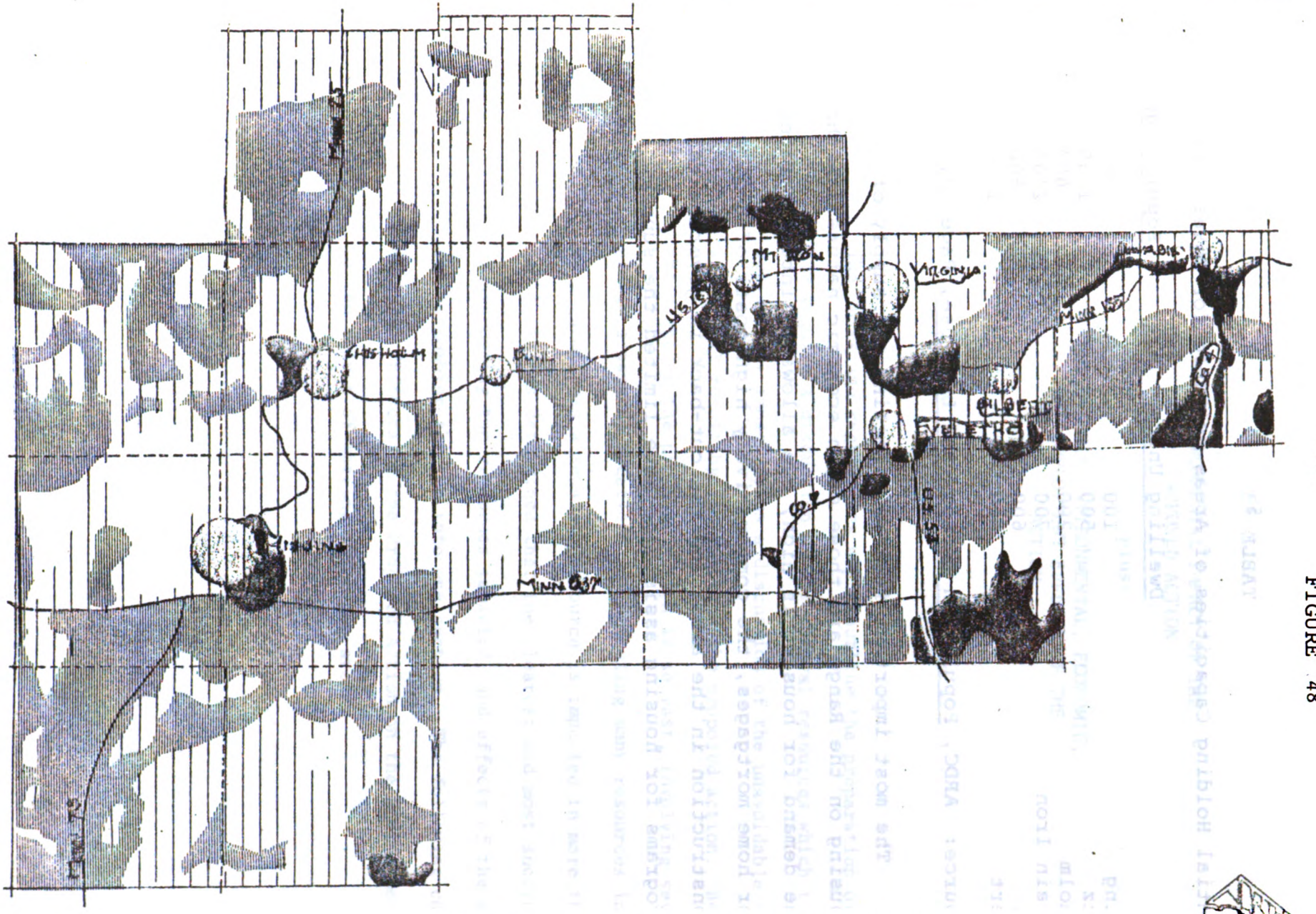
FIGURE 48



COMPOSITE OF DEVELOPMENT POTENTIAL FACTORS

VERY GOOD

GOOD

POOR

VERY POOR

source: ARDC

TABLE 55

Residential Holding Capacities of Areas Suitable for Development

Area	Dwelling Units	Population
Hibbing	100	300
Stuntz	500	1500
Chisholm	200	600
Mountain Iron	700	2100
Fayal	600	1800
Gilbert	400	1200

Source: ARDC, Population Economy and Land Use, Page 27.

The most important factors affecting the supply of housing on the Range are those of an economic nature. Although the demand for housing is high, the allowable interest rates for home mortgages, the comparatively high costs of home construction in the area, and the cut-back in governmental programs for housing assistance have limited the supply.

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ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

-plus-

UNAVOIDABLE ENVIRONMENTAL, ECONOMIC, AND EMPLOYMENT EFFECTS OF THE ACTION

The rules and regulations which outline the preparation of the EIS require a discussion of the natural resources which the action will impact, plus a discussion of the unavoidable effects which will result by implementing the proposed action. Because the scope of the proposed action is so vast, involving several widely separated locations and affecting many resources in varying ways (sometimes a separate resource is impacted in more than one way), it was determined that the clearest and most succinct way of discussing the resources impacted, and effects of the action, was to combine the two into one section. The following chapter entitled "Effects of the Proposed Action on the Environment", is the result of merging these two areas.

EFFECTS OF THE PROPOSED ACTION ON THE ENVIRONMENT

- The Mine Areas -

Impact on Air Quality

Possible sources of air pollution are the fine cuttings from rotary drilling and the ejection of spilled material from the jet piercers, road dust and exhaust fumes from vehicular traffic, and, airborne particulates and gasses from blasting operations. To eliminate or minimize the extent of that pollution, water sprays will be utilized to hold down the dust during drilling operations and to control dusting of haul roads. Blasting operations will be controlled to minimize the possiblity that airborne solids and gasses will be carried toward areas of public usage and habitation. Haulage equipment will be maintained in good repair to minimize discharge of polluting gasses.

The sites selected for the waste rock and overburden disposal areas should be screened, if possible, by terrain and forest cover from the prevailing winds to minimize the possibility of wind erosion of the exposed berms and slopes of the stockpile with the resultant pollution of the atmosphere by airborne solids. To further minimize that possibility, the active slopes and berms should be revegetated at the earliest possible date. Still further, should wind erosion occur before revegetation has been established, an attempt should be made to eliminate or minimize that potential source of air contamination through erection of wind breaks or stabilization of the surface by water or chemicals.

- The Plant Site -

The iron-rich amphiboles (Grunerite, Cummingtonite and Actinolite), which have been shown to be the source of asbestos-like fibers, are not present in the magnetite taconite of the Eveleth-Virginia area. (1) (2) (3). However, other possible sources of pollution from the plant site would be the fuels used for agglomeration and heating, dust from the dry crushing and pelletizing operations and dust raised by vehicular traffic. Elimination of pollution from these possible sources will be accomplished through (1) installation of well-engineered dust collection and smoke elimination equipment meeting state requirements; (2) hard surfacing of the plant site access roads and parking lots and periodic flushing of those areas into the ditch leading to the sump south of the plant for pumpage into the tailings basin; and (3) surfacing of haul roads used by off-highway equpment with stabilized gravel and utilization of water sprays and/or applications of an approved chemical for dust control. In the general area adjacent to the plant site, another potential source of air pollution is fugitive dust resulting from wind erosion of dried portions of the tailings ponds. (Depicted in Figure 49). The major portion of the area will remain under water, and continually varying the point of tailings slurry discharge will minimize the amount of beach area which can dry out and be vulnerable to wind erosion. Nevertheless, under certain climatological conditions (unusual dryness and high

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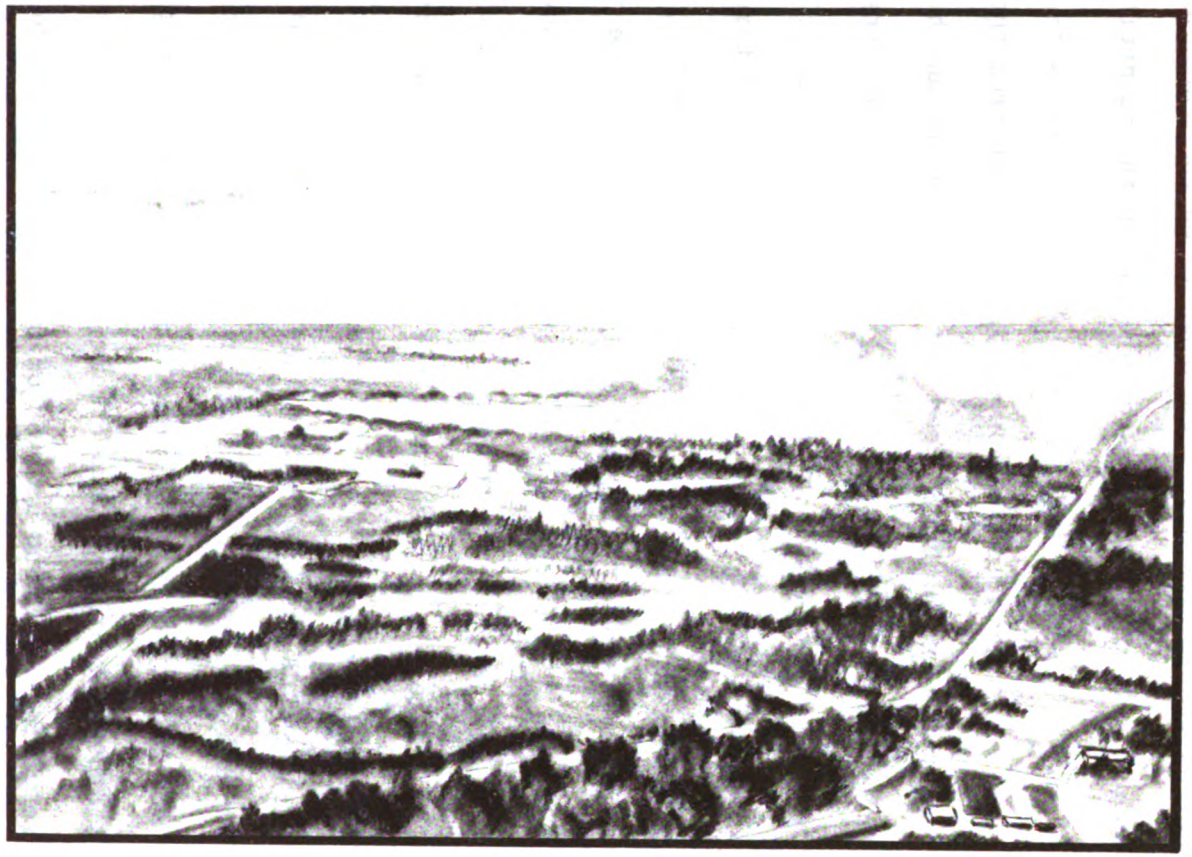
Figure 49 Dust Storm on the Present Tailings Basin



winds, for example), fugitive dust emissions can be expected to occur. If necessary, further control measures can be taken, including spraying and ultimately revegetation.

The staff of the Minnesota Pollution Control Agency considered the air pollution consequences of the proposed expansion in connection with its review of the application for an air pollution control installation permit. The permit application and other relevant information and exhibits submitted by the applicant and the preliminary review of the application prepared by the Division of Air Quality staff were, in accordance with the requirements of Minnesota Regulation APC 3(h), made available for a 30-day public review in the City of Virginia. No adverse comments relative to the proposed action were received. Following approval by the MPCA Board, the necessary installation permit was then issued on November 19, 1974.

In its review, the PCA staff calculated that particulate emissions from the additions to the Fairlane Plant would be 1,307 tons per year, and that sulphur dioxide emissions from the expansion pelletizer coal combustion would approximate 1,400 tons per year. Using recognized dispersion model equations, the PCA estimated that these emissions would contribute less than 5 micrograms per cubic meter annual geometric mean of particulates to the existing level estimated to be around 25 micrograms per cubic meter annual

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geometric mean, and under the worst anticipated meteorological conditions would contribute a maximum 24-hour particulate concentration of approximately 70 micrograms per cubic meter. The corresponding ambient air secondary standards are 60 micrograms per cubic meter, annual geometric mean, and 150 micrograms per cubic meter, maximum 24-hour concentration. Similarly, the pelletizer will add approximately two micrograms per cubic meter of sulphur dioxide, in comparison with the primary and secondary standard of 60 micrograms per cubic meter maximum annual arithmetical mean.

Nevertheless, the air installation permit requires Eveleth Expansion Company to establish an air sample monitoring network for obtaining ambient air quality data both before and after the expansion facilities are in operation. Eveleth Expansion Company has submitted a proposal for a monitoring program to be conducted by company personnel under the supervision of Interpoll Incorporated, a private engineering consulting firm, at eight monitoring stations, with the apparatus, data processing and preparation of reports to be supplied and performed by Interpoll. The proposed plan for particulate monitoring has been approved by the Division of Air Quality, and implementing of it is underway. Plans for monitoring sulphur dioxide are currently being worked out.

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As indicated by the PCA staff report on the Expansion project dated October 3, 1974, and also in the St. Louis County Health Department 1974 Air Pollution Report, air quality in the expansion area generally falls within ambient standards. The emissions from the expansion facilities will comply with all present applicable emission standards of the Minnesota Pollution Control Agency, and are not expected to have a substantial impact upon the air quality of the area.

Climate - References

1. "Mineralogy of the Thunderbird Mine and the Expansion Area Magnetic Taconite Deposit" by Jack V. Everett, Consulting Mining Geologist, Duluth, dated August 20, 1974.

2. Listerud, William H. (DNR) Memo to Paul Pojar (DNR) "Thunderbird South Project" October 3, 1975.

3. Cook, Philip M., U. S. Environmental Protection Agency letter to Paul Eger (DNR), August 6, 1975.

Noise

Impact of Blasting Operations

Mining of taconite would not be possible if the material could not be fragmented by blasting with explosives. However, this one facet of the operation in all probability has the greatest, albeit momentary, adverse effects on the environment. These adverse effect stem from noise, seismic shock wave, air blast, fly rock, fumes and airborn solids. To minimize or eliminate the hazards of setting off the large blasts required to meet specified production levels at the Thunderbird Mine, Eveleth Taconite Company embarked on a program of blasting research, which was so successful that others in the

industry were soon adopting the new innovations in blasting practice.

Evelth Taconite Company's experience at the Thunderbird Mine has proven that the ground shock wave, or seismic wave, that would be created by simultaneous detonation of all the explosive in a blast pattern could be dampened by creating a series of waves by successive explosions of portions at micro-second intervals. The spacing of the explosions is obtained by the use of delay mechanisms between each of the rows of blast holes in the pattern. In addition, Eveleth Taconite minimizes or eliminates the damages due to air shock by blasting only under favorable weather conditions tha then, only after two test shots and a pilot blast have been made and monitored for air shock at eight separate stations whose locations are varied as indicated by wind conditions. The two test blasts are made from 1½ to 2 hours before the blast and the pilot blast only a minute before the pattern is detonated. The noise of the blast has been reduced by covering the primacord and stemming of the blast holes. The throw of fly rock has been dramatically reduced through the use of properly sized granular materials for blast hole stemming and placement of the explosives for accurate distribution of the energy. The dust and fumes from blasting cannot be eliminated, but the blasts can be timed to coincide with favorable wind and weather conditions.

Through development of these techniques, Eveleth Taconite Company has been able to maintain its production requirements without property damage or injury to inhabitants of the surrounding area.

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Impact of Truck Transport

With the opening of the Expansion Mine, a number of trucks and other mine vehicles will be travelling between the Thunderbird Mine and the Expansion Mine. The route will follow a mine haul road along the east edge of the Thunderbird North Mine which abuts the immediate west edge of the city of Eveleth near a number of private residences. The nearest residence is approximately eighty feet from the haul road. The increased truck traffic may affect the private residences through increased noise levels.

Oglebay Norton has indicated that the mine vehicles will made from 76 to 96 one-way trips per shift per day between the Thunderbird North and the Expansion Mines, once the Expansion Mine is in operation. The mine operates on three shifts per day, eight hours per shift. The breakdown of the trips according to type of vehicle is indicated in Table 56. It should be noted that the total number of one-way trips along this haul road per twenty-four hour day will be from 218 to 288. The speed of the vehicles will range from ten miles per hour for graders to twenty-five to thirty miles per hour for trucks.

Oglebay-Norton has taken sound level readings from six different types of vehicles at two different distances. The results, measured in the A scale, are shown in Table 57 .

TABLE 56

Activity Movement Between Thunderbird North and Expansion Mine

Vehicle	Total One Way Trips Per Shift Per Type of Vehicle	Remarks
Bus (2)	4	
85-ton haul packs (14 haul packs, 12 in service at any one time)	12 - 32	Present plans indicate 32 trips per shift. Alternative plans under consideration may reduce trips to 12.
service trucks (1)	10	
pick-up truck (2)	20	
low-bay trailer (1) and water truck (1)	6	
rubber tire dozer (1)	2	
3 cubic yard and 12 cubic yard loaders (1 in service at any time)	2	
maintenance vehicles (4)	14	
hydraulic cranes (1)	2	
grader (1)	4	
TOTAL	76 to 96 one way trips per shift	

Source: Oglebay-Norton Company, October, 1975

TABLE 57

Sound Readings in dBA

Measured at / Noise Generated by	85 Ton Truck	Pick-Up or Service Truck	Twelve Cubic Yard Loader	Grader	Water Truck	Rubber Tire Dozer
Edge of Haul Road Approx. 15-20' from trck.	86 - 89	77	92	78 - 84	89	86
Nearest Residence Approx. 80' from vehicle	72	--	84	68	75 - 83	71

Source: Oglebay-Norton, October, 1975

Experience has indicated that even on low volume roads, discourteous behaviour by drivers may cause a nuisance to nearby residents. The need for courteous driving habits and good vehicle maintenance should be encouraged.

Oglebay Norton is aware of the potential noise impacts from their operation to the general populations on the west and south edges of Eveleth. They are also cognizant of the potential noise impacts from their operation in the direction of Highway 53. Oglebay-Norton company representatives have indicated plans for noise abatement to DNR and PCA staff.

Noise abatement procedures are planned for three areas. First, Oglebay-Norton plans to shift the mine haul road away from the platted portion of the western edge of Eveleth. As the haul road is moved further west away from the city, the surface will be contoured to form a hill and later revegetated. This will provide a buffer zone between the mine vehicle traffic and the city residences. The first shift in the road will be made about 1990 (1) with the contouring of the hill being finished in 1966 and revegetation finished after 1996. The next shift will be made in 2008. By 2028 the contouring will be completed and revegetation will be finished after 2028. At this time, the road will be completed at its westernmost location and will not be shifted any further. The buffer zone will be approximately 1500 feet from the east edge of the pit.

Second, Oglebay-Norton plans to utilize the Fayal open pits and underground caves to create a hill as a buffer zone between the platted portion of Eveleth on the southern edge and the Expansion Mine. This should be completed by 1980 assuming that the permission of the fee owners can be obtained. This buffer zone will also be approximately 1500 feet between the edge of the city and the edge of the pit.

Third, the Fayal extension open pit would be utilized to create a hill as a buffer zone between the Expansion Mine and Highway 53 to the east of the mine. This hill, approximately 1500 feet in

width, would be completed in 1980. Revegetation would be completed after 1980. (2).

Pit Dewatering Equipment

Company officials have indicated that the pit dewatering equipment will be electrically powered. This equipment will generate less noise than a diesel powered generator.

Pollution Control Agency staff working on noise pollution control recommends that consideration be given to noise specifications for dewatering equipment. The equipment must meet state nighttime noise standards, which means it should not exceed 50 dBA at the boundary of the closest residence.

Reference - Noise

1. Based on estimates given by Oglebay-Norton. The exact dates may change as the mining proceeds.

2. Noise abatement information obtained from Herb Axelson, consultant to Oglebay-Norton, October, 1975.

Topography

There will be some alteration of the topography of the area due to the mining. The greatest change will result from the pits, the tailings basin and the stockpiles. During the operation these features will enlarge and change the landscape. The tailings basins upon completion of filling, are expected to contain nearly 160 feet of tailings and will cover about 6 square miles. The waste disposal area containing the stockpiles and the open pits will cover an area of about 5.4 square miles.

For a more detailed analysis of the effects on the land form, the action has been broken down into the following components for individual description and analysis.

1. Thunderbird Pit Area
2. Spruce, Hull-Nelson, Leonidas Pit Area
3. Expansion Open Pit
4. Waste Pile
5. Plant
6. Tailings

Thunderbird Area

As mining progresses in the Thunderbird mine, more and more of the lean materials will be exposed and the active mining area will shift westward thus increasing the distance to Trunk Highway 53, Midway Gradens and Terrace - the closest points of human habitation and public usage. In addition, the mined out area over the footwall shall be utilized as soon as it is operationally feasible to do so for the deposition of save and/or waste materials from mining. The increase in distance together with the buffer created by the waste or save stockpile and the strip of undisturbed forest cover beyond the pit limits on the north and west sides should serve to reduce noise levels and insure greater safety in blasting operations.

Spruce, Hull-Nelson Pit Areas

Oglebay Norton Company anticipates that, upon depletion of the remaining natural ores in the Cloquet and Cloquet Annex Properties, the entire area from the west limit of the platted area of Eveleth through to and including the Leonidas Properties on the west will become available for deposition of waste rock and surface materials from the Thunderbird operation. In that event, the entire area

shall be filled, contoured to blend into the natural topography and, revegetated as part of its mineland reclamation program. The filled area may be utilized for relocation of county-state aid highway No. 7 which must be vacated to permit westward development of the Expansion Open Pit.

Expansion Open Pit

Development of the Expansion Open Pit to its ultimate limits will involve:

1. Removal of the D.M. & I.R. trackage between county-state aid Highway No. 7 and Trunk Highway No. 53;
2. Relocation of the rock and lean ore stockpiles remaining from the adjacent natural ore mining operations;
3. Filling of the open pits and caved ground north of the Expansion Open Pit limits, contouring to present a pleasing appearance and to control runoff, and, revegetating to provide a screened buffer zone adjacent to the platted portions of Eveleth and Fayal Township;
4. Realignment of county-state aid Highway No. 7;
5. The diversion of the unnamed streams running from Mud Lake in Missabe Mountain Township to Elbow Lake in Clinton Township and from Fayal Pond to Mud, Horseshoe and Long Lakes in Fayal Township.

Like the Thunderbird Mine, the Expansion Open Pit will be developed by approximately horizontal benches at 50' vertical intervals in the southerly dipping iron formation. Exposure of the lean ore iron

formation materials will not only serve to push the active mining benches, but will also serve as a site for deposition of save and waste materials from mining.

Mining of the Expansion Open Pit may well involve relocation of the present residents of the Spruce Location and Chicken Town at some future date together with a small number of the residents in Leonidas and West Eveleth because of the proximity of their dwellings to the ultimate limits of the Expansion Open Pit.

Waste Piles

Portions of the land areas west of the Expansion Open Pit and west of the Thunderbird Mine (see fig. 8) may have to be utilized for the deposition of a portion of both save and waste materials from mining. The deposition of these materials in stockpile shall be in lifts with each lift restricted to a nominal 40 foot height. The exposed slopes of the stockpiles will be terraced through control of the various lifts to enhance the appearance of the waste disposal area and to encourage revegetation. State reclamation standards will also be met once they are formulated.

Plant

Eveleth Taconite Company has initiated a continuing program of improvement in the appearance of its Fairlane Plant area by filling of the surrounding low swampy areas with coarse tails, gravel, and muskeg or top soil followed by seeding of the filled areas to provide ground cover. Access roads and parking areas have been hard surfaces and off-highway haulage roads are sprayed to stabilize the surface and to hold down the dust. All drainage

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from the area flows to a pond on the south side of the plant complex from which it is pumped into the tailings basin for clarification and utilization as plant make-up water thus reducing the demand for fresh water from the St. Louis River.

Tailings

The staged development of Oglebay Norton's tailing disposal system will defer full utilization of the area for a substantial period of time, provide a system by which several areas may be permanently reclaimed as they become inactive, and provide a diversity of land form not obtainable by a mono-basin system.

Aesthetics

The expansion operations will inevitably disturb the aesthetics of the surrounding environment. The aesthetics will certainly be altered from the natural beauty of forests and swamps to an operating mine. However, the expansion mine will be in an area of old natural ore pits and near existing mining operations. It will not be an unusual alteration since it is in an area that has been used for mining in the past. The alteration in the environment will be consistent with the environment along the Mesabi Iron Range. The tailings basins will also be built ajacent to an area already disturbed by tailings deposision. Thus, the alterations here will be consistent with the immediate environment.

Visibility

All of the stockpiles and tailings basins mentioned in the topography section page will reach a height that will be visible from some distance and may be seen by Eveleth residents, and users of some of the lakes. As a result, it should be noted that the stockpiles may

disturb the visual aesthetics of the area. Furthermore, the mine roads and portions of the dumping operations are very close to the city of Eveleth. A visual buffer would be desirable along the interface of these conflicting land uses, where displacement is insufficient.

Buffer Zone

Oglebay Norton has purchased lands around their operation which will be used to buffer the aesthetic impact of their action. These lands and their locational relationship to the operation are represented in fig. 50. Notice that lands for buffering are not available on the West side of Eveleth.

Soil Stockpiling

Large quantities of soils will be moved, stored and reused during the life of the proposed operation. Segregation of the overburden from the waste rock (a desirable reclamation and resource management practice) is not planned for this operation because more efficient use of storage volume can be made by mixing the soil with the rock.

Slope Stability

There is a need for careful design of the stockpile west of the Thunderbird pit because it will be built on peat which can be difficult to stabilize when it is covered by stockpile material.

Erosion

Silty, clayey and loamy soils like those found in the pit areas are subject to rapid erosion by wind and water. Against water erosion stockpile shaping, contour cultivating, interceptor trenching and revegetating can be quite effective. The objective

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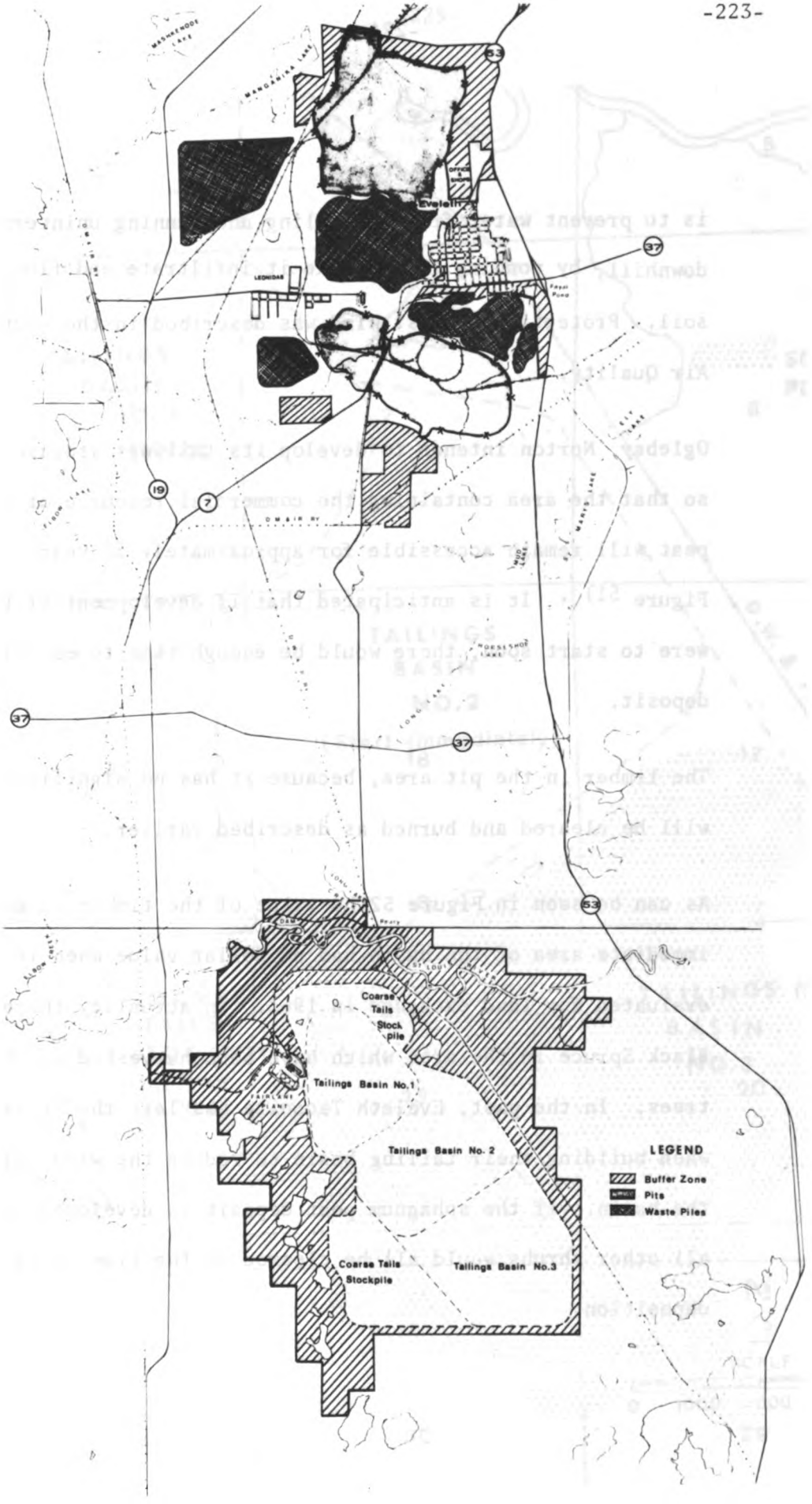

Figure 50 Buffer Zones

is to prevent water from channeling and running uninterrupted downhill, by ponding it, to make it infiltrate and flow through the soil. Protection against wind was described in the section on Air Quality.

Peat Reserve

Oglebay Norton intends to develop its tailings storage facilities so that the area containing the commercial resource of sphagnum peat will remain accessible for approximately 38 years. (See Figure 51) : It is anticipated that if development of the peat were to start soon, there would be enough time to exploit the deposit.

Timber

The timber in the pit area, because it has no significant value will be cleared and burned as described earlier.

As can be seen in Figure 52the value of the timber in most of the immediate area of the basin had no dollar value when it was evaluated for land exchange in 1963. In actuality there are stunted Black Spruce in the area which have been harvested as Christmas trees. In the past, Eveleth Taconite has left the trees in place when building their tailing basin to reduce the wind velocity across the basin. If the sphagnum peat deposit is developed, the trees and all other shrubs would all be cleared at the time of tailings deposition.

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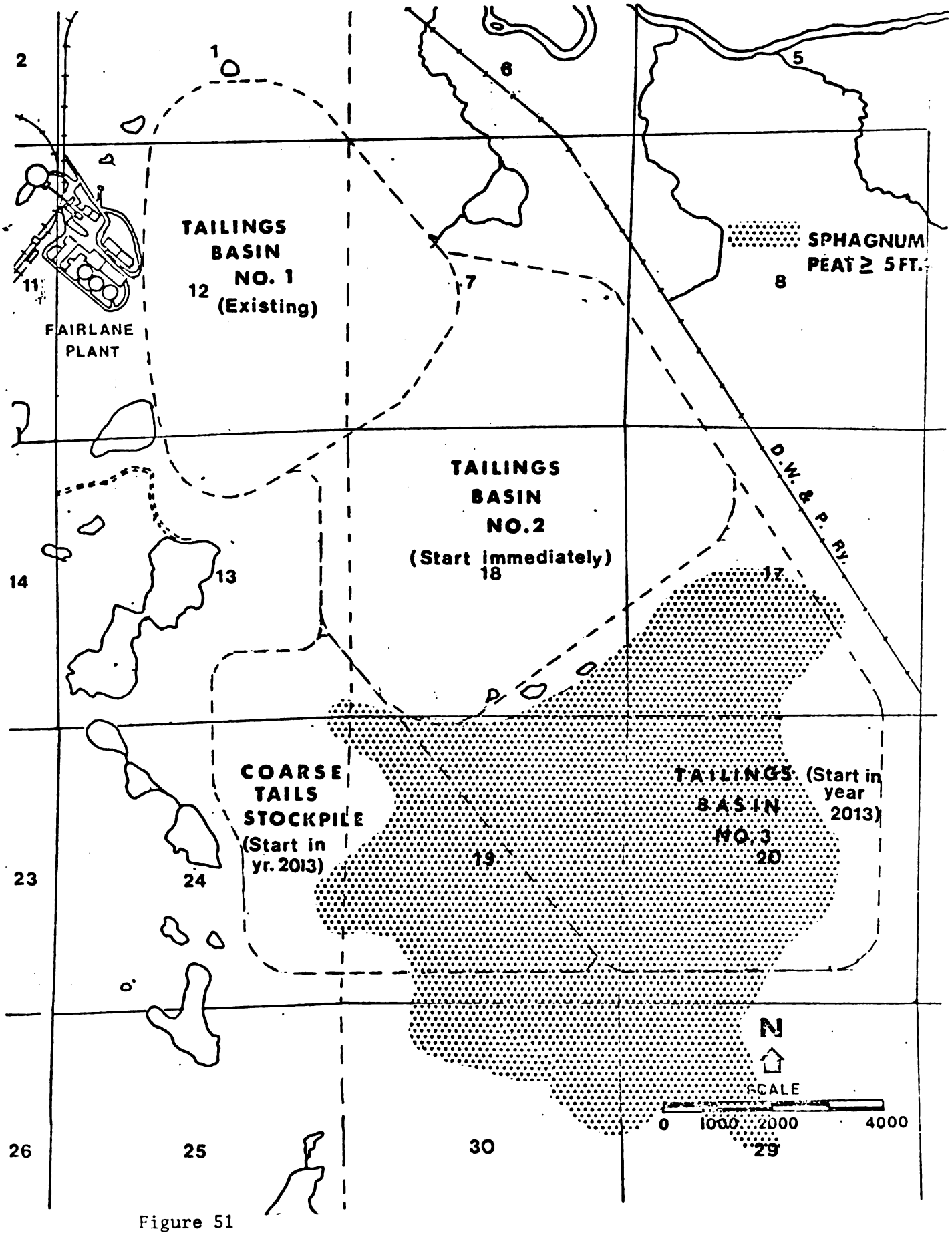

Figure 51

Areal relation between the sphagnum peat reserve and the tailings basin

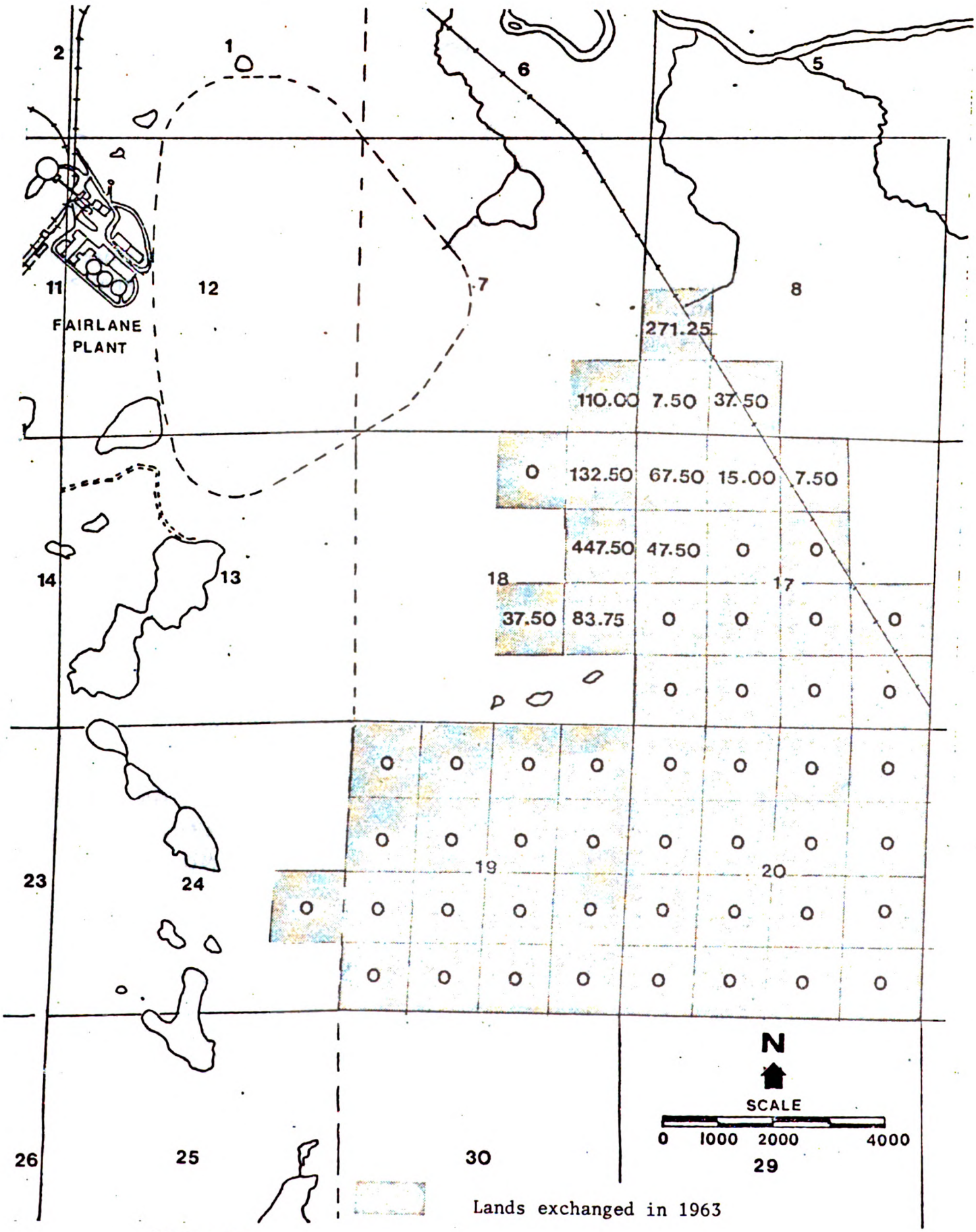

Figure 52

Dollar value of timber in 1963 land exchange by forties

Wildlife Habitat & Population Thunderbird Area

The actual loss of forest cover now serving as habitat for small animals and birds will be minimal because the surface area primarily involved in the expansion of the open pit is that lying between the south limit of the present pit and the crests of the Spruce, Hull-Nelson, Leonidas Complex of natural ore open pit mines. This area encompasses the active Gross-Nelson and Virginia Mines being operated by Rhude & Fryberger for their remaining tonnages of heavy media and wash ores. The habitat within the crests of these open pits was lost long ago. Much of the remaining land outside of the pit limits is already either committed for Rhude & Fryberger's plant and auxilliary facilities such as road, parking areas, power and pipe lines, etc., or is being utilized for Eveleth Taconite Company's system of haul roads. In either case, the habitat on the land involved has already been eliminated.

Expansion Open Pit Area

Resumption of mining will remove much, if not all, of the vegetation and associated wildlife in this area. Typically, the plant and animal community is composed of a few species of hardy plants and non-specialized birds and animals.

Some of the smaller animals such as small rodents will be destroyed. Other animals will be displaced to the adjoining areas where they will probably suffer an increased mortality rate because of their forced migration.

Abandoned mine pits generally are not productive fish habitat unless they are stocked, and usually provide little angling opportunity. None of the pits to be dewatered have ever been stocked. Any fish in the abandoned pits will necessarily be removed or lost as the pits are dewatered. In view of other adequate fish populations in nearby lakes where angling opportunities are available, any loss of fish populations as a result of dewatering operations would have little adverse environmental or recreational effects.

Upland Areas

Ecological effects of the expanded operation on the upland area between the mines and the plant will be minimal. The extremely low level of activity in this area will have practically no effect on vegetative or wildlife populations. Indirectly, the increased labor force resulting from the expansion may create additional disturbance and recreational demand. At this time it is impossible to estimate what impact this may have on the environment.

Bog Area

The maximum impact of the expansion will be felt in this area. Fine tailings will cover about 2,920 additional acres of bog habitat to a height of approximately 160 feet. Birds, having a greater mobility, may be able to move and find new habitat but many small mammals within the area will be destroyed. Larger mammals such as deer and bobcat will have the ability to migrate to adjoining areas which are presently below carrying capacity,

but will probably suffer an increased mortality rate because of the stress of adaptation and competition.

Loss of the existing bog habitat will be nearly total in the 4.6 square mile area covered by tailings. Bog habitats are not unique features in this part of Minnesota.

Rare and Endangered Species

No rare or endangered species have been observed in the areas.

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Hydrology

The resource which has, perhaps, the greatest potential for being affected by Oglebay Norton's proposal is the water resource. The appropriation, use and discharge of water at all stages of the mining beneficiation sequence can be expected to have both beneficial and adverse impacts on the area's aquatic environment. Both the quantity and quality of the area's existing water will be changed.

Water Quality Mine Area

The most significant change involving water quantity will occur at the mines. In order to keep the mine pits from filling with rain water, surface runoff, and infiltrating groundwater, a mine pumping, or dewatering, program will be established. The effects of this program will be:

1. the lowering of the water table in the immediate area, and
2. the increased flowage of the streams into which the mine water discharge will be released.

The amount of draw-down that will be experienced in the local water table is difficult to predict. The company believes that since past mine dewatering has not adversely affected the surrounding of the new mines will also not significantly affect them. However, a pair of ground water wells was discovered during a company survey of the area's ground water users. The following description of the wells, and means of mitigating the problem were prepared by the company.

A farm in the Ne-Se of Section 7, 57-17

A Mr. Joseph O'Korn stated that he had dug two wells into an an underlying gravel layer and encountered a good supply of water at 25 feet and 18 feet respectively. Neither well has

ever run dry. The water is used mainly for cattle consumption, but M. O'Korn has drunk the water and stated that it is good tasting. The wells are sealed to prevent surface water contamination.

M. O'Korn's property lies approximately 800 feet southeast of the crest of the Pearsall Mine. From the topography, the Consultant estimates that O'Korn's 18' and 25' deep wells bottom out at 1432' and 1425' elevations, respectively. The elevation of the ground water table as indicated on Exhibit B-3 is 1454' at the Troy Mine and 1451' at the Pearsall Mine. Top of ledge on the south slope of the Pearsall is 1385 elevation. From this data, the Consultant feels that O'Korn's wells will remain productive until the Troy and Pearsall Mines are dewatered to permit expansion of the open pit into the Stage III area in 1982. During the dewatering at the Troy and Pearsall, the hydraulic gradient of the water table will fall below the well points in O'Korn's shallow wells. Upon completion of the dewatering operation, the hydraulic gradient would undoubtedly reverse with flowage back into the open pit when the water table to the south rises above a 1385' elevation. However, there is little likelihood that reversal of flow will bring the ground water level on the O'Korn property up to the point where it would be tapped by the two shallow wells. The obvious solution to the problem is to sink a well to ledge rock either during or prior to dewatering the Troy and Pearsall Mines.

Lake Levels

Although the company has expressed confidence that the area's lakes will not be affected by the dewatering, the possibility exists that by depressing the surrounding water table a lowering of the lake levels could result. The company feels that the likelihood of this occurring is remote since most of the lakes will be recharged with waters from the dewatering program. If a lowering of the lake levels were to occur, dewatering would have to be suspended or, additional water might have to be directed to the lake or lakes where the levels were fluctuating.

The only area lakes which will not benefit from such recharging are Ely Lake and St. Mary's Lake. A lowering of the levels in either of these would be very detrimental since both have significant numbers of year round residences on their shores, and St. Mary's Lake is Eveleth's water supply. If the company's dewatering program were to affect the level of Ely or St. Mary's Lakes remedial action would be necessary. Such actions As:

1. augmenting the lake levels with mine water
2. supplementing Eveleth's water needs with mine water, or
3. decreasing the company's own sizeable use of water from St. Mary's Lake (via Eveleth municipal water system)

would be mitigating measures available to the company.

Dewatering Discharges

The other major water quantity change resulting from the dewatering of the mines will be an increase in the flow of the streams into which the water will be discharged. The streams which could be affected include:

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A) an unnamed stream flowing into Manganika Lake

B) an unnamed stream flowing into Elbow Lake

C) an unnamed stream flowing into Long Lake

D) an unnamed stream flowing into Mud, Horseshoe and Long Lakes.

These streams are shown on Figure 53 (the letter on the figure correspond to the letters found on the list above).

Streams A and B will definitely be utilized for mine dewatering. The use of streams C and D however provide several options since they occur in the same vicinity. The options include:

1) utilizing either stream separately to carry the total added flow or

2) both streams could be utilized simultaneously with each receiving a portion of the increased flow.

The company favors the use of both simultaneously since this offers several advantages (see Alternatives to the action).

The maximum discharge which could be pumped into these streams at any one time would be:

-stream A : 4.5 cu. ft. per sec.
-stream B : 4.5 cu. ft. per sec.
-stream C : 10.0 cu. ft. per sec) if used separately
-stream D : 10.0 cu. ft. per sec)

These maximum discharges are regulated by the maximum pumping capacity of each dewatering pump. Since these pumps will not always be discharging at the maximum rate the actual increased stream flows will be less than those listed above.

The company does not believe that the addition of discharge water will significantly affect the flow of the receiving streams, or add

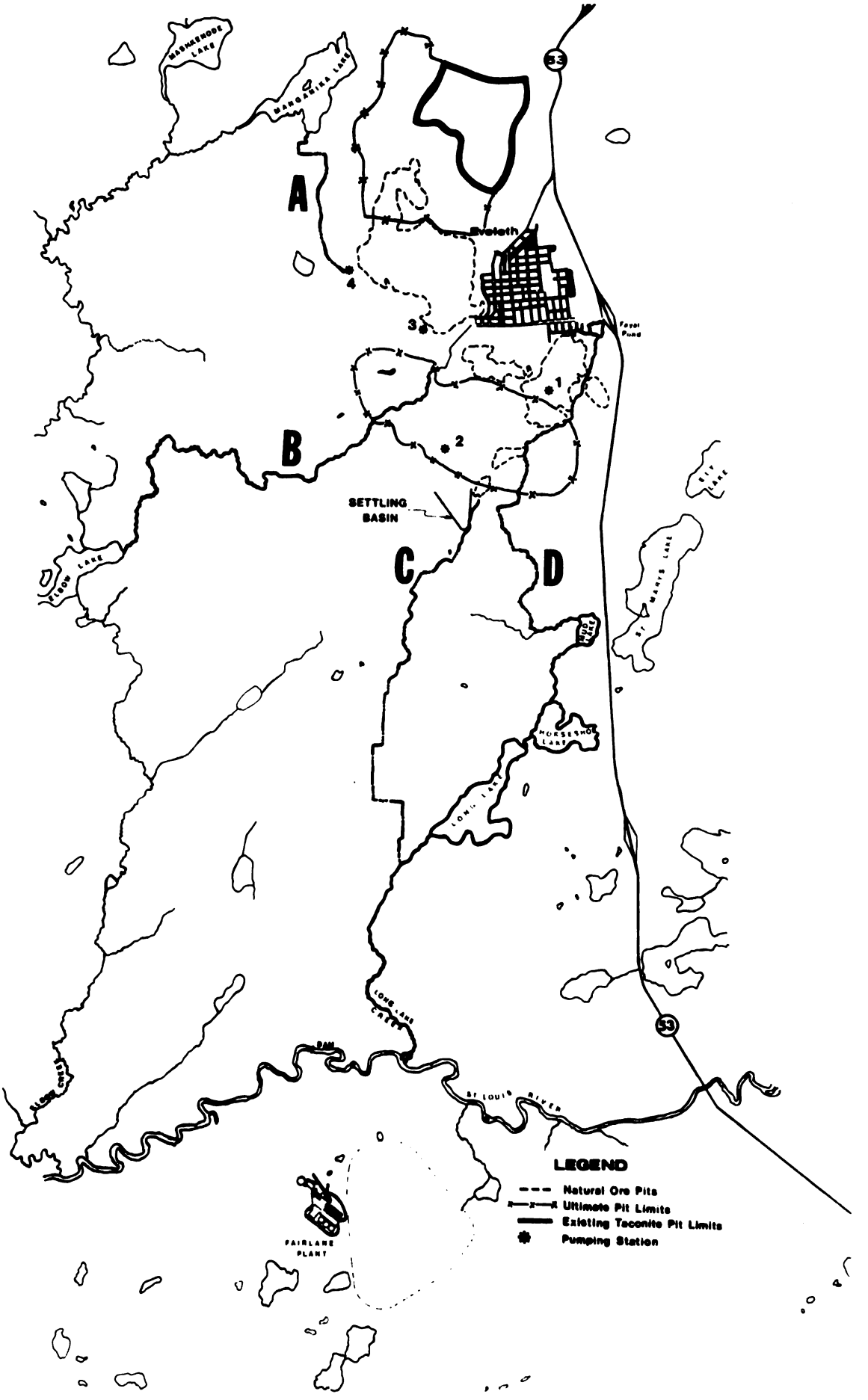

Figure 53 Pumping Stations and Their Recieving Streams

to the levels of the lakes into which they flow. However, to ensure that these streams will be capable of handling flows even during severe flooding conditions (in the event of a 100-year storm), the company proposes to upgrade the stream's flow capacities by removing and replacing any culverts which may constrict the flow (see Figure 54 and Tables 58, 59, and 60)

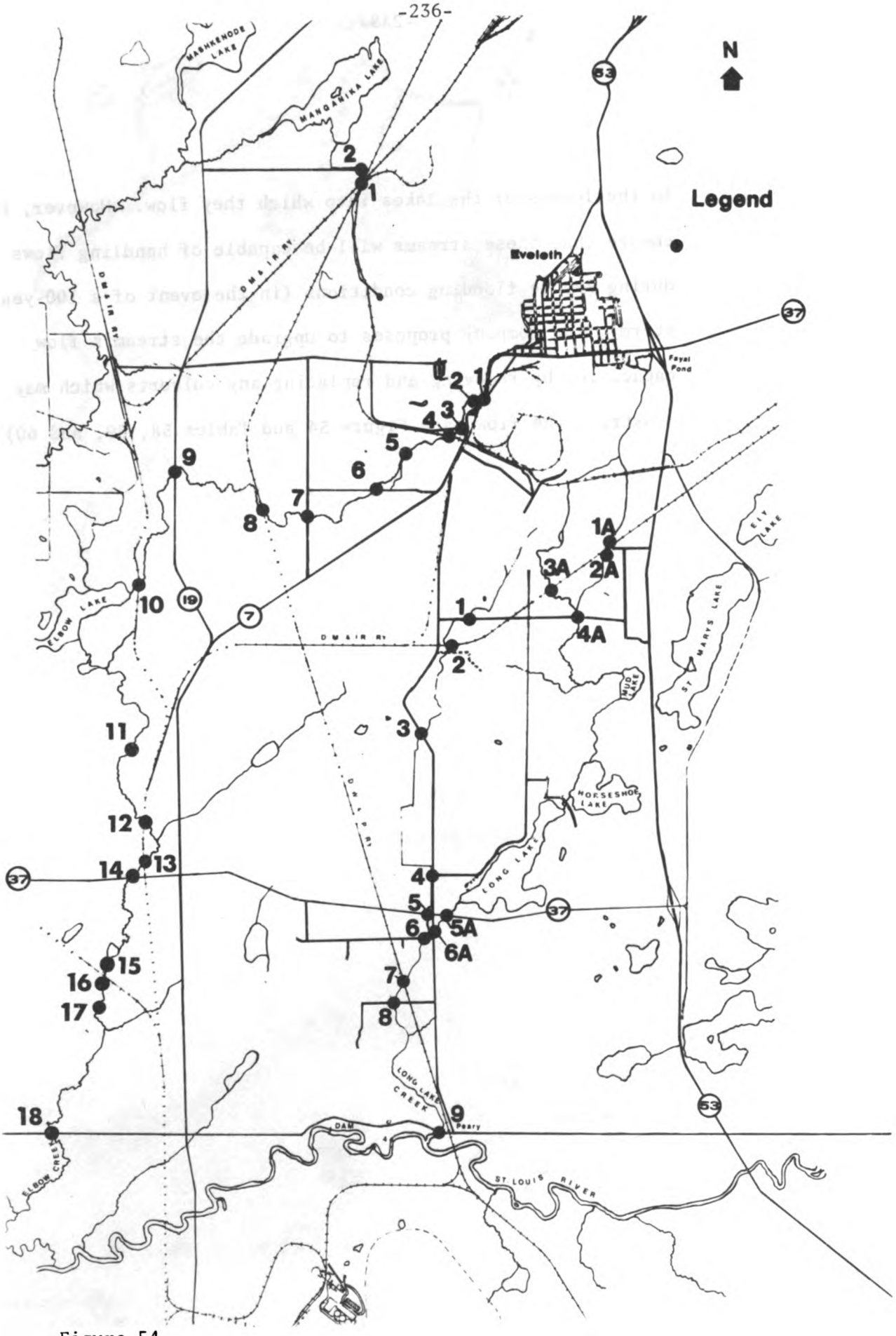

Figure 54

Constricted areas along receiving streams

Evaluation of Culvert Capacities

Table 58 — Stream to Long Lake Chain

Location	Type of Structure	Drainage Area	Run-off Coefficient		Discharge CFS		Max Culvert Capacity	Discharge & Mine Pumping		Proposed Modification	Resultant Capacity
		Sq. Mile	K	Ave.	50YR.	100YR.	CFS	50YR.	100YR.		CFS
1A	48" RCP	2.12	125	1.48	193.3	217.0	130	None	None	Add 36" CMP Overflow Remove Culvert downstream	220
2A	36" RCP	2.13	125	1.49	193.8	217.5	65	None	None	Remove	
3A	48" RCP	0.34	100	0.24	53.9	60.5	165	63.9	70.5	None	165
4A	30" CMP 36" CMP	2.75	110	1.93	197.8	222.0	63	207.8	232.0	Replace with 2-72" span CMP-Arch plus aprons	232
5A	65" span CMP-Arch	5.81	25	4.07	69.4	77.9	140	72.5	81.0	None	140
6A	2-65" span CMP-Arch	5.89	25	4.12	69.9	78.5	200	73.0	81.6	None	200
					Unnamed Stream to Long Lake Creek						
1	36" CM	0.73	100	0.51	83.3	93.5	32	93.3	103.5	Add 58" span CMP-arch Plus aprons	94
2	36" RCP	0.80	95	0.56	83.5	93.7	105	93.5	103.7	None	105
3	36" CM	1.37	70	0.96	84.0	94.3	35	94.0	104.3	Add 58" span CMP-Arch	97
4	36" CM	2.19	55	1.53	86.7	97.3	27	96.7	107.3	Replace with 2-50" span	110
5	44" span CMP-Arch	2.36	55	1.84	90.5	101.6	55	100.5	111.6	Add 36" RCP plus aprons	115
6	2-65" span CMP-Arch	8.33	35	5.83	119.7	134.3	200	129.7	144.3	None	200
7	5'x4' DBL. Timber Box	8.47	35	5.93	120.8	135.7	320	130.8	145.7	None	320
8	72" span CMP-Arch	8.81	35	6.17	123.6	138.8	100	133.6	148.8	Add 36" CMP plus Aprons	150
9	2-84" CMP	11.08	45	7.76	181.6	203.8	1195	191.6	213.8	None	1195

Table 59 — Unnamed Creek to Elbow Lake

Location	Type of Structure	Drainage Area	Run-off Coefficient		Discharge CFS		Max Culvert Capacity	Discharge & Mine Pumping		Proposed Modification	Resultant Capacity
		Sq. Mile	K	Ave	50YR.	100YR.	CFS	50YR.	100YR.		CFS
1	2-48" RCP	1.80	115	1.26	162	181	210	172	191	None	210
2	2-36" RCP	1.80	115	1.26	162	181	140	172	191	Add 36" RCP	210
3	3-60" RCP	2.15	110	1.51	171	192	385	181	202	None	385
4	8' wide 75' high Conc. Arch	2.16	110	1.51	172	193	480	182	203	None	480
5	120" RCP	2.35	110	1.65	180	203	1000	190	213	None	1000
6	2-42" RCP	2.63	110	1.84	193	216	116	203	226	Add 73" span RCP-A	236
7	11.5' span Timber Br.	2.98	105	2.07	198	222	80	208	232	Raise Road Grade 2.5' at Low points	270
8	2-54" RCP	3.13	105	2.19	203	228	500	213	238	None	500
9	W106 Conc. Br	3.38	100	2.37	203	228	1080	213	238	None	1080
10	2-60" RCP	3.90	95	2.73	209	235	560	219	245	None	560
11	11'-5'x7'-3" Multiple Arch	7.54	65	5.28	210	235	510	220	245	None	510
12	4-11.5' span Conc. Br.	8.12	65	5.68	219	246	1450	229	256	None	1450
13	4-13' spans Conc. Br.	10.98	65	7.69	261	293	1200	271	303	None	1200
14	W88D B.C.	11.01	65	7.71	261	293	1250	271	303	None	1250
15	7'-0 Multiple	11.51	60	8.06	247	278	320	257	288	None	320
16	84" RCP	11.51	60	8.06	247	278	320	257	288	None	320
17	Steel Beam Br. 22'x50'pening	11.82	60	8.27	251	282	500	261	292	None	500
18	Steel Beam Br. 29'x70' penning	13.98	60	9.79	277	311	930	287	321	None	930

Table 60 — Unnamed Creek to Manganika Lake

Location	Type of Structure	Drainage Area	Run-off Coefficient		Discharge CFS		Max Culvert Capacity	Discharge & Mining Pumping		Proposed Modification	Resultant Capacity
		Sq. Mile	K	Ave	50YR.	100YR.	CFS	50YR.	100YR.		CFS
1	48" RCP	0.24	65	0.17	28	32	100	38	42	None	100
2	2-30" CMP	0.24	65	0.17	28	32	45	38	42	None	60
3	48" CMP	0.69	65	0.48	52	59	45	62	69	Remove	

One of the streams (Stream D) that has been proposed for possible use as a dewatering receiving stream flows into the Mud, Horseshoe and Long Lake Chain. Because these lakes are used for recreation, and have residences along the shores, the PCA, DNR and the Company wanted assurances that if this route were utilized there would be no detrimental effects. The company therefore initiated a hydraulic study to determine whether any lake level changes would occur if the discharges were pumped into the lake drain's feeding stream. Although the company's intent is to discontinue pumping during times of peak runoff, the state requested that the hydraulic study be made considering the worst possible conditions. These conditions would be; to discharge water into the stream at the maximum capacity of the pumps during a 100-year storm. The calculated lake level elevations for such a set of circumstances is contained on Table 61

TABLE 61

LAKE ELEVATION (MSL)

Time Hours	Without Stream Realignment		With Stream Realignment	
	100 Yr. Storm	Storm + Pumpage	100 Yr. Storm	Storm + Pumpage
0	1356.02	135.16	1356.02	1356.16
1	.05	.19	.05	.19
2	.10	.24	.10	.24
3	.14	.28	.16	.29
4	.19	.33	.21	.34
5	.23	.36	.25	.37
6	.27	.39	.30	.41
7	.31	.43	.37	.48
8	.39	.50	.47	.58
9	.47	.58	.54	.66
10	.52	.63	.60	.71
11	.54	.66	.63	.75
12	.56	.68	.64	.77
13	.56	.69	.65	.77
14	.56	.68	.65	.78
15	.55	.68	.64	.77
16	.54	.67	.63	.76
17	.53	.66	.61	.75
18	.52	.65	.59	.74
19	.50	.64	.58	.73
20	.48	.62	.56	.71
21	.47	.61	.55	.70
22	.45	.59	.53	.68
23	.43	.58	.51	.67
24	.42	.56	.49	.65
25	.40	.54	.47	.63

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The company feels the elevation changes would not be significant, but to minimize them, the company wants to have the option of dischargeing the mine water into either Stream D or Stream C.

The other mine water receiving streams were not studied in such great detail as Stream C and D. Since the maximum discharge will be less than ½ that expected for Streams C or D, and because the lakes into which they empty are not utilized to the extent of Mud, Horseshoe, or Long Lakes a detailed study did not seem warranted.

Mitigation of Effects

The environmental effects which might arise because of water quantity changes are expected to be minimal. But if adverse effects do result mitigative measures are available. Such options as:

- -Better management of stream flow by a more even discharge to the four receiving streams.
- -Augmenting lake levels, should groundwater drawdown affect the lakes.
- -Increased use of mine water as process water to decrease discharges and;
- -Suspension of dewatering activities during extreme precipitation conditions would provide solutions to problems which could possibly develop.

One of the more significant water quantity effects which will result if the action is developed as proposed, involves the company's consumption of Eveleth's municipal water, for mining purposes. The city of Eveleth recently requested the DNR to investigate the current low levels on St. Mary's Lake, Eveleth's water supply. The results of this investigation (see Appendix H) led the state to conclude that the present appropriation from the lake just balances the water inflow. The report also concludes that if additional pumping were to occur the lake's level would deviate from the present "normal" condition.

Oglebay Norton presently purchases water from Eveleth at the rate of 82,000 gallons per day. The company intends to increase its purchases to 145,000 gallons per day when the operation is expanded.

This increase would require significantly more pumping from St. Mary's Lake, there would probably be a drawdown of the lake level. Therefore, it would not be wise to allow the company to purchase additional water. Other water sources are available to the company (see Alternatives to the Proposed Action).

Plant Site

The water quantity changes at the plant include:

-an increase in the amount of water appropriated for processing, and
-an increase in the amount of water stored in the larger tailing basin.

Water Appropriation

The company presently has the right to appropriate water from the St. Louis River at a rate of up to 17 cubic feet per second. The present plant only requires about 3.5 cfs., while the expanded facilities will require 11.1 cfs (see Figure 46). Both these figures are within the limits established by the DNR when the initial plant was constructed in 1965. In addition to the statement of a maximum appropriation rate, the permit established a minimum flow for the river. In the event that minimum flow is reached the pumping will cease. Therefore the expansion of the plant should not greatly affect the St. Louis River.

Two effects on the areas water quantity could result from an increase in the amount of water stored in the tailings basin. These include:

-an increase in the quantity of seepage, due to the enlargement of the water pond, or
-a decrease in the quantity of water, due to the covering of the bog which presently contributes to the areas watershed.

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Tailings Basin Seepage

Very little information has been generated on the quantity of the seepage which might result from the tailing pond. Soil tests are not being run which will help provide information from which seepage effects can be evaluated. If it can be determined that excessive seepage will occur, the company will be required to provide a seepage collection system that will return water to the tailings basin.

Removal of water contributor

The action as proposed will require the covering of a 6 square mile area of bog. The bog area to be covered is an extension of a much larger bog which covers perhaps 60 square miles. Because both the tailings pond, and the total bog, cover extremely large areas, it is impossible to economically determine the amount of water which the 6 square miles of bog contributes to the area's watershed. Such an investigation to determine quantities would require several dozen wells and many seasons of data to accurately quantify the amount of water contributed. Since this is impossible to achieve in the time frame available, it is the opinion of the DNR staff that the project proceed, but that a monitoring program including:

-measurement of the areas lake levels and,
-determination of seepage from the tailings basin be initiated.

In the event that lake levels are adversely affected, either by increases or decreases in lake heights, mitigative measures such as

-seepage collection (discussed above) or
-augmenting lake levels with water from the pond or other sources can be established.

Such a monitoring program will also be needed to adequately reclaim the tailing pond. Upon abandonment of the tailings pond, the basin will have to be graded and contoured in such a manner so that runoff will flow in the direction necessary to maintain the watershed characteristics that monitoring will establish.

Water Quality

Water quality impacts will result from:

1. Dewatering the mine area.
2. Erosion and runoff from stockpiles.
3. Tailings basin seepage.
4. Diversions and stream crossings.

Water quality is evaluated by its physical-chemical characteristics like temperature, color, turbidity, dissolved oxygen, biochemical oxygen demand (BOD), pH, alkalinity and concentrations of dissolved salts. The water quality of surface waters depends upon the physical, chemical and biological processes to which it has been exposed.

Alkalinity and pH are related factors. Alkalinity is a measure of the ability of a stream or lake to moderate pH fluctuations, while pH is related to hydrogen ion concentration. Both variables are important to aquatic organisms. The pH of water influences the availability of dissolved substances and alkalinity functions as a CO_2 reservoir for photosynthetic organisms.

Total dissolved solids indicate the presence of dissolved materials in the water. These materials are usually derived from the weathering of rocks and include carbonates, sulfate, chlorides, phosphates and nitrates. They function as nutrients, in osmotic stress and in toxicity.

Turbidity is the light-scattering effect of suspended and settleable solids present in the water. This factor reduces photosynthesis and affects water temperatures. The solids that cause turbidity generally originate from erosion and normal stream processes and can be directly toxic to aquatic organisms if present in high concentrations for prolonged periods.

Macronutrients are the major nutrients for aquatic plant growth. These substances are derived from the weathering of rock and from man-made products.

Oils are organic compounds which, in sufficient quantity, create a biochemical oxygen demand and are toxic to aquatic plants and animals.

Heavy metals are substances that are generally derived from the geologic formations and are potentially toxic to aquatic plants and animals. Some metals in low concentrations are necessary for living organisms, but slightly higher levels may be toxic. The toxicity of some metals can be affected by pH, dissolved oxygen, temperature, turbidity, carbon dioxide, magnesium salts, phosphates and stream organics.

Dewatering

Available water quality information for the area is listed in Table 62, and monitoring stations are located on Figure 55 . It must be noted that comparative observations about single samples taken on different days cannot be made with certainty, because within certain limits, the chemistry of any water is continually changing and a single analysis can only be considered a temporary resultant of many continuously interacting factors. Before a more quantitative analysis can be made of the effects of dewatering on the lakes and streams, the limited data must be augmented.

Before mining operations can begin, water that has accumulated in the old natural ore pits and water that will drain into the pits must be removed. The water quality that will result from this water removal and its flushing action is a function of the quality and quantity of the pit-and-mine waters and the natural lake drainage.

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Table 62
Chemical analysis, summary of all stations

Location	Feyal Extension Pit	Feyal No. 3 Pit	Feyal No.2 Pit	Alice Pit	Leonidas Spruce Pit	Unnamed Creek	Thunderbird mine drainage	Unnamed Creek	Manganika Outflow	Unnamed Creek	Troy Pit	Pearsall Pit	Unnamed Creek	Long Lake Outflow	St. Louis	St. Louis	St. Louis	Little Tony Outflow	Tailings Seepage
Station	A	B	C-1	C-2	D	E	F	G	H	I	J-1	J-2	J-3	K	L	M	N		O
Date	5/24/74	5/24/74	5/24/74	5/24/74	5/24/74	7/17/74	5/24/74	5/24/74	5/24/74	7/17/74	5/24/74	5/24/74	7/17/74	7/17/74	7/24/74	7/24/74	7/24/74		7/24/74
pH	8.2	7.9	7.9	7.8	7.6	7.6	8.4	8.0	9.1	7.2	8.1	8.1	6.9	8.4					
Total Alkalinity, mg/l (as $CaCO_3$)	101	139	167	171	175	328	213	144	111	90	138	130	133	52					
Ca Hardness, mg/l (as $CaCO_3$)	74	134	174	166	334	416	44	138	90	100	194	130	90	41					
Total Hardness, mg/l (as $CaCO_3$)	142	298	424	434	1044	964	267	334	176	188	414	270	152	89					
Sulfide, mg/l (S)	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	.1	.1					
Sulfate, mg/l (SO_4)	30	195	145	180	710	467	195	174	65	90	385	170	68	10					
Chloride, mg/l	16	10	7	7	13	9	38	19	45	20	5	3	1	8					
Bromide, mg/l	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	.1	.1					
Fluoride, mg/l	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	.1	.1					
Nitrate, mg/l (NO_3 as N)	.01	.04	<.01	.07	.59	.21	2.40	2.30	1.17	1.10	<.01	.02	.11	.02					
Nitrite, mg/l (NO_2 as N)	<.01	<.01	<.01	<.01	<.01	.06	<.01	<.01	.04	.06	<.01	<.02	.01	.01					
Ammonia, mg/l (NH_3 as N)	<.1	<.1	<.1	<.1	<.1	.96	<.1	<.1	<.1	5.09	<.1	<.1	.20	.03					
Oil & Grease, mg/l	<10	<10	<10	<10	<10	<5	<10	<10	<10	5	<10	<10	5	5					
Color, Pt-Co units	15	5	10	5	<5	80	5	50	60	95	5	<5	200	20					
Turbidity, J.T.U.	4	3	5	3	4	4	2	3	5	14	5	3	19	2					
B.O.D., mg/l	3	2	2	2	<1	2	<1	1	9	9	<1	<1	1	2					
Dirrolved Oxygen, mg/l	10.2	10.3	9.9	9.8	9.6	7.2	9.4	9.8	11.7	6.8	10.0	10.1	4.7	8.0					
Total Bacteria, per ml	62	71	53	61	4	944	31	11	32	688	45	10	736	628					
Total Coliform, MPN/100 ml	38	38	8.8	8.8	2.2	38	38	15	38	38	15	5	38	38					
Suspended Solids, mg/l	9	5	4	2	8	16	7	2	13	15	8	10	10	4	32	16	8		13
Total Solids, mg/l	186	423	496	491	433	1520	554	510	300	345	607	354	206	116					
Dirrolved Solids, mg/l	177	418	492	489	425	1504	547	508	287	330	599	344	196	112	238		442		763
Phosphate, mg/l	.02	<.01	<.01	.02	<.01	2.5	<.01	.11	.40	3.0	<.01	<.01	.09	.05					
Mercury, ug/l (total)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1					
Aluminum, ug/l "	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	100	100					
Chromium, ug/l "	<100	<100	<100	<100	<100	<1	<100	<100	<100	<1	<100	<100	1	1					
Copper, ug/l "	3	2	3	4	3	5	3	3	5	8	3	3	20	6	10	5	4		2
Iron, ug/l "	33	40	79	121	30	600	24	163	119	900	33	31	6100	18	211	102	122		101
Lead, ug/l "	6	5	5	5	5	<1	6	6	6	1	5	6	1	1					
Manganese, ug/l "	15	122	2600	2700	400	8400	3	400	180	600	28	10	3800	100	8	4	65		500
Nickel, ug/l "	7	10	12	11	11	3	10	10	10	4	6	6	4	1	11	9	9		8
Zinc, ug/l "	8	6	8	8	8	5	8	8	12	11	6	7	6	3					

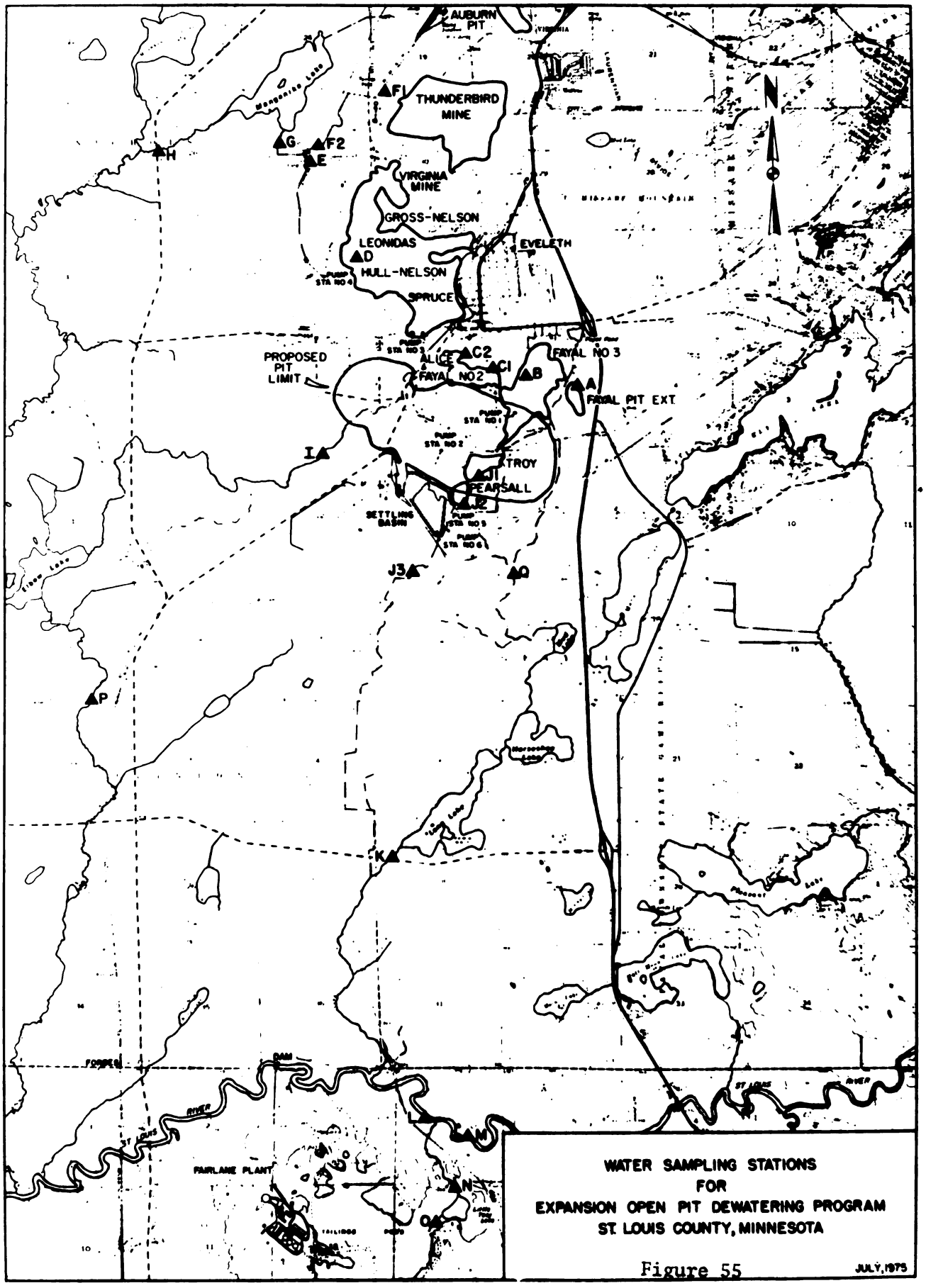
AUBURN PIT
THUNDERBIRD MINE
VIRGINIA MINE
GROSS-NELSON
LEONIDAS
HULL-NELSON
SPRUCE
EVELETH
PROPOSED PIT LIMIT
ALICE
FAYAL NO 2
FAYAL NO 3
FAYAL PIT EXT
TROY
PEARSALL
SETTLING BASIN
F1
F2
G
E
H
D
C2
C1
B
A
I
J1
J2
J3
Q
P
K
L
M
N
O
DAM
FAIRLANE PLANT
ST LOUIS RIVER
WATER SAMPLING STATIONS
FOR
EXPANSION OPEN PIT DEWATERING PROGRAM
ST. LOUIS COUNTY, MINNESOTA
JULY, 1975

Figure 55

Waters pumped from the several natural ore pit areas will be of two basic types. During the initial phase, standing waters from the existing natural ore pits will be pumped to receiving streams. As these waters decrease and mining progresses, the pumped waters will take on a new character, that of mine water. "Mine water" is composed of, direct precipitation into the pit, surface runoff from adjacent lands that cannot reasonably be diverted from flowing directly into the pits; and ground water seepage or flows from aquifers penetrated or intercepted by open pit operations. Ground water is the major component of mine water.

Mine water quality is affected by the high level of operations occurring within the pit area. Table 63 compares typical mine waters with the present pit water.

Based on the limited data available, it can be seen that both "mine" and "pit" waters have high hardness, sulfate and dissolved solids. The only significant difference is the high nitrate concentration in mine waters, which may be the results of the use of ammonium nitrate explosives.

The quality of the dewatering discharge will not change significantly except that there will be an increase in nitrate. Since nitrate is a nutrient, the increased level may cause increased biological productivity in the receiving waters. The extent of this increase would depend on the availability of other nutrients like phosphate.

Table 63

	Reserve & Erie Minewater[1]	Thunderbird Mine Minewater[2]	Pit Water[3]
pH	7.5	8.4	8.0
Total Alkalinity, mg/l (as $CaCo_3$)	82	213	147
Ca Hardness, mg/l (as $CaCO_3$)	110	44	151
Total Hardness, mg/l (as $CaCO_3$)	185	267	334
Sulfate, mg/l (SO_4)	100	195	238
Chloride, mg/l	33	38	8
Floride, mg/l	.39	.1	.1
Nitrate, mg/l (NO_3 as N)	11.2	23.0	.03
Nitrate, mg/l (NO_2 as N)	.22	.01	.01
Ammonia, mg/l (NH_3 as N)	.1	.1	.1
Color, Pt-Co units	20	5	5
Turbidity, J.T.U.	3	2	4
Dissolved Oxygen, mg/l	10.1	9.4	10.2
Suspended Solids, mg/l	5	7	6
Dissolved Solids, mg/l	325	347	461
Phosphate, mg/l		.01	.01
Iron, mg/l	750	24	41
Manganese, ug/l	54	3	285

1. Average value for sample collected in November, 1974.

2. Represented by sample taken from mine drainage, sample location F.

3. Volume weighted average of pit water samples A, B, C-1, C-2, J-1, J-2, at Oglebay Norton Properties.

In the later years of the project, ground water will be pumped from Stations 3 and 4. Since these pumps will be located in abandoned mine shafts, the water that will be discharged will have flowed through the iron formation. As a result, much of the suspended matter originally in the water will be removed and no settling facilities for the removal of suspended matter should be necessary. (Normally, mine waters are ponded before discharge to provide for sedimentation of suspended water.) If pumped waters fail to meet PCA water quality standards for turbidity or suspended solids, mitigating facilities will be required to allow for settling.

Specific Impacts Dewatering

The limitations of the existing data have been described on page 243. To augment this data the following monitoring program is needed.

1. Water quality analysis similar to those run on stations A to K should be run in early spring and mid-summer on all lakes receiving the dewatering discharge. Analysis should also be conducted for total phosphorous, dissolved iron, and dissolved manganese.

2. Every month throughout the growing season the following field analysis should be made:

   A. A temperature and dissolved oxygen profile.
   B. A secchi disk reading.
   C. Determination of the maximum depth at which vegetation can exist.
   D. Chlorophyll analysis.

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3. Inflow and outflow data should be gathered and analyzed to determine the mixing and flushing characteristics of each lake. When this is done a more quantitative analysis of the effects of dewatering can be made.
4. Stations showing high levels of iron or manganese C-1, C-2, D, E, G, I, J-3, should be analyzed for dissolved concentrations of these ions.

The specific discharges are:

1. Pump stations 1 and/or 2, will discharge through facilities for settling particles, to Long Lake Creek via a.) Mud Lake, Horseshoe Lake and Long Lake for the life of the mine or b.) an unnamed stream.
2. Direct discharge of ground water from pump station 3 to the unnamed creek leading to Elbow Lake during Stage III & IV of the operation.
3. Direct discharge of ground water from pump station 4 to Manganika Lake via an unnamed creek during Stage IV of the operation.

Long Lake Creek Discharge

This discharge and its difference stages is shown schematically in Figure 56 through 58 .

Since all of the pit waters will be mixed during this dewatering operation, the water quality data for each pit (sampling stations A, C, C-2, J-1, J-2) has been weighted by the water volume in that pit and then averaged to approximate the discharge water quality. The resulting quality analysis is presented in Table 64along with samples representing the Long Lake chain alternative, represented by its outflow (K), and the unnamed creek alternative (J-3).

Alternative I

Although more data is needed, it can be generally implied that pit waters are of significantly different quality than the present lake waters as represented by their outflow.

It can be seen that the pit waters have significantly higher levels of total alkalinity, total hardness, sulfate, total dissolved solids, and total manganese. Nutrient levels are expected to be significantly lower in the pit waters than in the receiving lakes.

During the peak of the growing season, a good portion of the nutrients are tied up in the biomass. Analysis of nutrient parameters performed at this time will show a net decrease from samples taken just prior to the growing season. Sample K shows no elevated levels of nutrients. It is probable that this is due to the above mentioned phenomenon. Because historical

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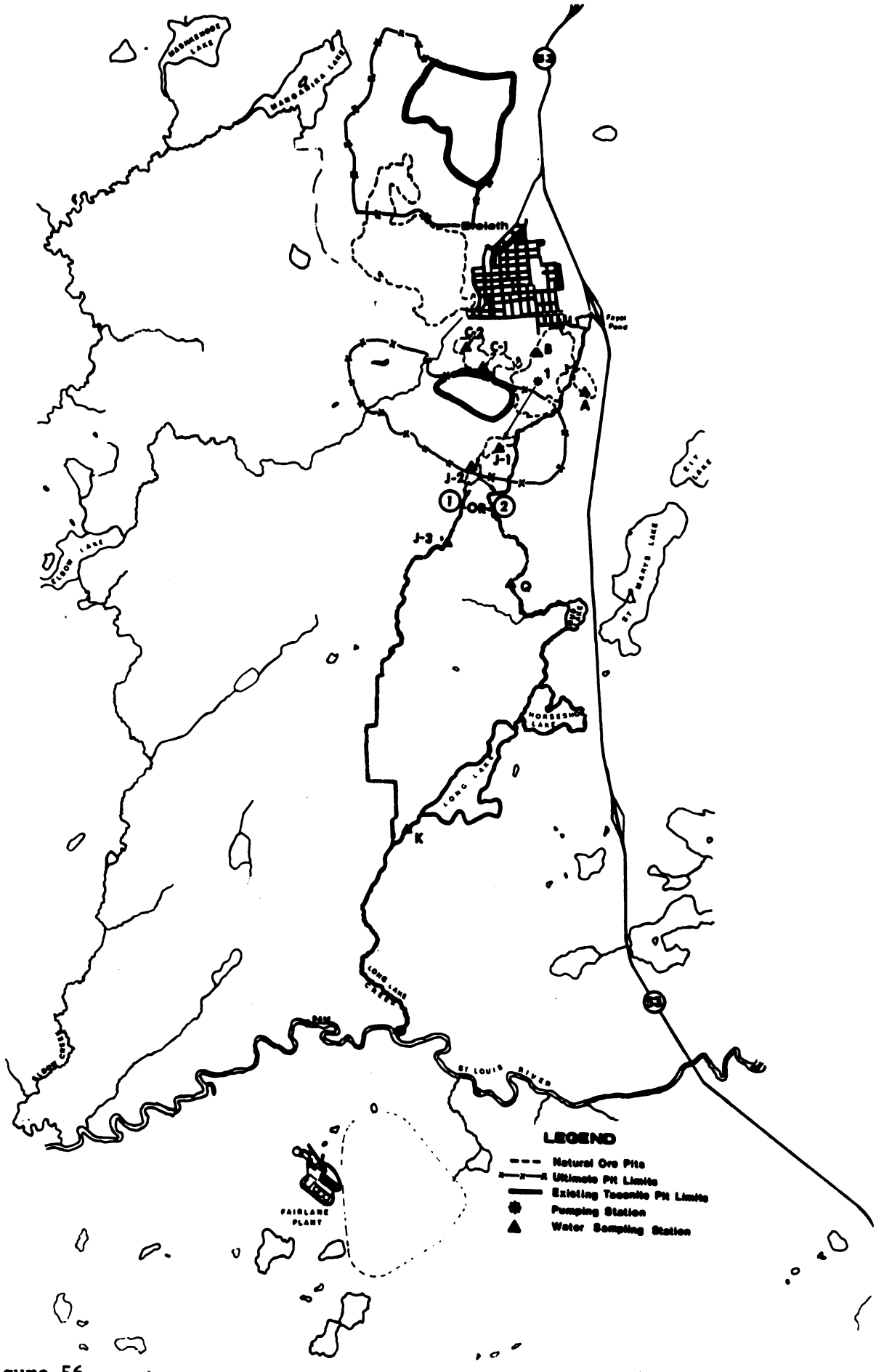

Figure 56
Discharge 1 pumped through two natural ore pits to settle out solids.
Discharged to alternatives 1 or 2

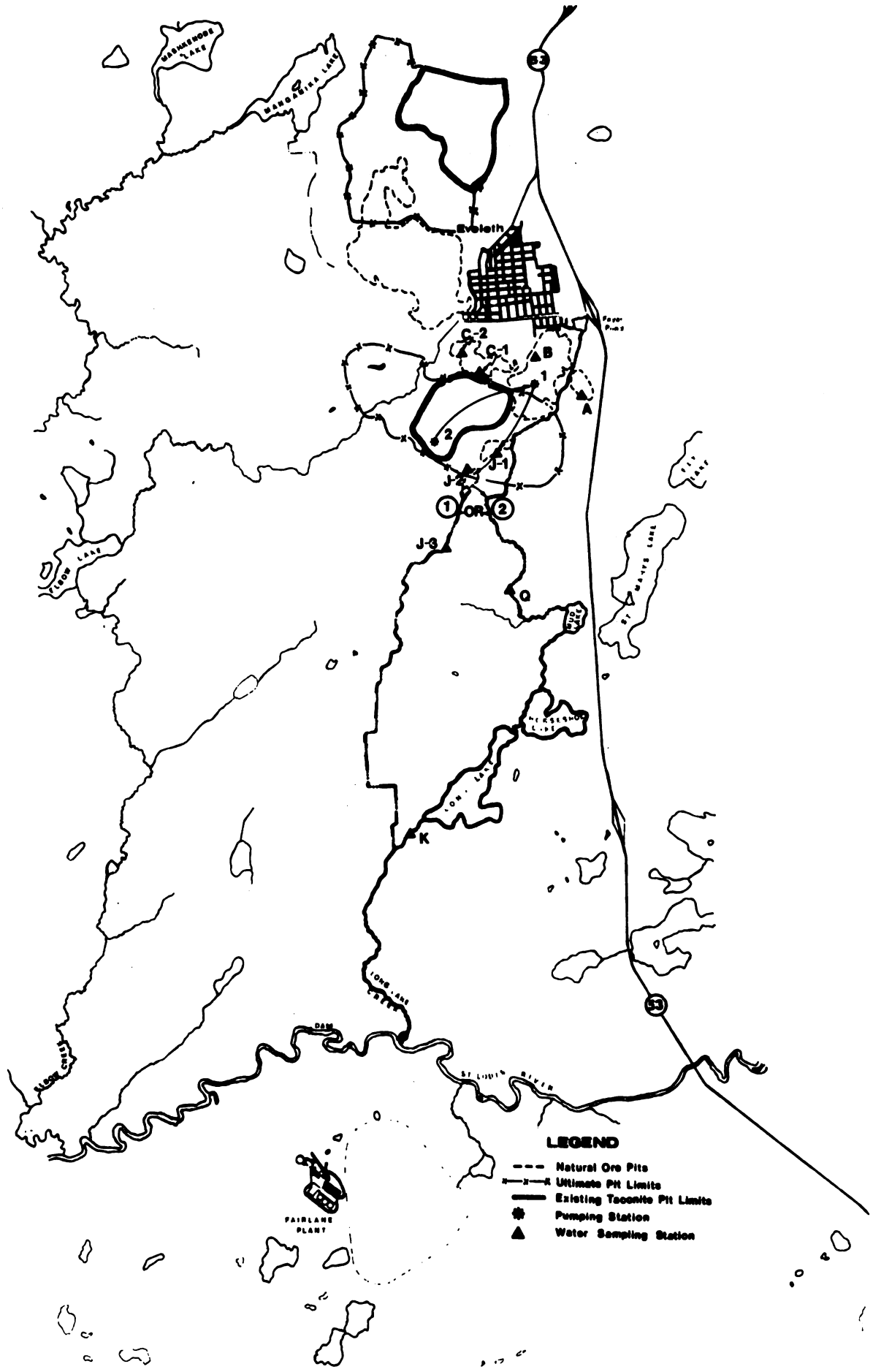

Figure 57
Pump station 2 adding water to pump station 1, then same as figure 56

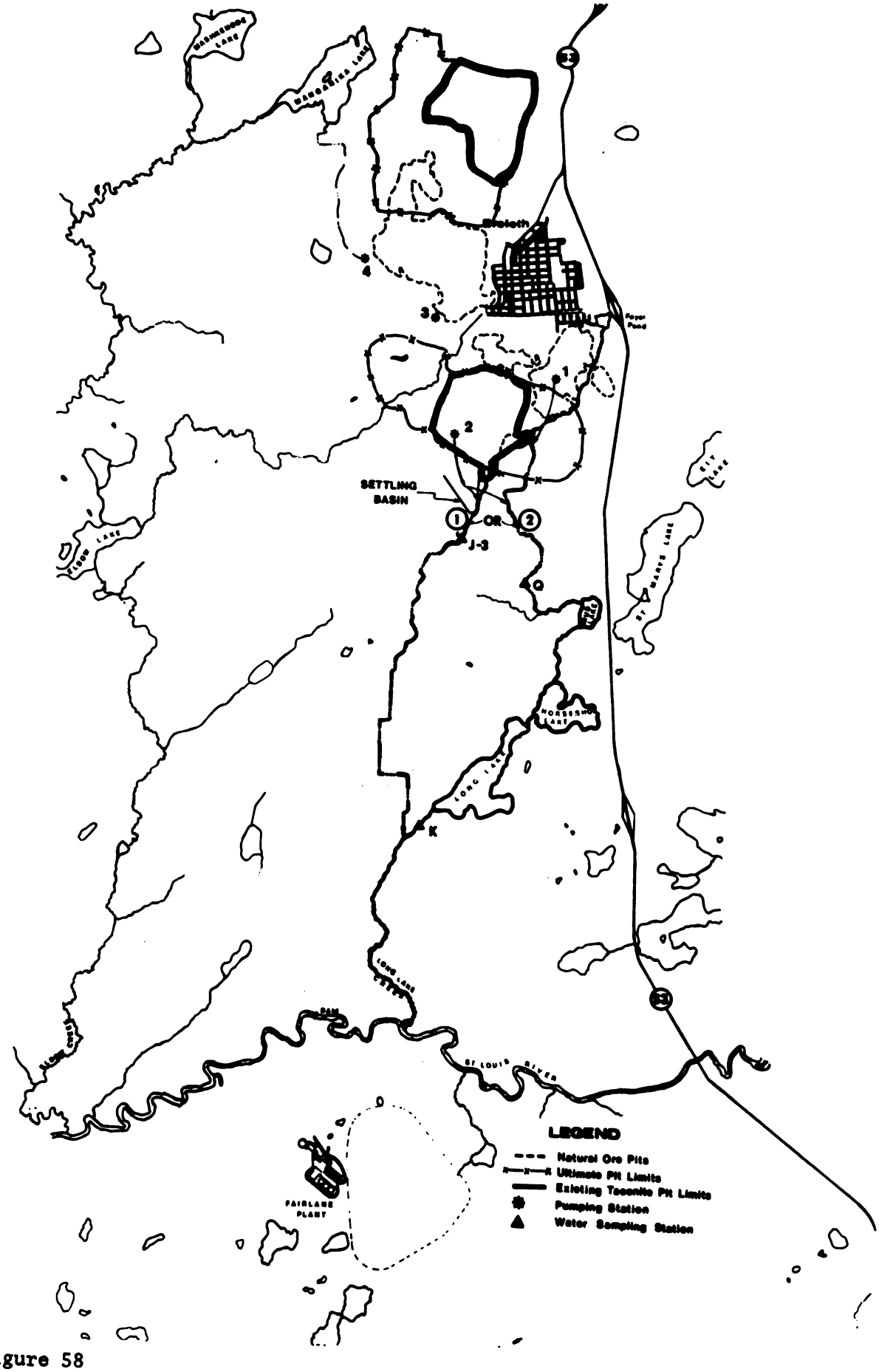

Figure 58
Pumps land2 lift water to settling basin for clarification, then discharge to alternatives 1 or 2

Table 64

Location	Pit Waters	Unnamed Creek	Long Lake Chain
Station		J-3	K
Date	5/24/75	7/17/74	7/17/74
pH	8.0	6.9	8.4
Total Alkalinity, mg/l (as Ca CO_3	147	113	52
Ca Hardness, mg/l (as Ca CO_3)	151	90	41
Total Hardness, mg/l (as Ca CO_3)	334	152	89
Sulfate, mg/l (SO_4)	238	68	10
Nitrate, mg/l (NO_3 as N)	.03	.11	.02
Nitrate, mg/l (NO_2 as N)	< .01	< .01	< .01
Amonia, mg/l (NH_3 as N)	< .1	.20	.03
Color, Ft-Co units	5	200	20
Turbidity, J.T.U.	4	19	2
B.O.D., mg/l	2	< 1	2
Dissolved Oxygen, mg/l	10.2	4.7	8.0
Total Bacteria, per ml	56	736	428
Total Coliform, MPN/100 ml	22	38	38
Suspended Solids, mg/l	6	10	4
Dissolved Solids, mg/l	461	196	112
Phosphate, mg/l	< .01	.09	.05
Iron ug/l	41	6100	18
Manganese, ug/l	285	3800	100

evidence shows that the lakes are of marginal fishing quality and residents of the lake's shores have asked that flushing be allowed to alleviate the algae problem, it is reasonable to assume that these lakes are high in biological productivity, and of generally low recreational quality.

Total manganese is a measure of both particulate and dissolved metal and is not a direct measure of toxicity. Dissolved manganese is considered to be more toxic to aquatic life and is the less desirable form to have in drinking water (1). The ratio of suspended manganese to dissolved manganese is the result of many factors affecting the equilibrium condition. There is no guarantee that manganese released to the environment in the dissolved state will remain in that state (2). Further monitoring of this parameter has been recommended on page 248 .

The water quality that will result from the discharge and flushing action will probably lower the productivity and nutrient levels of the lake. The total ionic and manganese concentrations will increase. While it is desirable to lower the productivity, the subtle effects of raising the ionic and manganese concentrations cannot be determined at this time.

It is the opinion of the DNR fisheries personnel that these pit waters should not harm the fish in the lakes, and may bring about subtle changes in the aquatic vegetation, which could be desirable to users of the lakes, such as clearer waters for swimming. A program for monitoring the flushing effects has been established on page 248.

Alternative 2

Data from the unnamed creek (station J-3) shows elevated levels of manganese iron, alkalinity, color, and bacteria. It can be seen that the pit waters are of better quality than the existing stream waters which at present receive Eveleth sewage. However, the total load of ions delivered to Long Lake Creek and ultimately to the St. Louis River would be proportionately increased by the discharge. (Using average flow conditions the ratio of the flow in the St. Louis to the flow in the unnamed creek would change from 79:1 to 44:1).

Elbow Lake Discharge

The second discharge will be from an old mine shaft (pump station 3) to Elbow Lake. (Figure 59).

In Table 65 are the water quality results from samples from the Spruce complex of pits and the unnamed creek which flows to Elbow Lake. Data on Elbow Lake itself has been requested on page 248.

Table 65

Location	Spruce Pit	Unnamed Creek
Station	D	I
Date	5/24/74	7/17/74
pH	7.6	7.2
Total Alkalinity, mg/l (as Ca CO_3	175	90
Ca Hardness, mg/l (as Ca CO_3)	394	100
Total Hardness, mg/l (as Ca CO_3)	1044	188
Sulfate, mg/l (SO_4)	710	90
Nitrate, mg/l (NO_3 as N)	59	1.10
Nitrate, mg/l (NO_2 as N)	< .01	.06
Amonia, mg/l (NH_3 as N)	< .1	5.05
Color, Ft-Co units	< 5	45
Turbidity, J.T.U.	4	14
B.O.D., mg/l	< 1	9
Dissolved Oxygen, mg/l	9.6	6.8
Total Bacteria, per ml	4	688
Total Coliform, MPN/100 ml	22	38
Suspended Solids, mg/l	8	15
Dissolved Solids, mg/l	425	330
Phosphate, mg/l	< .01	3.0
Iron ug/l	30	900
Manganese ug/l	400	600

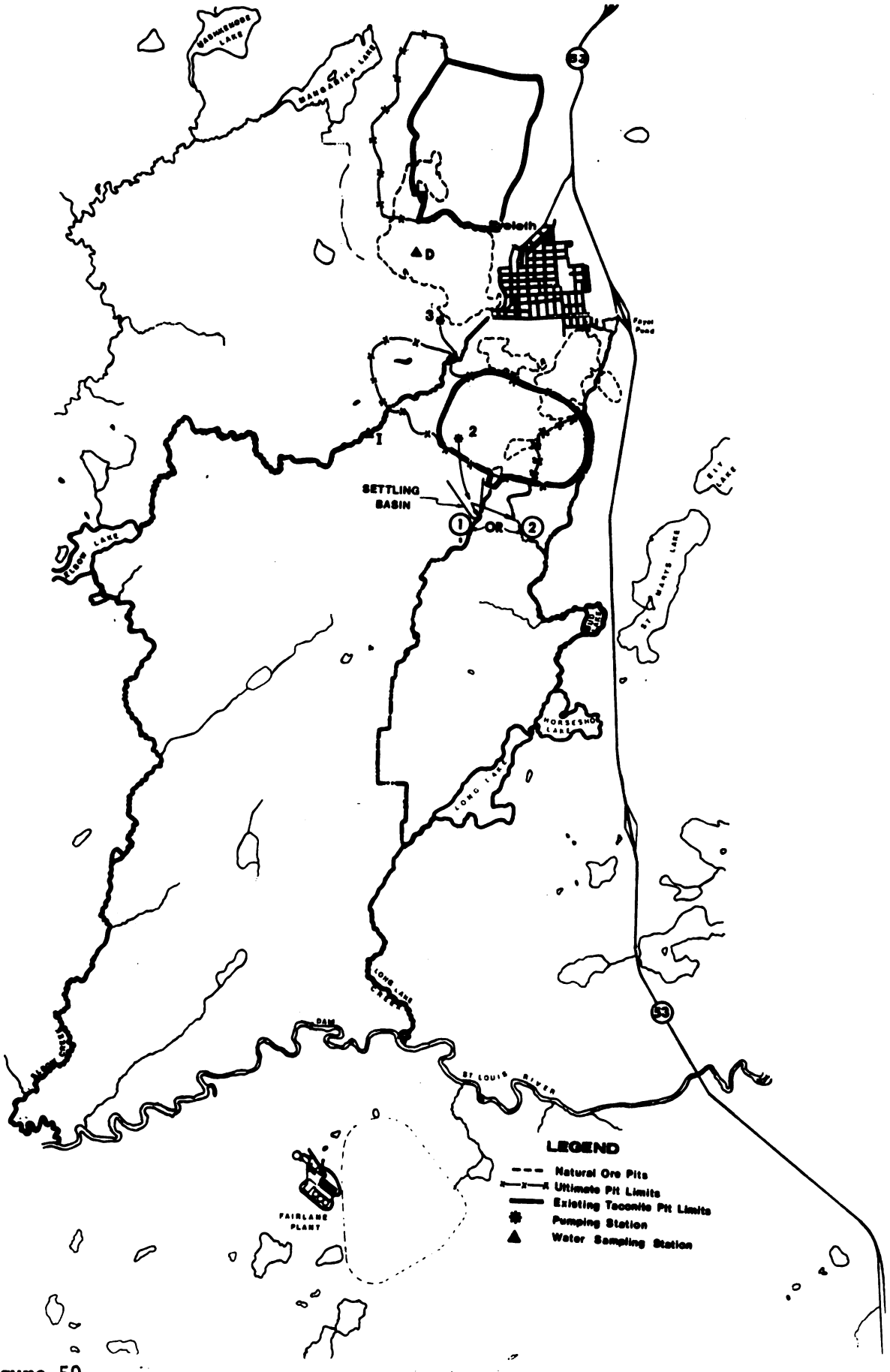

Figure 59
In addition to pump 2 discharging to alternatives 1 or 2, pump 3 is discharging to the unnamed creek to Elbow Lake

In general, the water quality difference between the pit water and receiving waters are the same as in discharge 1. The Leonidas, Hull-Nelson, Spruce pit is higher than the other pit samples in hardness and sulfate and not as high in manganese. Again the pit water is low in nutrients while the natural water is high in nutrients. The impact of manganese does not appear to be a problem here. As can be noted in the water quantity section, the discharge volume, although small, is significant compared to the normal flow of the stream. The efficiency of flushing on Elbow Lake's water quality and the hydrologic volumes have not yet been documented. It is known that Elbow Lake often suffers from winterkill and is considered to be a nutrient polluted lake. It is expected that mine waters flowing to Elbow Lake will lower the nutrient levels of the lake and flush it to some degree. Probably this chemical quality change will bring a rise in overall lake quality.

Manganika Lake Discharge

The third discharge will be from an old mine shaft (pump station 4) to Manganika Lake via an unnamed creek. (Figure 60).

Presented in Table 66 are the water quality results of samples taken in the Leonidas-Hull-Nelson-Spruce pit complex, and the inflow and outflow of Manganika Lake. Data on Manganika Lake has been requested. (Page 248).

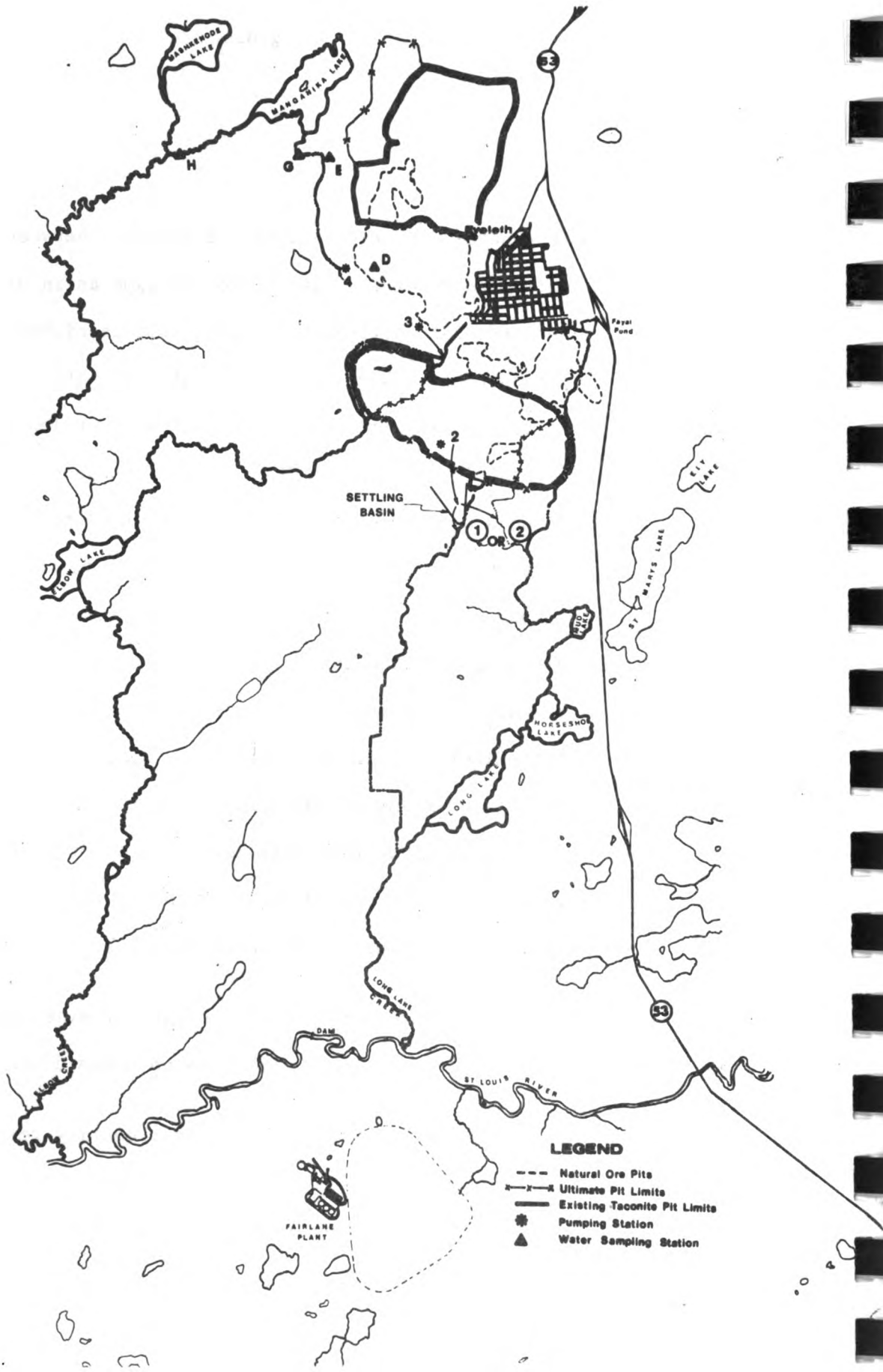

Figure 60

In addition to those discharges in figure 58, pump 4 is discharging to Manganika Lake

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Table 66

Location	Spruce Pit Complex	Unnamed Creek		Manganika Lk. Outflow
Station	D	E	G	H
Date	5/24/74	7/17/74	5/24/74	5/24/74
pH	7.6	7.6	8.0	9.1
Total Alkalinity, mg/l (as Ca CO_3	175	328	144	111
Ca Hardness, mg/l (as Ca CO_3)	394	416	138	90
Total Hardness, mg/l (as Ca CO_3)	1044	964	334	176
Sulfate, mg/l (SO_4)	710	467	174	65
Nitrate, mg/l (NO_3 as N)	.59	.21	2.30	1.17
Nitrate, mg/l (NO_2 as N)	<.01	.06	<.01	.04
Amonia, mg/l (NH_3 as N)	<. 1	.96	<. 1	<. 1
Color, Ft-Co units	< 5	50	50	50
Turbidity, J.T.U.	4	4	3	5
B.O.D., mg/l	< 1	2	1	9
Dissolved Oxygen, mg/l	9.6	7.2	9.8	11.7
Total Bacteria, per ml	4	944	11	32
Total Coliform, MPN/100 ml	2.2	38	15	38
Suspended Solids, mg/l	8	16	2	13
Dissolved Solids, mg/l	425	1504	508	287
Phosphate, mg/l	<.01	2.5	.11	.40
Iron ug/l	30	600	163	119
Manganese, ug/l	400	8400	400	180

The ground water discharged, would be similar to sample D, except that the suspended solids would be removed thus lowering total solids and turbidity. Manganika Lake receives sewage from Virginia as well as from Eveleth. Winterkill is a problem. It is anticipated that lake quality improvement will occur due to the mixing of the infertile pit waters with the overly fertile existing waters.

Impacts

It is probable that the pit waters when discharged to the surrounding waters will lower the nutrient levels of the waters, raise the ionic concentrations, necessitate adaptation by the aquatic community and in general, improve the quality of the waters.

The high nitrate levels found in mine waters should be monitored to observe their possible impact on nutrient levels in the surrounding waters, in light of the desire to reduce the biological productivity of these lakes.

Erosion & Runoff

Erosion and runoff from stockpile areas will be high in turbidity and suspended solids. Some increase in total dissolved solids can be expected. Most of the eroded material will deposit when the water velocity decreases. This can cause sedimentation problems in the immediate area of the piles. If the runoff has an established channel upon reaching the bottom of the pile, turbidity and suspended solids in that body of water will be

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higher than surrounding natural waters. When the suspended material includes iron oxides the water has a rusty color. This is the "red water" often associated with iron mining operations.

Techniques for controlling erosion and runoff have been described on page 222 under the title "Soil Stockpiling". When these techniques are successfully employed, water leaving the stockpile area will be sub-surface runoff. These ground waters are expected to be similar in quality to the natural ground waters in the area.

Tailings Basin Seepage

There is a potential for water quality degradation from tailings basin seepage. Results from samples taken around the existing tailings basin are shown in Table 67. Sample locations are shown in Figure 61.

Based on the limited available data, it appears that the seepage from the tailings basin is higher in total manganese and total dissolved solids than the surrounding water represented by station M. A decrease of these high levels of dissolved solids and manganese can be seen as the sampling locations are moved away from the seepage source. This decrease is probably due to a combination of dilution and precipitation.

Table 67

Location	Tailing Basin Seepage	Outflow Little Tony LK.	Downstream St. Louis	Upstream St. Louis
Station	O	N	L	M
Date	7/24/74	7/24/74	7/24/74	7/24/74
Suspended Solids, mg/1	13	8	32	16
Dissolved Solids, mg/1	763	442	238	
Copper, ug/1	2	4	10	5
Iron, ug/1	101	122	211	102
Manganese, ug/1	500	65	8	4
Nickel, ug/1	8	9	11	9

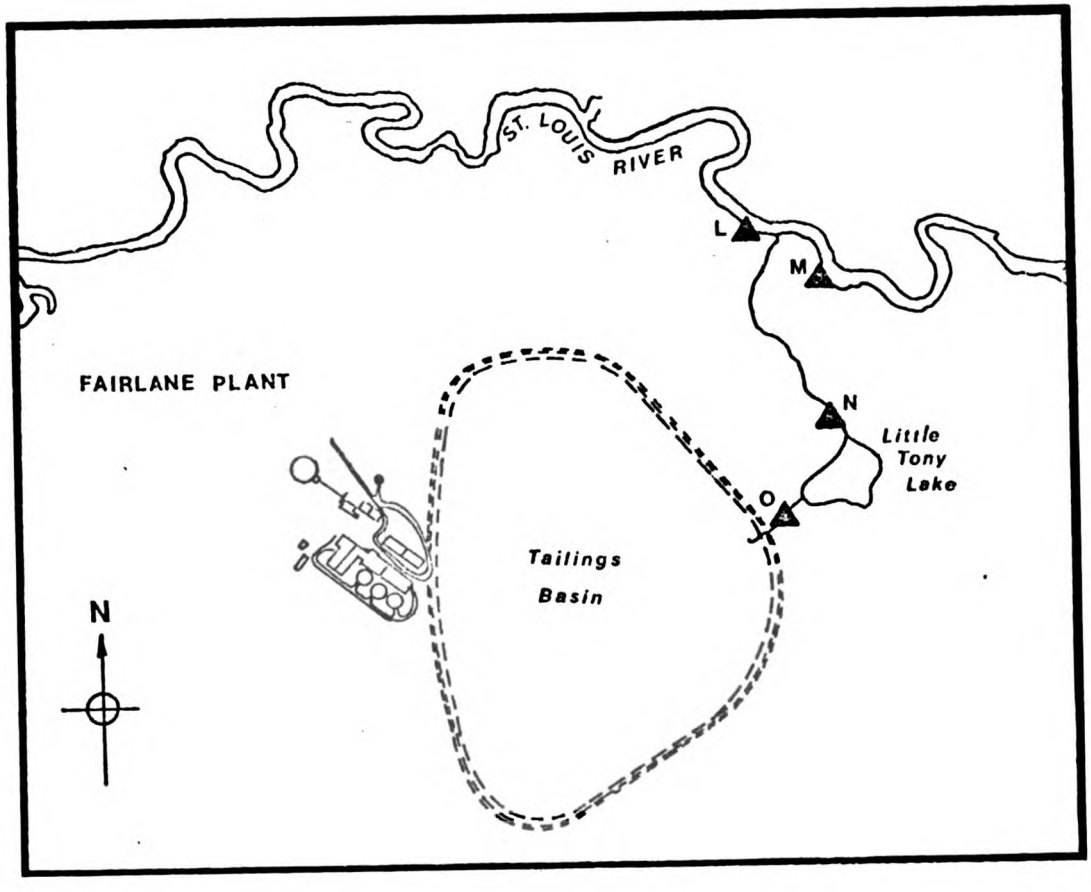

Figure 61 Sampling locations for tailings seepage analysis

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Studies conducted by Reserve Mining Company (3) (4) and the EPA National Water Quality Lab (5) (6) on Reserve Mining Company's tailings indicate that tailings are not inert but actually dissolve at a slow but measurable rate. Calcium, magnesium, sodium, alkalinity, mangaense and silica are the major constituents composing the soluble portion.

The dissolved components of the seepage from the basins are not filtered by the dike material. However, the dike material will help reduce turbidity and suspended solids to a satisfactory level. The seepage will be of lower quality than the surrounding water quality and is expected to be elevated above the natural surrounding waters in total manganese and in total dissolved solids (5). This seepage must meet PCA regulations or be collected and treated.

Overflow

Since tailings basins become more and more efficient in sealing as the slimes build up, overflow of the basin at the end of operation can be expected. Oglebay Norton intends to cut a drain to the side of the basin to prevent overflow. It is desirable to drain these waters from the completed tailings basin into the active basins, so that the water can remain within the closed system of the plant and the completed basin can be reclaimed. When production ceases, Oglebay Norton intends to install their draining system so that it can drain through the coarse cob pile adjacent to tailing basin 3 (Figure 62). This should provide some suspended solid removal before the water is

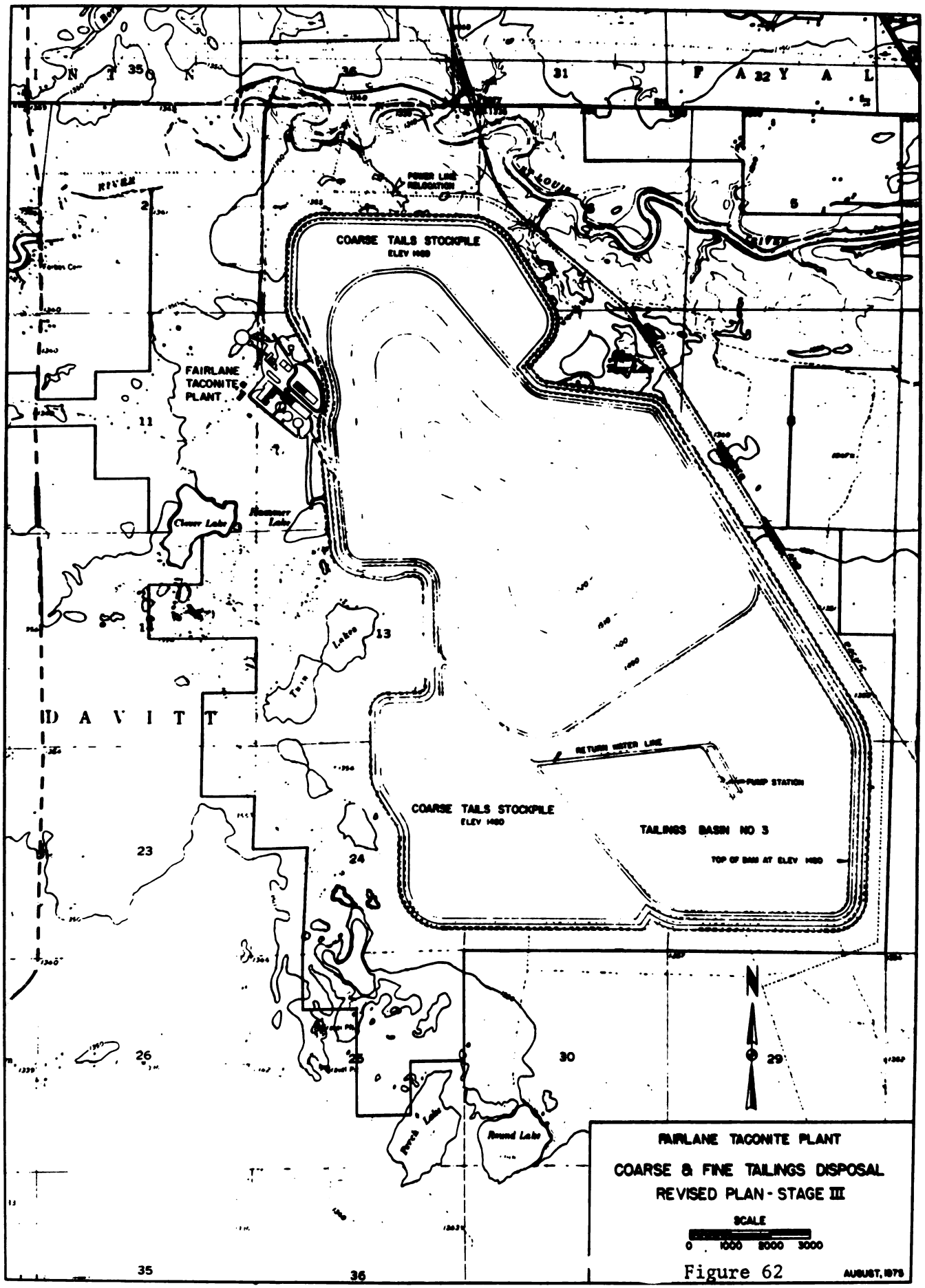
COARSE TAILS STOCKPILE
ELEV 1480
FAIRLANE TACONITE PLANT
COARSE TAILS STOCKPILE
ELEV 1480
TAILINGS BASIN NO 3
TOP OF DAM AT ELEV 1480
RETURN WATER LINE
PUMP STATION
POWER LINE RELOCATION
DAVIDT
FAIRLANE TACONITE PLANT
COARSE & FINE TAILINGS DISPOSAL
REVISED PLAN - STAGE III
SCALE
0 1000 2000 3000
AUGUST, 1975

Figure 62

discharged. This water is expected to be of a quality similar to the seepage described above.

Impact

The seepage and overflow waters from the tailings will be of lower quality than the surrounding waters.

Diversions & Stream Crossings

There is significant potential for disturbing the existing water quality of streams when they are crossed or diverted. The main problem is increased erosion, and the resulting increase in turbidity and suspended solids. This condition is usually temporary and lasts only until the stream channel reaches a new equilibrium. However, the increased amount of suspended material adversely affects fish and aquatic vegetation.

Impacts can be minimized if the construction occurs during periods of low flow and when the fish are neither hatching nor spawning. Additional mitigating measures that can be employed for diversions are:

1. Rip-rap the banks and channel to minimize erosion.
2. Construct a series of bends in the channel to reduce flow velocity and provide a variety of aquatic habitats.

References on Water Quality

1. Environmental Studies Board for the U. S. Environmental Protection Agency, "Water Quality Criteria 1972."

2. Conference on Toxicity to Biota of Metal Forms in Natural Waters, International Joint Commission, Duluth, Mn. Oct. 7-8, 1975.

3. July 13, 1971 - Lake Superior Water - River Water Comparison Leaching Test using dry cobbed taconite tailings. Reserve Mining Company Memorandum from D. M. Wagner to K. M. Haley.

4. January 13, 1972 - Lake Superior Water - River Water Comparison Leaching Test using dry cobbed taconite tailings. Reserve Mining Company Memorandum from D. M. Wagner to K. M. Haley.

5. Glass, G. E. April 29-30, 1970. Effects of taconite tailings on Lake Superior in Conference on the matter of pollution of Lake Superior and its tributary basin. U. S. Department of the Interior, Federal Water Quality Administration. 1:309-304.

6. Glass, G. E. April, 1973 (Data Report). Analysis and laboratory experiments with taconite tailings in studies regarding the effect of the Reserve Mining Company's discharge on Lake Superior, May 2, 1973, U. S. Environmental Protection Agency.

7. Mount, D. I. April, 1973 - A summary of the Studies Regarding the Effect of the Reserve Mining Company Discharge on Lake Superior, in studies regarding the Effect of the Reserve Mining Company's discharge on Lake Superior, May 2, 1973. U. S. Environmental Protection Agency.

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Mineral Development

If the action progresses as planned, a significant impact affecting the future use of several iron ore reserves and some potential iron resources will occur. The natural ore mines in the Eveleth area, all of which will be affected (see description of the action - waste disposal areas), are reported by the University of Minnesota's Mining Directory to contain available natural ore reserves (see table on next page).

Covering a Resource

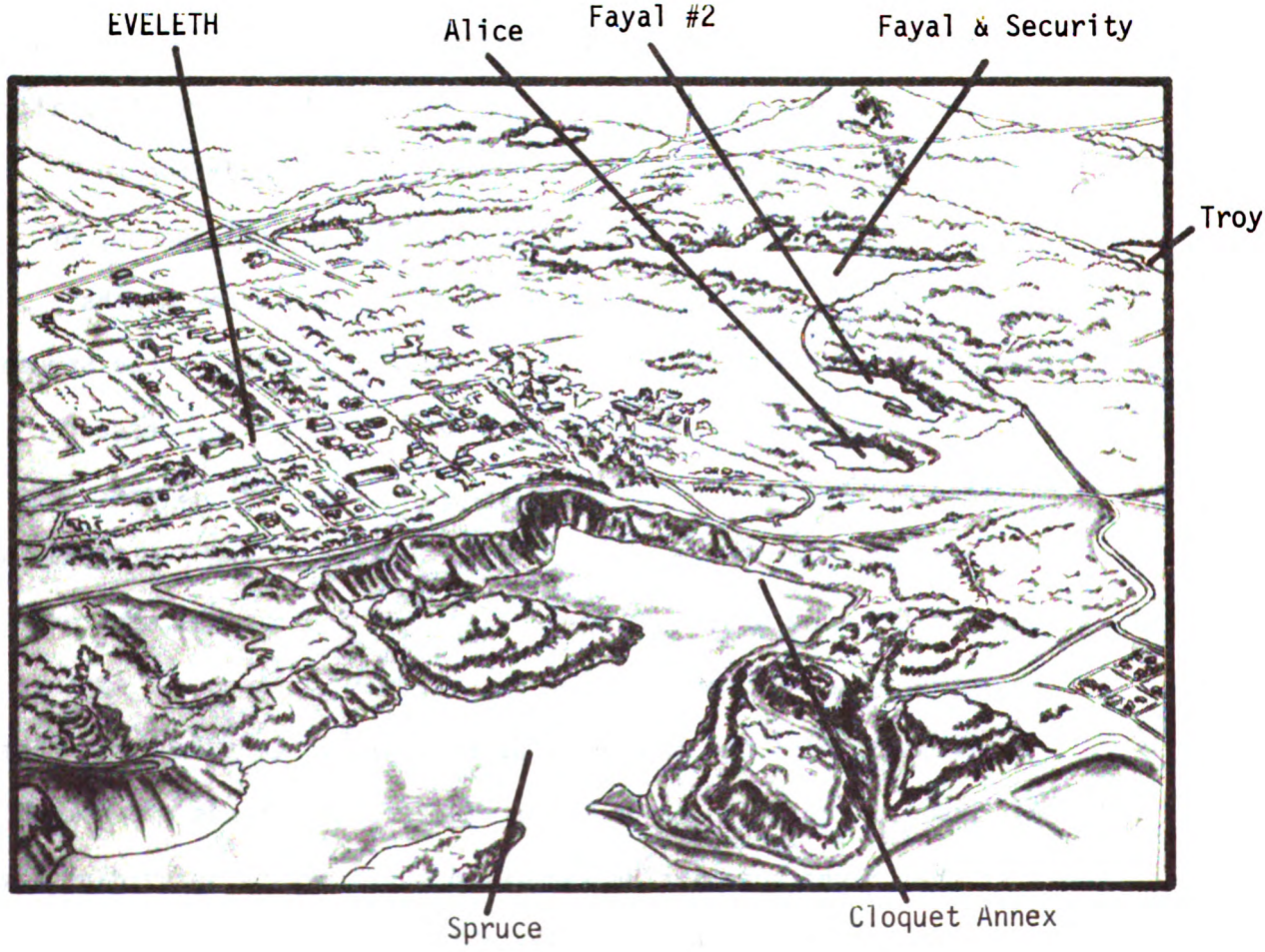
Oglebay Norton anticipates that many of these reserves will be developed during the life of its expanded operations. For example, the company plans to mine and stockpile any natural ore, from the Troy and Security Mines, which is encountered during the stripping operations. In addition it expects that other operations will mine the ore from the Cloquet Annex (south end of Spruce Mine), the Leonids and the Gross-Nelson Mines. No additional plans, however, have been developed which would utilize the other natural ore reserves in the area. In addition to these natural ores, the company reports that a small amount of magnetic taconite, which might be equivalent to a few months production from its expanded operations, is located in the Spruce Mine. This reserve, however, will not be mined or processed. Instead Oglebay Norton intends to cover it, as well as the areas containing unmined natural ores, with waste rock and overburden as part of its mine waste disposal plans. If the natural ores and magnetic taconite reserves are amenable only to open pit mining, implementation of the company's plans would waste these resources. If, however, they can be mined by underground methods the possibility that they might sometime be recovered still exists, providing the overlying stockpile does not make this impossible.

Available Natural Ore-Eveleth Area

Property or Mines	Tonnage Available	Type
Alice Mine	51,288	U.G. Hry Med.
Cloquet Annex	1,345,500	U.G. Dir. Shp.& Wash.
Fayal Mines	168,638	U.G. Dir. Shp., Wash & Hvy. Med.
Gross-Nelson	16,629	O.P. Hvy. Med.
Hull-Nelson	54,200	U.G. Dir. Shp.
Leonidas Mine	870,810	U.G. Dir.Shp.
Pearsall Mine	76,577	O.P. Hvy. Med. & Wash.
Security Mine (south Fayal)	794,114	O.P. Dir. Shp. & Wash. U.G. Dir. Shp.
Spruce Mine	928,544	O.P. Dir. Shp. & Wash. U.G. Dir. Shp. & Wash.
Troy Mine	62,110	O.P. Hvy. Med.
Total	4,718,964	

Key: O.P.-Open pit
U.G.-Under ground
Dir. Shp.-Direct shipping ore
Wash.-Wash ore
Hvy. Med. Heavy media ore

Figure 63 Aerial view of Eveleth mines



Commingling Iron-bearing Material

The reserves which will be buried are not the only potentially economic minerals which the action will affect. The waste rock which is to be dumped into the pits consists of non-magnetic taconite which might some day be utilized as an iron ore. Ordinarily disposing of this rock in a stockpile, or using it to fill a pit would not greatly detract from its possible future use. However, the current plans of Oglebay Norton call for commingling this iron-bearing material with surface overburden. This action might so contaminate, or degrade, the non-magnetic taconite that it may be rendered unacceptable for future use.

It is presently the policy of most "fee" owners including the DNR, which administers state owned minerals, that if during the development of an ore body mineralized material must be placed over other mineralized material either in place or in an existing stockpile, the material which is being deposited must be of equal or better value than the underlying material. Further if stockpiling precludes the use, or diminishes the ease of future access to mineralized deposits, the action is generally not permitted. At the present time it appears doubtful that these policies would be significantly altered to facilitate Oglebay Norton's mining plan. Therefore some modification's of waste deposition plans such as in the case of potential open pit magnetic taconite located in the state owned Leonidas property, will have to be made. Oglebay Norton is aware of the attitudes of the mineral owners and has therefore listed the benefits which both the mineral fee owners and the company can receive if its plans are developed. These benefits, insofar as the mine operator and mineral fee owner are concerned extend to:

(For the Operator)

1. A shorter haul and less lift, thus realizing savings in haulage cost of the waste materials.

2. Lesser cost for dump maintenance due to depth-area relationship of dump site.

3. Greater utilization of dump volume through comingling of surface and rock with resultant partial filling of voids.

4. Elimination of water pools and caved areas thus reducing the hazards to the public and obviating the need for installation and maintenance of fencing.

(For the Fee Owner)

5. An opportunity to realize immediate revenue through compensation for the loss of potential royalty revenue from the remaining iron formation materials that, in all liklihood, will never be mined.

6. Realization of the benefits achieved by elimination of hazardous areas upon termination of the lease or dumping agreement.

7. Increase in surface values and possibility of additional revenue upon sale of the surface following reclamation.

These benefits may be very attractive to the fee owners and the fee owners may utimately accept the company's plans. However, this does not negate the potential loss of the mineral resources.

Several mitigative measures might be considered:

*Place only material of equal or higher value on the underlying material.

*Segregate waste rock form surface overburden.

*Delineate areas having natural ore or magnetic taconite potential and avoid if possible dumping in these areas.

*If dumping must occur atop resources, leave the area free of stockpiles until absolutely necessary, thus prolonging their potential for utilization.

*Remove the potential iron units before using area for waste disposal.

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Dam Failure

The structural stability of a tailings basin is a definite concern when assessing the impacts of an action which will utilize such a structure. Naturally, depending on the surroundings in the basin area, a structural failure could produce varying magnitudes of detrimental effects. However, with the basins that are being considered for magnetic taconite operations along the Range, a failure at any site would be unacceptable. The potential loss of property, and the safety hazards that would result from a failure would be extremely devastating.

Although a failure at Oglebay Norton's basin could result in major property losses, the basin's relatively remote location, as well as the surrounding topography, help minimize the safety hazards. The company's proposed basin is located in a broad flat bog with no defined downstream paths (stream valleys) through which water and shines tailings could flow if a dike were to rupture. Instead, the water would probably spread out on the flat landscape, thus dissapating their potential energy. In addition, no communities or homesteads are located in the immediate area, or along the banks of the nearest watercourse, the St. Louis River, for several dozen miles downstream of the basin. The main area with human involvement which is in a vulnerable area is the Fairlane Plant, lying immediately adjacent to the basin.

Several major natural and man-made features could be affected by a failure. The natural features include:

the bog outside the confining dikes
a series of lakes which ring the basin, and
the St. Louis River.

The man-made features include:

a railroad (the Duluth Winnipeg and Pacific)
a major powerline, and
the Fairlane Plant.

The only acceptable way to mitigate the effects of a dam failure is to assure that a stable basin will be built. This can only be achieved by properly designing the dams, and constructing the basin to meet the design specifications. To date, such designs have not been presented by the company. Only a conceptual idea of the basin has been developed. However, before the permits can be reviewed the design plans will have to be supplied.

The DNR and PCA have repeatedly requested information on the dam stability and related water seepage factors. In an attempt to provide such data the company has begun a sampling program which should provide a general idea of the capacity of the underlying foundation soils to maintain the loading caused by the dams. When such information becomes available, further analysis of the entire basin's stability can be made and evaluated. If this information becomes available before the hearing on this draft EIS and is deemed adequate by the permitting agencies, the hearing might be expanded to include a hearing on the permits.

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1) SOCIO-ECONOMIC IMPACT

Forecasts of future range population were presented earlier in Tables 10 and 11. These estimates for 1990 ranged from 66,340 to 71,740 for the entire Main Range area. In the immediate project area of Eveleth and Fayal Township, the 1990 population is expected to range from 8210 to 9130 with McDavitt Township expected to continue to show a decrease in population. The population figures for these areas are repeated below:

	1970	1990 Range
Main Range	58,654	66,340-71,740
Eveleth	4,721	3,480- 5,180
Fayal Township	2,025	3,960- 4,730
McDavitt Township	426	220

The future population associated with the Eveleth Expansion Company's activities includes those persons in the temporary construction work force as well as the permanent employees needed to operate the new facilities. This permanent work force will be double the present size and has been estimated at between 800 and 900 employees. It is expected that construction will have been completed by late 1976-early 1977 and that the facilities will be fully operational by 1980.

Assuming an average family size of three persons, the population directly related to permanent employment at the Eveleth Expansion Company facilities would range from 2400 to 2700, or double the current number. This should be considered

a maximum population since family size has shown a decrease in recent years, and there has also been a significant increase in the number of women in the labor force.

The number of non-basic jobs generated by employment in the taconite industry has been estimated at .47 by ARDC. That is, for each 100 jobs in the taconite industry another 47 jobs are generated in such fields as retail trade, services, government, etc. Using this multiplier the indirect employment stimulated by the total permanent employment at the Eveleth Expansion Company facilities would be between 375 and 425. Related population would be between 1125 and 1275 and the total population associated directly or indirectly with the project between 3525 and 3975.

Current population linked directly or indirectly with the Company's operations is estimated at about 1800. The project then will add some 1700 - 2200 persons to the area's population. This would represent about 16 percent of the 1970 - 1990 population increase on the Main Range using the high forecast figure of 71,740.

Construction employment on the project is expected to peak in December of 1975 with some 840 workers on the job. There will be a buildup towards this peak through the balance of 1975 and then construction employment will taper off. Table 68, which gives the manpower projections by craft, indicates a total of 14,967 man-months of construction work with the requirements for laborers, iron workers, and electricians the highest.

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TABLE 68

Manpower Projection By Construction Craft

	1975 June	July	August	Sept.	Oct.	Nov.	Dec.	1976 January	Feb.	March	April	May	June	July	August	Sept.	Oct.	TOTAL For PROJECT
Boilermakers	2	15	20	35	40	70	65	40	20	10	5	5	5					413
Bricklayers	5	7	7	0	0	0	5	10	16	30	30	20	20	15	9			164
Carpenters	110	92	78	70	63	52	52	42	42	42	37	35	30	30	30	25	15	1,742
Cement Fin.	12	12	11	10	9	9	9	7	7	7	7	6	6	6	6	6	4	285
Electricians	48	72	73	100	128	142	157	157	168	177	188	207	220	180	140	70	50	2,247
Ironworkers	99	105	125	160	189	179	177	156	148	146	134	120	100	80	70	40	25	2,304
Laborers	103	94	85	73	73	73	73	73	73	78	78	70	65	60	60	60	60	2,372
Millwrights	16	20	30	35	57	65	70	80	90	100	100	85	90	100	90	80	40	1,294
Oper. Engr.	112	73	65	55	47	43	38	33	32	33	35	32	34	30	30	20	10	1,302
Painters	12	12	12	12	10	13	13	13	15	15	15	10	10	10	8	8	6	176
Pipefitters	32	44	54	69	79	94	104	114	114	124	124	120	130	120	100	90	50	1,624
Sheetmetal	15	15	25	36	56	59	54	55	59	46	36	25	20	20	20	10	10	564
Teamsters	27	27	27	29	29	29	27	26	24	21	21	18	15	12	10	8	6	480
TOTAL	593	588	612	684	780	828	844	806	809	829	810	753	745	663	573	417	276	14,967

(Man Months)

The peak for all construction projects on the Range is expected to occur in the third quarter of 1976 with some 8025 workers employed at all taconite projects and other construction jobs on the Range. The peak employment at the Eveleth Expansion Company project amounts to about 15 percent of estimated total construction employment in the first quarter of 1976. The projected labor demands for these various construction projects is shown in Table 69. The Table indicates the total projected labor demanded in each quarter of each of the next four years for each of the major taconite companies. Although the labor demands refer to labor for construction work, it also indicates the number of persons demanded for permanent taconite labor. The permanent employment in 1979 will be 3450 jobs for all companies.

As indicated in Table 68 , some of the construction jobs involved on the Eveleth Expansion Company project require relatively lower skill levels and are being filled locally from the existing work force in the area. Other crafts are more highly skilled and will have to be filled by construction specialists imported from beyond the Range specifically for this and other taconite projects. It is this latter group, which will affect population temporarily, that is the most difficult to estimate. Some will be employed for the life of the project, while others may work for only a short period. Some may move on to similar projects in the area once the Eveleth Expansion project is completed. Some will be weekend

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TABLE 69

Projected Iron Range Labor Demand*

Constr.	Projects	1975 1	1975 2	1975 3	1975 4	1976 1	1976 2	1976 3	1976 4	1977 1	1977 2	1977 3	1977 4	1978 1	1978 2	1978 3	1978 4	1979 1
United	-Hibbing Tac.	812	1250	1800	1300	1300	1400	1300	1900	1400	1450	1500	1900	1400	1300	1300	50	--
Bechtel	-Natl. Stl. Plt.	921	989	1242	940	800	950	1200	900	200	--	--	--	--	--	--	--	--
	-Inland/Minorca	50	300	340	320	250	600	780	800	650	800	700	--	--	--	--	--	--
	-(Butler-Cooley)	--	--	--	--	--	--	50	400	500	900	1200	1100	800	1000	1200	1300	900
U.S. Steel	-Minntac Phase III	40	40	500	880	800	1500	2000	1800	1800	1100	1300	700	50	--	--	--	--
A.B.I.	-Fairlane (Ev. Tac.)	344	450	600	750	800	800	200	40	--	--	--	--	--	--	--	--	--
	-Thunderbird (Ev. Tac.)	75	75	100	150	250	250	300	20	--	--	--	--	--	--	--	--	--
Sub-Totals		2242	3104	4582	4340	5210	5500	5830	5860	4550	4250	4700	3700	2250	2300	2500	1350	900
A.B.I.	-Blandin Exp.	327	330	320	20	--	--	--	--	--	--	--	--	--	--	--	--	--
Housing Contrs. Areawide		40	260	400	280	120	220	320	240	60	180	240	240	30	100	120	130	40
Other Misc. Constr.		35	96	125	120	35	95	125	120	30	200	300	400	120	200	260	320	100
Sub-Totals		402	686	345	420	155	315	445	360	90	380	540	640	150	300	380	450	140
Total Constr. Labor		2754	4150	6027	5980	5765	7315	8025	7720	6140	6330	6340	5640	2400	2500	2880	1800	1040
Permanent Tac. Labor		--	--	--	100	250	300	1100	1500	1800	2100	2200	2400	2900	3150	3200	3450	3450
GRAND TOTALS		2644	3790	5427	5360	4615	6115	7875	7720	6940	6730	7440	6740	5300	5750	6080	5250	4490

*Construction labor force consists of prime contractors employees, plus supervisory personnel, plus sub-contractors.

Source: ARDC, Assessment of Growth Impacts on the Iron Range, June 1975 (Based on survey of primary sources on April 1971).

commuters, staying in rented quarters during the workweek and leaving their families at home. This is the general experience of most large construction projects of this nature.

Accurate information to assess this situation is not available. Therefore, it is assumed that half the peak construction work force of 840 workers would be imported craftsmen and that half of these would bring their families with the remainder being weekend commuters. On this basis the maximum population, because of the project at its peak construction time, would be 840 persons, and total population, including those already residents of the area, would be 2100. Again the estimates assume an average family size of three persons. These calculations are summarized below:

Workers at peak construction	840
Local residents	420
Imported craftsmen	420
Weekend commuters	210
With families	210
Population-Local labor force	1260
Population-Imported craftsmen	630
Population-Weekend commuters	210
TOTAL POPULATION	2100
Population Associated with Project	840

How much of this temporary and permanent project related employment will reside in the immediate area of Eveleth and Fayal Township will depend on a number of factors, most of which are not predictable. These would include such things as personal lifestyle preferences, the availability of housing, sales and rental prices of housing, taxes, the importance attached to commuting time and the importance attached to schools, recreational opportunities and other community facilities.

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Total employment in the Range taconite industry more than doubled between 1964 and 1973 as shown in Table 70. Another 4795 workers will be added by 1984. Total employment in taconite by 1984 is expected to reach 15,510. Of this total, 7550 workers will be on the Main Range, about 5000 on the East Range, and 1960 in Itasca County. The East Range figure includes Reserve Mining's employment at the Peter Mitchell Mine in Babbitt. Employment at the Eveleth Expansion Company's facilities is shown at 900 by 1984.

An earlier table, Table 69 , which gave the construction labor demands on the Range over the next several years also presented estimates of the buildup of new permanent employment at the taconite facilities to become operational through 1979. By that year some 3450 new jobs in taconite will have been added throughout the entire Range area.

The increase in taconite employment for the Range by 1984, as already noted, will be about 4800 workers. Within the Main Range the increase in employment is estimated at 3825, more than double the present number. An additional 1790 jobs would be generated in other employment sectors using the multiplier of .47. Total new employment including those in the service and taconite industries, would be about 5600. Total new employment created by the Eveleth Expansion Company project would be between 580 and 740, or approximately 14 percent of the total added new jobs.

The secondary or spin-off employment impacts of the construction work force on the Range taconite projects are more difficult to estimate. Those construction workers who are

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TABLE 70

Mining Industry Growth in N.E. Minnesota

		TONNAGE (millions)			EMPLOYMENT			CAPITAL INVESTMENT $ MILLIONS		
		*1964	1973	1984	1964	1973	1984	1964	1973	1984
1.	Minntac (U.S. Steel)	.75	12.50	18.5	500	3250	4100	50	275	200
2.	Erie Mining (Bethl. & PM)	7.50	10.50	10.7	2400	2850	3000	300	350	5
3.	Reserve (Armco & Republic)	6.50	10.80	10.8	2500	3000	3000	210	350	70
4.	National Steel (Hanna)	--	2.80	6.0	--	580	1000	--	90	150
5.	Eveleth Tac. (Oglebay-Norton)	--	2.40	6.0	--	475	900	--	45	110
6.	Butler Tac. (Hanna)	--	2.40	2.5	--	560	560	--	56	--
	Snowball Lake? (Hanna)	--	--	3.0	--	--	400	--	--	150
7.	Hibbing Tac. (Bethl. & PM)	--	--	6.0	--	--	1250	--	--	200
8.	Minorca (Inland Steel)	--	--	2.6	--	--	500	--	--	90
9.	McKinley (Jones & Laughlin)	--	--	2.5	--	--	500	--	--	100
10.	Empire (Detroit Steel)	--	--	1.5	--	--	300	--	--	?
	Taconite	14.75	41.40	70.1	5,400	10,715	15,510	$560	$1,166	$1,075
11.	Natural Ore - All Companies	30.40	15.30	7.3	2,750	1,885	1,100	N/A	N/A	N/A
	Totals	45.15	56.70	77.4	8,150	12,600	16,610		$2.8 billion	
12.	Inco	--	--	2.0	--	30	800	--	6	250
13.	Amax (Amer. Mtl. Climax)	--	--	1.0	--	20	400	--	2	100
14.	Amer. Shield Corp.	--	--	?	--	10	?	--	?	?

* Prior to Taconite Amendment by Minnesota Legislature

NOTE: Natural Ore in 1953 Produced 31.5 million tons with 18,000 employees

Source: ARDC, 1975

already residents of the area will not be creating new or additional demands for goods and services that cannot be met by existing stores, service establishments or local governments with their existing employees and facilities. Some additional demand will probably be generated through those workers from outside the area on a short or long term temporary basis. For those without families, the weekend commuters, this will probably be limited to demands for housing facilities, eating and drinking, and personal and entertainment services that can be met by existing employees in these sectors or with limited additional employment drawn largely from the existing resident labor force.

Those outside construction workers with families will be the primary factor in creating additional, although temporary, new employment in other sectors. Using the same assumptions followed previously with regard to the Eveleth Expansion Company project, some 2000 construction workers of the projected Range peak of 8025 can be expected to reside in the area with their families on a semi-permanent basis. Associated population, again on the basis of a three-person family, would be about 6000. A population of this size would create short-term demands for goods and services that might result in additional temporary employment in the service or non-basic employment sectors.

The number of employees in the trade and service categories of employment, including government, was 10,883 in 1970 on the Main Range. On the East Range it was 972. The number of workers in these categories per thousand population then was 185 and 105

respectively. Using these figures secondary short-term employment in the trades and services generated by the construction work force with families could range from 1630 to 1100. This would be about a ten percent increase over 1970. The temporary increase would be spread over the area and, assuming the 1970 employment distribution, would mean the following numbers of employees in the various categories.

Trade	230
Finance, insurance, real estate	80-140
Personal, business, entertainment services	235-410
Professional services	40 -70
Public administration	45 -80

On the basis of these same assumptions, the peak construction force on the Eveleth Expansion Company project could generate some 90 to 150 temporary jobs in these same categories.

Almost all of these additional employees could probably be drawn from the existing unemployed labor force or from that segment of the population which is not now participating in the labor force. The categories of employment shown, particularly trade and the non-professional services, rely heavily even now on women employees and part-time workers.

Employment at the existing Eveleth Taconite facilities includes 86 salaried and 303 hourly production workers. The breakdown of these workers is shown in Table 70, as well as the number of employees in each category needed to achieve the production objectives of Eveleth Expansion Company. The new facilities will require 51 more salaried and 359 hourly wage earners. Total employment will be 137 and 742 respectively for a total of 879 employees.

TABLE 70 a

Existing and Projected Employment,
Eveleth Expansion Company

Category	Existing	Future	Increase
Staff	11	14	3
Thunderbird	175	381	206
Salary	21	39	18
Operations	101	238	137
Maintenance	53	104	57
Fairlane	169	277	100
Salary	21	28	7
Operations	76	120	44
Maintenance	72	129	57
Maintenance	73	130	57
Salary	11	20	7
Hourly	62	110	48
Research	21	36	15
Salary	2	5	3
Hourly	19	31	12
Accounting, Personnel	20	31	11
TOTAL	469	879	410
Salary	86	137	51
Hourly	383	742	359

Source: Oglebay-Norton Company

The current median annual salary for salaried employees at the operation is $17,875. This is exclusive of fringe benefits such as unemployment compensation, health insurance, social security and similar items which are paid directly by the company. The estimated value of the fringe benefits is approximately $5000 additional. For hourly wage earners, the current median annual wage is $13,944, again excluding company paid benefits which are also about $5000.

At current wage and salary levels, future salaried employment at the Eveleth Expansion Company operations would generate a payroll of over $2.4 million. The payroll for employees on an hourly rate would be over $10.3 million and total annual payroll of $13,795,300. The increase in employment brought about by the expansion will generate a payroll in excess of $5.9 million. These figures are summarized in Table 71 .

TABLE 71,

Current and Projected Payroll
By Class of Worker*

	Salaried	Hourly	Total
Current Payroll	1,537	5,340	6,877
Future Payroll	2,449	10,346	12,795
Increase	912	5,006	5,918

* Payroll in thousand dollars

Source: Oglebay-Norton Company

Federal income tax payments to be paid by employees of the expanded facilities would be in excess of $800,000 with about $370,000 of this accounted for by the added employment. Estimated state income tax payments by employees would be approximately $171,000 with about $80,000 of this from the new employment.[1]

1. Based on average tax per return for St. Louis County in 1970 of $910 Federal and $194 State income taxes. Factors developed by Lichty and Jesswein of UMD in report, The Employment Impact of Reserve Mining Company On the Arrowhead Region of Northeast Minnesota Plus Douglas County, Wisconsin, from data reported in State of Minnesota, Dept. of Revenue, Minnesota State Individual Income Tax, July 1973.

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In addition to income taxes, employees would be contributing to tax revenues of state and local government through the state retail sales tax and local property taxes and others. The annual retail sales tax generated through purchases of the total employment is estimated at more than $250,000 with about $80,000 of this from newly added employment. The amount of property taxes paid would depend, of course, on the location of residence, the assessed valuation of that area and the total mills levied for county, school and other governmental purposes.

The most significant tax impacts will be the result of taxes paid by the Eveleth Expansion Company to the state through the occupation, taconite, royalty, sales and ad valorum taxes. In 1974 the total of these amounted to more than $1.4 million. Since the start of operations more than $5.5 million in taxes has been paid. Table 72 summarizes these tax payments to the state.

TABLE 72

Minnesota Taxes Paid by Eveleth Taconite*

Tax Category	1965-67	1970	1974	Total To Date
Occupation	53	119	279	1,213
Taconite	199	261	669	2,810
Ad Valorem	33	12	19	136
Sales	2	4	219	517
Royalty	88	65	225	901
TOTAL	375	461	1,411	5,577

* In thousand dollars

Source: Eveleth Taconite

The most important of these is the taconite tax which is based on tons of concentrated ore produced. This has accounted for fifty percent of the total taxes paid by the company in the past. The tax has risen to 36¢ a ton with the legislature adding an additional 39¢ a ton this past session. The statutory rates per ton are tied to the wholesale price index which presently results in a 4¢ increase. It has been estimated that the rate will have increased to 49¢ by 1980 and with the additional 39¢ will mean an effective rate of 88¢ per ton of concentrated ore by that date. On the basis of the production goal of 6 million tons of taconite pellets, the taconite tax would yield approximately $5.3 million in tax revenues.

The taconite tax is distributed to the county, municipalities, school districts and other jurisdictions by a legislative formula. Increases in the basic 36¢ per ton rate are to go to municipalities and to property tax relief while the recently added 39¢ per ton is to be distributed to the county, schools, Iron Range Resource and Rehabilitation Commission (IRRRC) and property tax relief only. Table 73 shows the approximate distribution of the 1980 taconite tax revenues generated by the Eveleth Expansion project.

The royalty tax goes to the state General Fund and is set at 15 percent of the ore value. The occupation tax is based on the value of the mining operation less certain allowable deductions which is then taxed at a fixed rate. The revenues go to the state General Fund, the University and the IRRRC. On the basis of the past relationship of the taconite production to all other taxes, it is estimated that the royalty, occupation and

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TABLE 73

Distribution of 1980 Taconite Production Tax*

Recipient	Original Rate	Added 39¢/Ton	Total
County	240,000	600,000	840,000
Municipalities	540,000	0	540,000
Taconite Municipal Aid*	480,000	0	480,000
Property Tax Relief	1,200,000	480,000	1,680,000
School Districts	480,000	1,200,000	1,680,000
IRRRC	60,000	60,000	120,000

*Distributed range-wide
Source:

all other taxes paid by the company could amount to another $5.3 million and total taxes to more than $10 million by 1980.

In addition to the employment and taxes generated by the added operations of the Eveleth Expansion Company, the new facilities will have a beneficial effect on the area and state economy through the purchases of the company and its workers. Much of the plant equipment will be manufactured on the Range or elsewhere in Minnesota. Concrete aggregates, lumber and other building materials used in construction will be supplied by local sources. Supplies for plant operations and for the many administrative functions will be purchased locally as will electrical energy and rail transportation service. The energy demands will be supplied by Minnesota Power and Light and the rail transportation services will be supplied by Duluth-Missabe and Iron Range Railroad.

The goods and services purchased by employees, as well as other workers indirectly supported by the Eveleth Expansion facility, will have a more demonstrable effect on the economy.

On the basis of current (1972) average per capita retail sales and service receipts in the four largest Range cities, the future sales resulting from direct and indirect employment would be $11.2 million and service receipts $1.5 million as indicated in Table 74. Both retail sales and service receipts attributable to project-related population would almost double with the increased employment and population. The increase in population directly related to the project would generate some $3.5 million in retail sales and $502,000 in service receipts.

The distribution of retail sales by store type is shown in Table 75 which gives future sales as well as those attributable to the expansion project. Population resulting from expansion of the facilities will generate more than $990,000 in new food sales, $782,000 in general merchandise, and $945,000 in automotive sales. Most of the sales for convenience items, such as food, drugs, gas, building materials, will be spent in the area of residence. The Range cities will be competing with Duluth and other large centers for the retail dollars generated for such comparison shopping items as autos, general merchandise and apparel.

Population growth resulting directly or indirectly from the Eveleth Expansion project, as well as the general growth on the Range that is being stimulated by other taconite projects, will have a major impact on community facilities and housing. The impact on housing is already being felt with the buildup of construction forces on the several projects that are already underway.

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TABLE 74

Estimated Future Retail Sales and Service Receipts Generated by Project Associated Population

	Existing Facility	Expanded Facility	Increase
Population			
Direct	1,400	2,640	1,240
Indirect	660	1,240	580
Total	2,060	3,880	1,820
[1]Retail Sales			
Direct	4,038	7,614	3,576
Indirect	1,903	3,576	1,673
Total	5,941	11,190	5,249
[2]Service Receipts (000)			
Direct	567	1,069	502
Indirect	267	502	235
Total	834	1,571	737

1. Based on 1972 per capita sales average of $2884 for Chisholm, Eveleth, Hibbing, Virginia
2. Based on 1972 per capita receipts average of $405 for same four cities.

TABLE 75

Future Sales by Store Type*

Type	Future Facility	Attributable To Expansion
General Mds.	1,667	782
Apparel	492	231
Furniture	515	241
Automotive	2,014	945
Lumber, Bldg. Material	806	378
Gas	951	446
Food	2,115	992
Drug	325	152
Eating, Drinking	884	415
Other	1,421	667
TOTAL	11,190	5,249

* Sales in thousand dollars

Source: Basic data from U. S. Census Business, Selected Sources and Retail Trade.

As a result of the low rate of new housing unit construction for the past decade as well as the lack of mortgage money and credit generally in the past few years, housing is already in short supply on the Range particularly for low and medium income families. Now vacancies are practically non-existent and there are severe pressures on the area's housing resources. Some of the changes that are occurring because of these pressures are as follows:

-- The conversion of existing single family units to multiple rental units.

-- The substantial increases in sales prices for existing homes which will ultimately be reflected in taxable valuations.

-- Rent increases that will enable landlords to improve their properties but which will also make housing costs more difficult for low and fixed income persons.

-- The increased demand for new building lots which in some cases is being met by lands that are unsuited for residential development because of soil conditions.

-- The development of a rental housing market that is starting to be met by a number of apartment projects but which will change the traditional Range emphasis on single-family home ownership in time.

As indicated in Table 50 in a previous section, more than 3400 new housing units will be needed across the entire Range by 1980. A number of projects are under construction or in the proposal stage that could help satisfy this demand. These include apartment projects which could add some 1190 rental units as well as elderly housing and mobile home parks. Although a number of projects are under construction, there is an immediate

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need for housing. During the time which will be needed to construct the projects, the demand may be filled by a scattering of mobile homes and other temporary housing. This may have a major impact upon the existing community facilities.

The Eveleth Expansion Company project will add 410 employees to the permanent employment in the area. An additional 190 employees could be added in other sectors because of the project for a total of 600. Some will be newly entering the labor force and already housed in the area, while in other cases two or more of these new employees will be from the same family. Assuming that fifty percent of the new employees fall in these categories, there would still be a demand for some 300 housing units.

New apartment projects are being considered in the Eveleth, Virginia and Mountain Iron areas which could help satisfy this demand. There is also land available in the Fayal, Mountain Iron and Gilbert area that is considered suitable for residential development. Table 53 indicated that these three areas could accommodate 1700 units at prevailing single family densities. The Fayal area, east of US 53, alone has a holding capacity for 600 single family units.

The impact of project related population alone on the incorporated municipalities and their community facilities is not considered significant. All of the communities in the project area have land that could be developed for housing and maintain police and fire facilities that are adequately manned and equipped. While lines might have to be extended to serve

new developments, the sewer and water utilities have the capacity to serve project-related population with those improvements that have already been scheduled. The hospitals in the area have the capacity for additional patient wards.

The impact of this population on the unincorporated areas within commuting distance of the project could be significant, however. As noted much of the land in the unincorporated areas has soils that are not suited for septic tank operation. Fayal Township, one of the better areas in terms of soil conditions and accessibility, is approaching urban densities around Ely Lake and has been seeking assistance to install sewers. Further development here without utilities might result in degradation of Ely, St. Mary's and other smaller lakes in this chain. Development in the unincorporated areas generally is expensive to serve with school buses, snowplowing and road maintenance because of its low density, widely scattered nature. Further development in some of the more rural areas may result in increased demands for services and higher taxes and interfere with farming or future mining operations. Strictly enforced land use controls could mitigate these adverse impacts.

The combined impact of the several taconite projects underway or scheduled could be significant on community facilities and utilities, depending on where workers locate. With some 5600 new jobs created directly or indirectly by the taconite industry on the Main Range, there will be demands for new or improved services in many of the smaller communities. Utilities in some of these may be overtaxed. Police and fire protection

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may have to be improve.

Estimates of future school enrollment based on expected Rangewide population are shown in Table 76. These estimates assume a continued low birth rate and small family size, a continued decrease in the relation of school enrollees to total population but at a lesser rate and a more normal distribution between elementary and secondary grades than has been the case in recent years because of post-war births. The percentage of population enrolled in public schools is projected to decrease from the 27.4 in 1969-70, to 22.9 in 1973, to 20.0 percent by 1990. The assumed distribution of elementary and secondary pupils is 52 elementary to 48 secondary. These are first approximations and should be used as such. They do not take into account the temporary impact associated with taconite construction.

Using both population forecast figures, the public school enrollment is expected to continue to decline through 1985 and then to start a slow increase by 1990. In the latter year the total enrollment figures range from 13,300 to 14,350. The higher forecast figure would give a total enrollment about 2000 lower than that in 1969-70, but about the same as that in 1973-74. Elementary enrollment in 1990 is estimated to range between 6920 and 7460, while secondary would fall between 6380 and 6890 students.

In order to accommodate the 1990 enrollment at the accepted standards of 30 and 25 pupils per classroom for elementary and secondary grades respectively, it will be necessary

TABLE 76

Future School Enrollment on Range

	WQM Plan	Range Impact Study
1970 Population	58,654	58,654
Enrollment	16,088	16,088
Elementary	7,518	7,518
Secondary	8,570	8,570
1980 Population	62,430	65,200*
Enrollment	13,420	14,020
Elementary	6,970	7,290
Secondary	6,450	6,730
1985 Population	64,450	68,450*
Enrollment	13,200	14,030
Elementary	6,860	7,300
Secondary	6,340	6,730
1990 Population	66,340	71,740
Enrollment	13,300	14,350
Elementary	6,920	7,460
Secondary	6,380	6,890

* By Interpolation

Source: ARDC (see Tables 21 and 22)

to require 248 elementary and 275 secondary classrooms using the maximum forecast. The existing elementary schools have a combined capacity of 9600 and the secondary, a capacity of 7050 students. The future enrollments in both grade levels then could be accommodated by existing facilities although localized overcrowded conditions could still occur.

Applying these same assumptions to the immediate project area population, Eveleth and Fayal Township, results in a 1990 enrollment ranging from 1490 to 1980 students. The high forecast figure would mean an increase of some 90 students

over the 1970-71 level and would require additional classrooms to accommodate the students at the current pupil/classroom standards.

TABLE 77,

Future School Enrollment, Project Area

	WQM Plan	Range Impact Study
1970 Population	6,746	6,746
Enrollment	1,893	1,893
Elementary	897	897
Secondary	996	996
1990 Population	7,440	9,910
Enrollment	1,490	1,980
Elementary	775	1,030
Secondary	715	950

Source: ARDC, Population, Econony and Land Use
ARDC, Assessment of Growth Impacts on the Iron Range

The value of the area's mineral resources has long been recognized and the long range plans and studies of the Range have all identified mining as a specific and legitimate land use activity for the area. The Regional Development Plan, Mesabi and Vermillion Ranges, the most definitive analysis of the Range, identified areas of potential mining activity and recommended that these be protected from future incompatible urban development. The study also recommended that several of the smaller communities that lie on the ore body itself gradually be phased out to be replaced by planned new communities in areas of no mineral resource potential.

Table 15, which gave the land use within the Main Range study area in 1965, showed that mining activities at that time occupied approximately 25,900 acres of the land in active use. This amounted to some 60 percent of the total developed acreage. The land in mining use throughout the Range, however, is relatively small because of the large amount of vacant or undeveloped land. Much of the vacant or undeveloped land is owned by the mining companies or various governmental units and serves to buffer or screen actual mining activities from adjoining land uses.

Table 13 also noted that there were 696,919 acres of land in the study area in 1965 that were vacant. This amounted to 95 percent of the total. Although additional areas have been brought into mining and other use since that time, the amounts have probably not been great enough to alter the developed-undeveloped relationship significantly.

With the addition of the Eveleth Expansion Company project and those of other taconite companies across the Range to the developed acreage, there is still considerable land overall, even within most municipal limits, for residential, commercial, industrial and other urban activities including those that will be directly or indirectly generated by the taconite projects themselves.

The one major land use activity that will be affected by the taconite expansion across the Range will be forestry. However, in the entire APJ or Main Range study, there are 9178 forty-acre parcels in forest use.[1] The area affected by the

1. Tablulations made from ARDC inventory data for Hibbing-Virginia APJ.

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Eveleth Expansion project has no commercial forest use.

The ARDC APJ inventory data showed that there were 1821 forty-acre cells in county, state and federal ownership. County ownership, most of which is tax forfeit land, was 774 forties. The range taconite expansions will have little effect on public lands. The growth in population and resulting demand for homesites would result, however, in the purchase of county-owned tax forfeit lands which would enhance the tax base of the Range and county.

There are county owned lands on the western edge of the Eveleth Expansion project. Utilization of these now unused tracts will generate new tax revenues to the county and the state through the taconite production, occupation and other related taxes. Operations at the project should have no effect on other state and county owned land in Fayal, Clinton and other surrounding townships.

The activities of the Eveleth Expansion Company are proposed on lands that have been in mining use for a number of years and which have been identified for mining activity in the long range plans for the area. The area was a source of natural ore before its use for taconite. So too were the areas of Spruce, Hull Nelson, Leonidas, Allice, Fayal and other open pits south of Eveleth that are part of the project. The "2020" plan, or Regional Development Plan, Mesabi and Vermillion Ranges, as well as the plan for Eveleth identified these areas for such use. The "2020" plan, Figure 3, shows proposed future mining activity following the ore body around Eveleth and swinging northeasterly through Fayal Township north of the chain of lakes.

The expansion project will result in the removal of several dwelling units and acres of land in residential use and the conversion to mining use. Most of these structures are in poor condition and in any area unsuited for further residential development or use. Adequate homesites exist in Eveleth and surrounding townships for the present occupants to relocate. There are no other urban uses, including commercial or industrial, in the project area. No urban activities are located within that part of the project in McDavitt Township and development in the surrounding area is sparse. If present land use regulations are adequately enforced here, the development should remain very low density, rural in character.

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IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF NATURAL RESOURCES

Introduction

Irreversible and Irretrievable Commitment of Natural Resources includes the proposed use of non-renewable resources, irreversible commitments of resources to a particular use, and any irreversible and irretrievable damage that may result from the proposed plan.

Iron

Proven and probable ore reserves at the Thunderbird and Expansion Pit are estimated to be 1,327 million long tons of crude ore which will produce 438 million long tons of pellets containing 272 million long tons of iron. The result will be an irreversible commitment of a non-renewable but potentially partially recyclable resource.

Waste Rock

All of the 103 million long tons of waste rock at the Thunderbird Pit, and most of the 137 million long tons of waste rock at the Expansion Pit is part of the Biwabik Iron Formation. At such, it contains iron units which though uneconomic at this time might be utilized at some future date. The type of waste disposal proposed by the company will dilute the low grade iron formation materials by commingling them with soil overburden. This dilution will make any potential use of these iron resources irretrievable and eliminate them forever from use.

Energy

Table 71 illustrates the distribution of the energy requirements among the principle uses in taconite mining at Oglebay Norton.

TABLE 71

OGLEBAY NORTON ENERGY DISTRIBUTION
Source (1)

Use	BTU's/yr.	BTU's/ton of Pellets
SPACE HEAT		
Plant	5.44×10^{11}	90,750
Mine	0.462×10^{11}	7,700
	5.91×10^{11} BTU's/yr.	98,450 BTU's/ton
PROCESS ENERGY		
Primary crushers	1.604×10^{11}	26,733
Pelletizing Heat	32.4×10^{11}	540,000
Grinding and Separating (Elec.)	14.84×10^{11}	247,333
Equipment	4.806×10^{11}	80,100
	53.65×10^{11} BTU's/yr.	894,166 BTU's/ton
TOTAL	59.56×10^{11} BTU's/yr.	992,616 BTU's/ton

At the rate of 59.56×10^{11} BTU's/yr., Eveleth Taconite Company and Eveleth Expansion Company will consume an estimated 40.5 trillion BTU's during the life of the mine.

In comparison with the rest of the Minnesota taconite industry Oglebay Norton's consumption of energy is higher than average. (2). For purposes of analysis the industry energy use was broken into the sectors of production and overhead. The overhead sector quantifies energy used mainly for space heat, lighting and ventilation. The average of the values was 72,600 BTU's/ton of pellets. The range was from 35,300 to 174,000 BTU's/ton.

Oglebay Norton's space heating bill alone equals 98,450 BTU's/ton. Also, in the production category which includes energy consumed in the operation of equipment used in the mining and processing of taconite (including all crushing, grinding, separating and pelletizing stages) the industry wide average is 786,400 BTU's/ton with a maximum of 1,230,000 and a minimum of 555,000 BTU's/ton. Oglebay Norton's consumption without including rail haulage to the plant equals 894,000 BTU's/ton.

This energy once committed is irreversible and irretrievable with current technology.

Oglebay Norton is installing a heat recycling process in their new pelletizer which will reduce the pelletizing energy requirements by 17 to 32%. This will save between 3.6×10^{11} and 7.37×10^{11} BTU's/yr. That it 6 to 12% of the annual energy consumption of the whole operation.

References - Energy

1. Letter from Gilbert W. Harries (attorney for Oglebay Norton) to Paul Pojar, DNR, Sept. 22, 1975.

2. Hirsch, Howard. For the Minnesota Energy Agency, "Energy Requirements in Minnesota Iron Ore and Taconite Mining 1953-2000". Aug. 1975.

Peat — If the sphagnum peat deposit located within the tailings area, but owned by the State, is not developed within the next 35 years, the operation will bury this valuable resource under 180 ft. of tailings. This action would be irreversible and would render the peat irretrievable.

Labor — The commitment of approximately 1,250 man-years for construction work and 27,200 man-years of mining and operational work for the life of the mine represent an irreversible commitment of human resources.

Construction — Construction of facilities associated with the proposed plan would result in the commitment of the natural resources required for buildings, roadways, rail spurs and the like. These resources have limited potential for retrieval at the end of the project.

Land Use — The proposed pit areas are located in land already used for mining natural ore. The tailings basins 2 and 3 as well as some coarse tailings stockpiles will cover a raised peat bog and significantly change the existing land use. It is hoped that reclamation will return the area to an alternative use upon deactivation of the operation.

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THE RELATIONSHIP BETWEEN LOCAL SHORT TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG TERM PRODUCTIVITY

The relationship between local short-term use and the maintenance and enhancement of long-term productivity of the lands involfed in this proposal is difficult to define.

Oglebay Norton's proposed use of the land would occur over a considerable period of time. They have ore reserves enough to produce 400 million tons of taconite pellets, which, at the design capacity of their plant of 60 million tons annually, would last for 68 years. Acquisition of more ore reserves or use of lower grade ores could well extend the plant life. During this period the lands being used for waste rock and tailings disposal would not be directly productive, but would be supporting a productive and economically valuable taconite iron ore plant. At the end of the life of the taconite plant, these waste disposal lands will be returned to some type of production of forest vegetation and animals. The waste rock piles will not have a good forest cover for many generations without intensive rehabilitation. The tailings, being fine textured material conducive to soil formation, will become fairly good quality and productive land with intensive rehabilitation. Although the life of a taconite mine is long, the committment of the land to mining is temporary. When the mining is done, the land will be returned to an alternative land use.

A. Future Reclamation

The reclamation that will be caried out at this mining operation is difficult to accurately predict at this time. Extensive mineland reclamation rules and regulations are being developed presently by the Minnesota Department of Natural Resources. When such rules

are adopted as law, Oglebay Norton will manage their operation to meet the state requirements.

In the interim, Oglebay Norton is planning on committing personnel to a reclamation program and will actively pursue research and implementation of erclamation methods. Several agencies such as the Minnesota Department of Natural Resources, the Agronomy and Forestry Schools of the University of Minnesota, the Soils Conservation Service and the U.S. Forest Service could be required by them to add expertise in pertinent areas to reclamation research and plans Oglebay Norton will also develop a reclamation timetable once the state mining rules and regulations have been developed.

Oglebay Norton has already taken some action toward reclamation. Standard practice when developing a new ore reserve with new partners in the venture it is to build a totally new plant tailings area, and reservoir. Oglebay Norton has succeeded in developing a plan where these facilities could be added to existing facilities by increasing the production capacity thus consolidating these mining activities in one place, which will result in less disturbance of nonmining committed land.

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ALTERNATIVES TO THE PROPOSED ACTION

Overview

The Rules and Regulations of the Environmental Quality Council pursuant to the Environmental Policy Act of 1973, in part outline the subjects that an EIS must contain. One of the main requirements outlined is a discussion of alternatives to the proposed action. The purpose of including such a discussion is to ensure that no options that may enhance environmental quality or have less detrimental effects will be prematurely foreclosed. However, because of the circumstances under which the EIS was ordered, namely construction of the facilities was allowed to continue, it is evident that the analysis of certain alternatives is meaningless. Consequently, alternatives such as:

no action,
deferrment of action, and
relocation of facilities

will not be addressed in this report. Instead the emphasis of this section will be directed at modifications, to the action. These changes are attainable and are designed to enhance the environment. They include:

-constructing the tailings basin in sections

-routing water from the dewatering of mines through algae-filled lakes

-modifying the water appropriations at the Thunderbird mine to decrease dependency on the Eveleth municipal water system.

Oglebay Norton originally proposed that the tailings deposition from the Fairlane Plant would be accomplished by the use of two basins.

These were to include the present tailings basin (developed for ore from the Thunderbird Mine) which measures about 680 acres in size, and a second basin, lying adjacent to the first, measuring about 1480 acres. These basins, plus a series of coarse tailings stockpile areas were to provide enough capacity for the life of the operation.

While investigating information about the tailings basin area, several references to the peat resources within that area were reviewed. These references indicated that the southern half of the proposed tailings basin covered a significant volume of high quality sphagnum peat. Upon suggestions by the DNR, the company redesigned the tailings basin in order to leave open, as long as possible, the area containing the peat. Complete avoidance of the peat was not possible since no alternative lands within the immediate area are readily available. By adoption of the plan, the peat resource will remain uncovered for approximately 35 years rather than the 5 to 10 years that the original plan would have allowed. During this extra time the peat resource will be available for removal.

The PCA and DNR feel that additional modification of the basin plans might further significantly reduce undesirable environmental impacts. One of the main problems that occur with every basin on the range is erosion of the fine particles by the wind. The solution offered by every operator is, that the tailings will be kept covered by water, and that the dams and basin tops will be vegetated as soon as possible.

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However, the problem still persists. Oglebay Norton's newest tailings basin design, with certain modifications, could offer an excellent opportunity to achieve both of the above objectives. Currently the company plans to continue its use of the original basin, and in addition, to immediately begin construction of starter dams for a second basin. These two basins will then be brought up concurrently to an ultimate design height. Upon reaching this height, in about 35 years, a third basin (in the area presently covered by sphagnum peat) will be developed to contain the tailings that will be produced from that point, until the designed life of the operation is reached. While the third basin is active the company intends to reclaim and vegetate the first two basins. The modification envisioned by the state would eliminate the concurrent operation of basins 1 and 2. Instead, the DNR and PCA feel that the consecutive development of the basins would minimize the amount of tailings that would be left uncovered, at any one time, and would allow reclamation and revegetation to proceed more quickly than it would if the company's plans are developed.

There are presently no apparent additional costs which the company would have to assume, if this modification were implemented. The benefits which could be derived appear obvious.

The second modification to the proposed action is to direct a portion of the water from the mine dewatering program through a chain of lakes. This lake chain consists of Mud, Horseshoe and Long Lakes, which are connected by streams to form a continuous surface water link between the northern most lake, Mud, and the St. Louis River, which receives the flowage. Mud Lake is sporadically fed by an unnamed intermittant stream, the source of which is Fayal Pond. Fayal Pond is located just southeast of Eveleth and receives the storm sewer runoff from the city. In addition the lake chain is believed to be hydrologically connected with Ely Lake and St. Mary's Lake, and is probably fed by ground water movements from them (see Figure 64).

Within the past few years a great deal of residential shoreland development has occurred on Long Lake. As a result the nutrient load of the lake has increased to the point that during mid to late summer an algae blume occurs in the water. Because Long Lake, as well as the others in the chain, are used for recreational purposes, the algae growth presents an undesirable situation. As a result, several local residents have suggested that a program of flushing the lake chain with mine waters from the Oglebay Norton mine dewatering program be undertaken.

It had originally (before the request of the local people) been the intent of Oglebay Norton to direct the water through a small unnamed

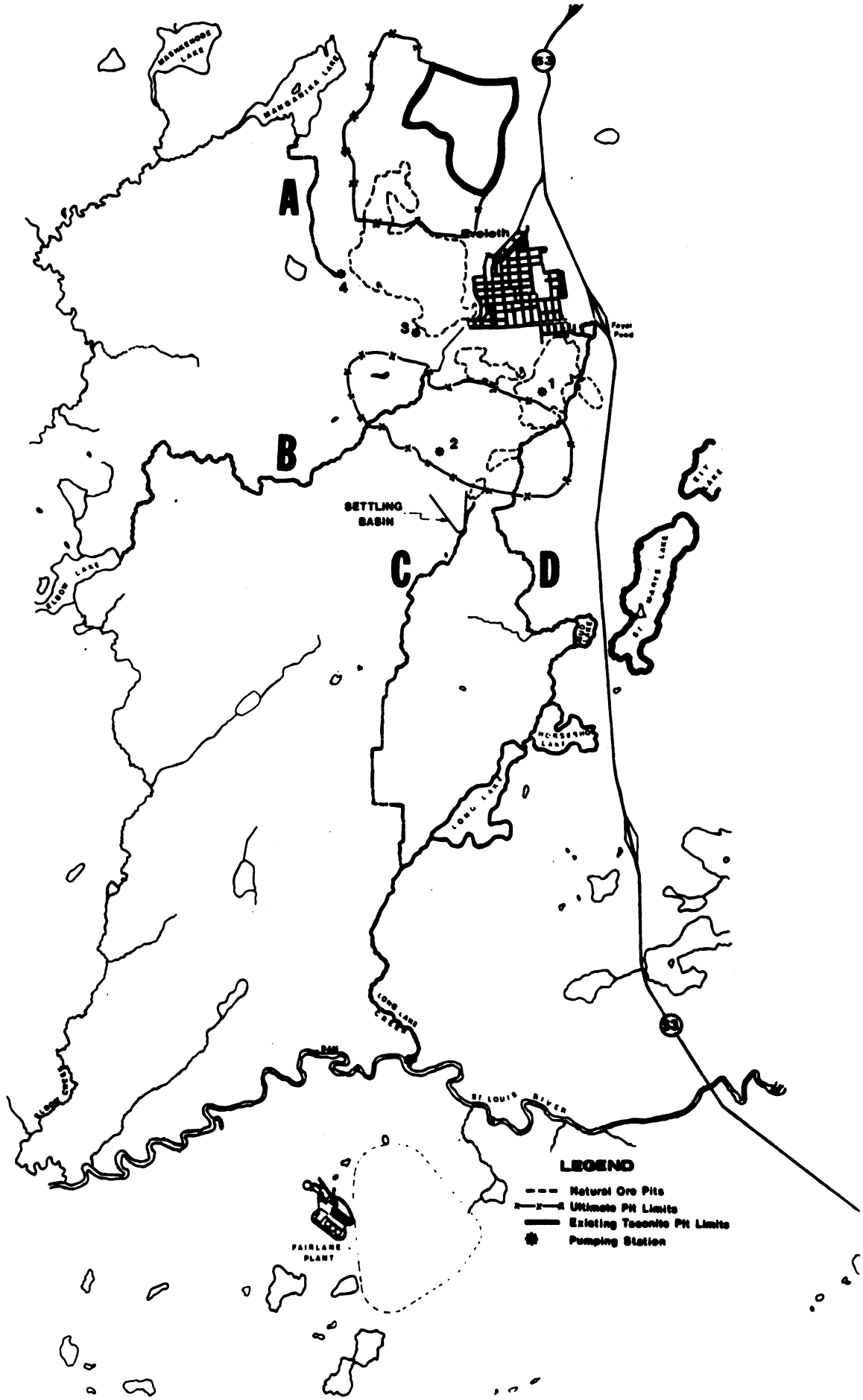


Figure 64 Area Hydrology

stream just west of the lake chain. This stream has apparently been used in the past for dewatering the natural ore mines in the area. However, because the volume of water that will be generated from the magnetic taconite mining operation will be much larger than any past discharges, the company had anticipated that several new larger culverts would have to be installed, where roads and railroads crossed the stream courses.

At the request of the DNR and PCA the company initiated a hydrologic and hydraulic investigation of the lake chain, in order to determine if the water from the mine dewatering operation could be routed through the chain without adversely affecting either the quality or quantity of the lakes' water. The company report of this investigation concluded that the water levels in the lakes would not be significantly raised by the dewatering. In addition, the report recommended that the Mud, Horseshoe and Long Lakes chain, as well as the unnamed creek to the west, be utilized to carry water from the mine to the St. Louis River. The company concludes that such a program would offer benefits to both the property owners and the company. Briefly stated, the benefits are:

For the Property Owner

1. Stabilization of the lake levels

   Inasmuch as pumping operations shall be closely controlled by the mine operator, discharge into the receiving stream shall be at its maximum during periods of little or no natural runoff - thus augmenting the base flows into the lakes when most needed. Conversely, the discharge into the receiving stream will be discontinued during those times that the levels are at or near the maximum desired by the property owners.

2. Clarification of Lake Water
   Continuous discharge at the maximum rate of 10 cfs would replace all of the waters stored in Horseshoe and Long Lakes in 140 days with mine waters that will be consistently monitored to assure that that replacement shall not adversely affect the quality of the lake water.

3. Recharge of Ground Water Aquifer
   Discharge of mine waters into the swamps and low areas of the watershed should serve to recharge the ground water aquifer and assist in maintaining base flows into the lakes.

For the Taconite Operator

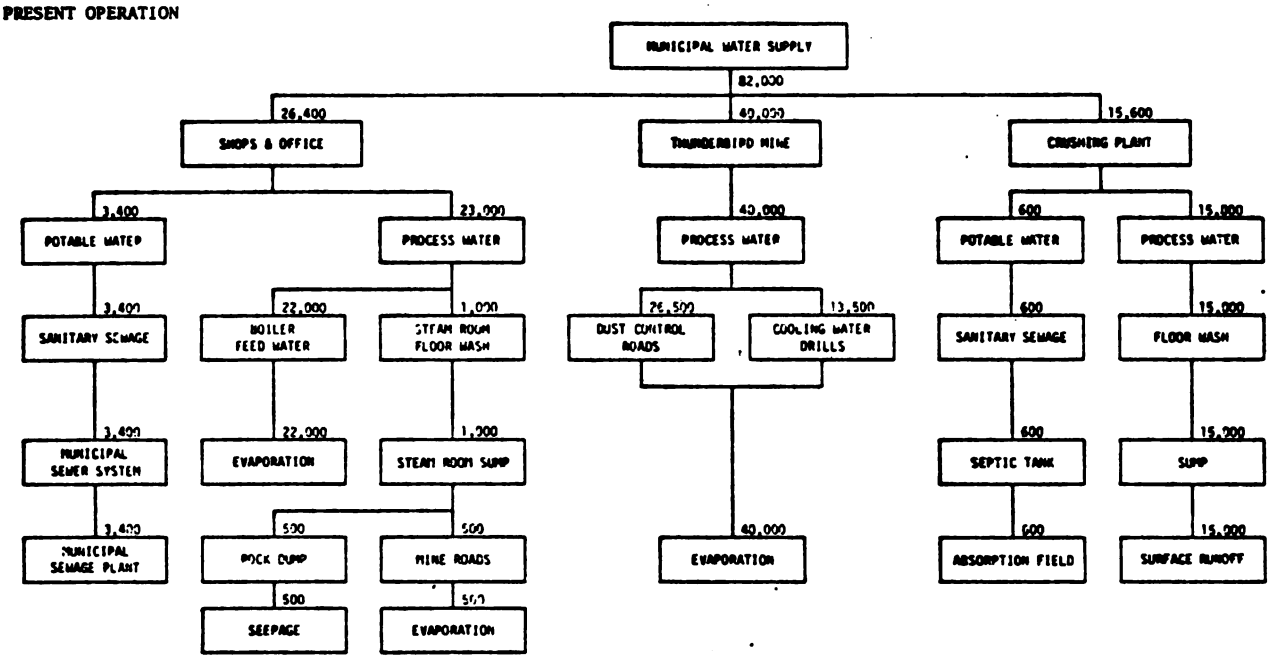
1. Less cost of culvert replacement
   Availability of two alternate routes for disposal of mine pumpage will obviate the need to upgrade some of the drainage structures.

2. Better utilization of mine dewatering season
   The ability to proportion the total flow between the two streams in accordance with the receiving streams capabilities will serve to increase the number of days that dewatering is permissible and to increase the volume pumped per day.

The possible adverse effects on the water quality of the chain of lakes is discussed in the section on effects of the action. A recommendation for studying the lake chain prior to directing waters from the mine dewatering though it, is included in that section.

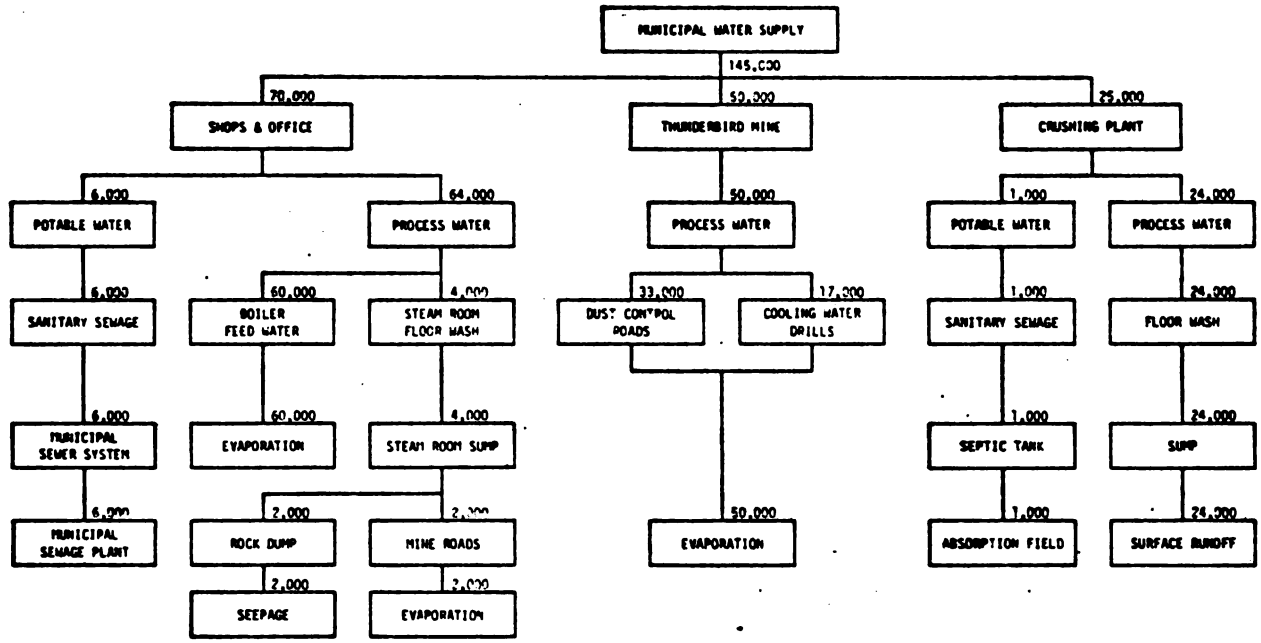
The third modification is the reduction of the company's reliance on the municipal water supply of Eveleth. The company presently consumes 82,000 gallons of water per day for a number of uses (see Figure). Many of the uses listed on the figure do not require municipal water. Such uses as road dewatering, jet piercer cooling and process water used as floor wash does not require treated city water. These needs could be better satisfied by using clean

PRESENT OPERATION



SCHEMATIC DIAGRAM - THUNDERBIRD MINE
AVERAGE WATER FLOW IN GALLONS PER DAY
6.6 MILLION TON OPERATION
OCTOBER 1974 EXHIBIT F-1

EXPANDED OPERATION



SCHEMATIC DIAGRAM - THUNDERBIRD MINE
AVERAGE WATER FLOW IN GALLONS PER DAY
8.2 MILLION TON OPERATION
OCTOBER 1974 EXHIBIT F-2

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mine water. A consultant for Oglebay Norton is presently developing such a water use plan for the company. The plan will be presented, at the hearing on the draft, and in the Final EIS.

This modification is essential since the proposed water requirements from Eveleth will be increased to 145,000 gallons per day. Further, the information on St. Mary's Lake, developed by the DNR, shows that any excessive appropriations could be detrimental (see Appendix H) to that water body. Therefore, no further appropriations, like those originally planned by the company should be considered.

The study of a fourth modification was requested by the DNR. This modification involved the piping of the mine water, obtained during dewatering, to the Plant Site for use as process water. The company undertook the study and determined that the pumping costs; including construction, maintenance and electric energy for the system were prohibitive. In addition, more water would have to be pumped than could be used by the beneficiation plant. Because no extremely adverse effects associated with the dewatering system, as originally proposed by the company, (pumping into natural water courses) were identified, and because piping the water would require the use of substantial energy, the state agrees that this modification is not warranted.

THE IMPACT ON STATE GOVERNMENT OF ANY FEDERAL CONTROLS ASSOCIATED WITH THE PROPOSED ACTION

1. The Interstate Commerce Commission has made an "Environmental Threshold Assessment of (the) Proposed Railroad Abandonment" that will be necessary to mine the expansion pit area. They are not opposed to the action.

2. The Internal Revenue Service is in the process of deciding the legal relationship of the Eveleth Taconite Company and the Eveleth Expansion Company. It is expected that this decision will not have a significant affect on the plans for operation, the operation itself, or the exploitation of the resources.

3. Federal air and water quality standards are enforced by the state.

4. There are no federal reclamation requirements for mines located on private lands. The pending federal reclamation legislation is limited in scope to coal mining and does not include metallic mining.

5. The Minnesota Department of Health is responsible for administering and enforcing the Federal "Occupational Safety and Health Act" during construction of the facilities. After that the Mining Enforcement Safety Administration of the U. S. Bureau of Mines is responsible for O.S.H.A. in mining and milling operations.

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THE MULTI-STATE RESPONSIBILITIES ASSOCIATED WITH THE PROPOSED ACTION

There does not appear to be any multi-state responsibilities associated with this project. The only affects this project will have on other states is that the pellets produced, will be utilized by steel making plants located in both Canada and the United States. The study of the environmental effects at these steel producing plants is beyond the scope of this report, and is therefore not included.

ORGANIZATIONS AND PERSONS CONSULTED

Minnesota Department of Natural Resources

Minnesota Pollution Control Agency

Minnesota Highway Department

Minnesota Department of Health

Minnesota State Historical Society

Minnesota State Planning Agency

Minnesota Energy Agency

Interstate Commerce Commission

U.S. Bureau of Mines

U.S. Forest Service

Environmental Protection Agency-National Water Quality Lab

Arrowhead Regional Development Commission

Dr. R. S. Farnham, University of Minnesota

Oglebay Norton Company

Herbert Axelson (Consultant for Oglebay Norton Company)

William Beck (Consultant for Oglebay Norton Company)

Gilbert Harries (Attorney for Oglebay Norton Company)

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APPENDIX A

Mineral Beneficiation

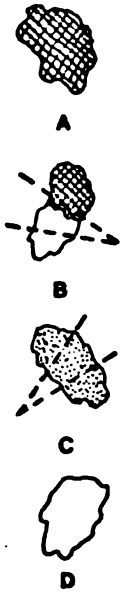
The Fairlane Plant is divided into a concentrator and a pelletizer.

The function of the concentrator is to:

1) separate the iron bearing magnetic particles (the mineral magnetite) in the ore from the non-magnetic portion (mainly the mineral silica) .

2) gather all the magnetic portion, called concentrate, together for additional processing at the pelletizer, while disposing of the non-magnetic, or tailings, portion in a tailings basin.

The pelletizing section takes the magnetite concentrate which has been ground into a powder during the concentrating process, and forms it into small balls or pellets. These pellets are fired in a kiln forming a very hard product which can be shipped without pulvertizing.



In order to understand the concentrating process a knowledge of the particles with which the process deals is necessary. After fine crushing, particles of taconite can be divided under a microscope into four recognizable types, as shown in the sketch to the left. Particle A is high-grade magnetite and should be included in the concentrate. Particle D is silica and should be discarded as tailings. Particles B and C show two types of middlings, the name given to particles that are a mixture of magnetite and silica. Both contain too much magnetite to be discarded and too much silica to be called concentrate. Both also contain sufficient magentite to be attracted by the magnets in the magnetic separators. (see discussion below). It is apparent that if Particle B is crushed finer, perhaps along the dotted lines, pieces will be produced that contain sufficient magnetite to be included with the A particles as concentrate, and the remainder can be discarded as tailings. The C particle presents a different problem. It is composed of so-called "dusty magnetite" particles uniformly dispersed in the silica. Crushing along the dotted lines breaks the particle into smaller pieces, none of which contains a greater percentage of magnetite than the original. If the amount of this type of middlings is not too great, it can be absorbed by the concentrate without seriously affecting its assay. But if the amount is large, it may not be possible to produce low-silica concentrate without discarding these middlings and causing a severe loss of iron to the tailings. Fortunately for Oglebay Norton their ores do not seem to contain significant portions of this "dusty magnetite".

Wuth this background it should be easier to understand the following description of the Fairlane processes. A schematic drawing of the coarse crusher at the mine, plus the processes found in the Fairlane Plant is presented in figure A. The operations at the Fairlane Plant begin when trains reach the plant site and unload the coarse crushed crude ore. This material is conveyed to a series of crushers referred to as fine crushers. These reduce the size of the ore to pieces 3/4 inch or less in size. This "minus 3/4 inch" (particles less than 3/4 inch in size) material is fed into a rod mill where it is ground to sand sized or finer particles. A rod mill is a large, heavy, cylindrical steel container lying on its side and mounted to rotate on hollow bearings, or trunnions. (See Figure A). Ore with

At right, the flow of material. The taconite rock, when mined, averages 22 to 26% iron. It takes three tons of taconite to make one ton of pellets, which contain about 63.5% iron.

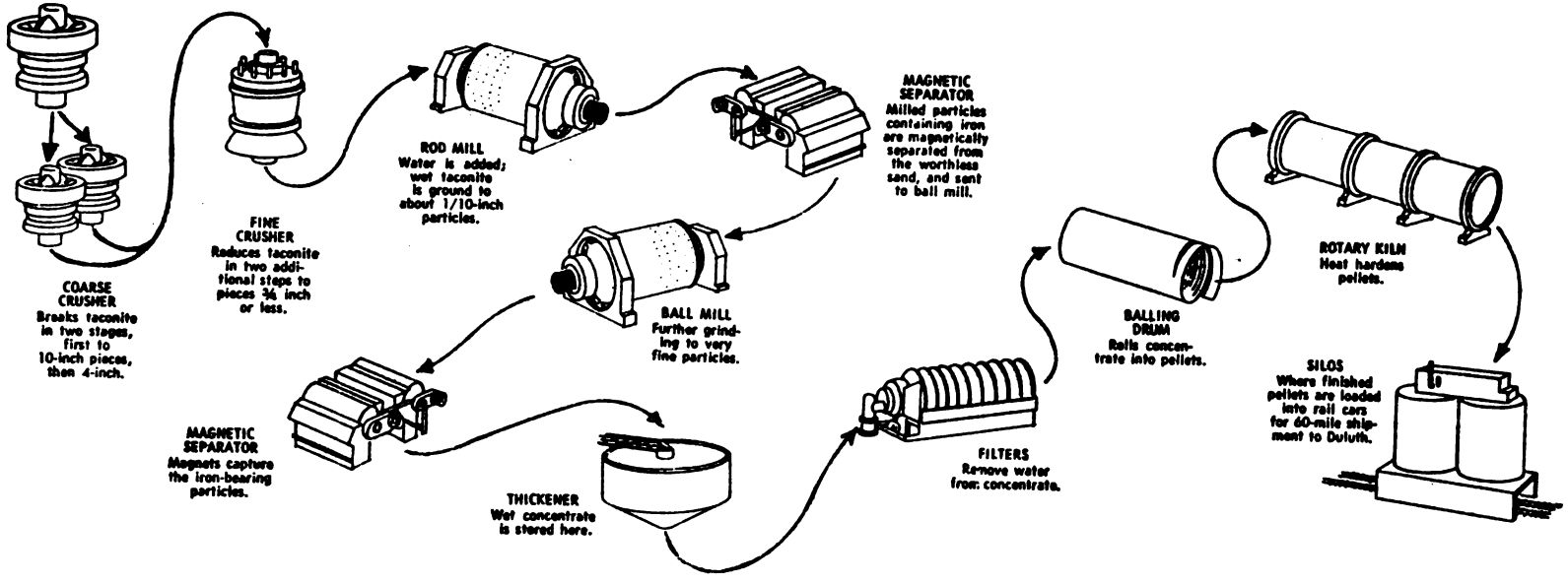
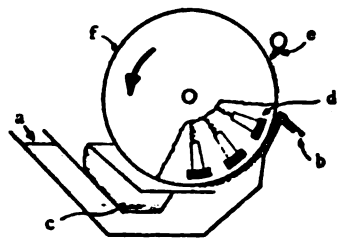


FIGURE A: MINERAL BENEFICIATION FLOW SHEET

water is fed into one end of the rotating container, and a mixture of crushed ore and water (pulp) flows out through the hollow trunnion at the other end. These mills may be ten or twelve feet in diameter and sixteen to twenty feet in length. They are lined with thick steel wearing plates, and they rotate slowly (normally from fifteen to twenty times a minute). These mills are normally about half full of steel rods which are nearly as long as the inside of the mill and as large as four inches in diameter. The rods weigh about 500 pounds each. They are not attached to the mill or to each other, and are free to roll upon one another and the inside surface of the mill, grinding the ore particles that are caught between them. The rods wear with use and gradually become smaller. Since new large rods are added frequently, the mill is normally about half full of rods ranging in size from approximately four inches to approximately one inch in diameter. At the latter size they break up into short lengths and are discharged with the ore. The rod mill is effective in grinding the 3/4 inch feed from the fine crushers into minus 10 mesh particles (about 1/10 inch size) which is like a coarse sand.

The pulp from the rod mill is then fed into a magnetic separator. The main component of this piece of equipment are strong magnets encased in a revolving watertight stainless steel drum. The drum is submerged to about one-third its diameter in a tank filled with pulp. The iron bearing particles of magnetite in the pulp cling to the revolving drum (see sketch) and are drawn out of one side of the tank. The non-magnetic sands are washed away and exit on the opposite side. The magnetic portion goes on for more processing

MAGNETIC SEPARATOR



a. feed pulp
b. magnetic particles
c. non-magnetic particles
d. fixed electromagnets
e. water spray
f. rotating drum

while the non-magnetic sands, or tailings are separated into coarse and finer fractions and disposed of in the tailings basin. Coarse particles are hauled by truck while the fine fraction is pumped to the basin. About ¼ of the material which enters this first magnetic separator, which is often called the coarse cobber, is disposed of as tailings with the remainder requiring additional processing.

The magnetic particles retained by the coarse cobber proceed to a ball mill for further grinding to eliminate the problems caused by the middlings. A ball mill, like a rod mill, is a cylindrical container mounted to rotate on hollow trunnions. In outward appearance the two machines look much alike. Both are about the same size, and both rotate at about the same speed. Inside, however, they are quite different. The ball mill is about half filled with steel balls two or three inches in diameter. As the mill rotates, the balls roll upon one another and the mill lining, grinding the sand sized particles that are caught in between. Like the rods, the balls wear with use and gradually become smaller. New balls are added frequently, and the worn balls, a half inch in diameter, are discharged with the ore.

For taconite, the grinding characteristics of the rod and ball mills are quite different. As mentioned, the rod mill is effective in grinding the three-quarter inch ore to 10 mesh, (the coarse sand size) but below that size grinding seems to taper off rapidly. The ball

mill, on the other hand, is rather ineffective on ore particles larger than 4 mesh, (about ¼ inch size) but is quite effective in grinding 10 mesh and smaller particles to 325 mesh (a fine powder) and finer. The finely ground material discharged from the ball mill is sent to a magnetic separator called a rougher, where a process similar to that of the cobber, described above, occurs. There is, however, one difference in that the tailings from the rougher are all very fine, and no separation of coarse and fine tailings can be made, thus all the tailings must be pumped to the basin. Experience with the Thunderbird ores has shown Oglebay Norton that in order to liberate the maximum amount of magnetite, nearly 90% of the material must be finer than 325 mesh (a fine powder). The ball mills, however, often discharge particles which are larger than this optimum size. To solve this problem the magnetic particles from the rougher are sized; the particles that are finer than the optimum size are sent on in the process, and the coarser are returned to the ball mill for regrinding. This recycling will continue until the particle attains the optimum size or is eliminated as a tailings particle.

The process of sizing this material is performed in three different steps and is not shown in figure R, the schematic process flow diagram. The equipment used to make the size separations include, cyclones, hydroseparators, and fine screens (see detailed Flowsheet Appendix). The main function of the equipment, is to separate different sizes of particles and thereby maximize concentration of the magnetite.

After all this sizing and regrinding only the finest magnetic particles are left. These are subjected to one more stage of magnetic separation in a "finisher". (The cobber, rougher, and finisher are all the same type of machine. The main difference is in the size of the magnetic product produced.) When the magnetic particles leave this last separator the concentrating phase of beneficiation is complete. From this point on the material is in the pelletizing phase.

From the finisher separator the "concentrate" (it can finally be called concentrate) is pumped to a thickener. This device serves two purposes:

1. storing the concentrate until it can be used
2. beginning the dewatering process.

From the thickener the thickened concentrate pulp is pumped to a filtering machine. In this machine water in the concentrate is next conveyed to the balling drum, here it is mixed with a clay called bentonite which will give the pellets certain strength and other desirable physical characteristics. In the balling drum, a long slow revolving cylinder with grooved interior walls, small pellets begin to form from the damp posdery concentrate and bentonite mixture in a process similar to the rolling of a snowball. By controlling the moisture of the feed and the speed of the rotating drum, the proper sized pellets, about ½ inch in diameter, can be produced. The pellets formed here are referred to as "green pellets".

The next piece of equipment which is encountered is the grate furnace. The pellets are fed on to a travelling grate, (a conveyor composed of hinged steel plates) surrounded by steel walls lined with refractory brick that form a horizontal shaft, through which hot air and gases pass. The purpose of this furnace is to slowly heat the green pellets and remove the remaining moisture. Temperatures approaching 1400°F are approached. At these temperatures a phenomenon occurs by which the magnetite in the pellets is oxidized, chemically changing to hematite.* This produces a rather unique situation in that since hematite is non-magnetic the finished pellets cannot be attracted by a magnet.

At the end of the travelling grate the pellets fall off that machine into the rotary kiln. Temperatures in the kiln approach 2400°F. This high heat hardens the pellets so they can withstand handling and shipping. The "fired" or finished pellets leaving the kiln are subjected to a stream of cool air. This air cools the pellets and is in turn heated by them. This hot air is then charged into the rotary kiln, then into the grate furnace thereby conserving much of the heat. The cooled pellets are then conveyed to silos whe where they are loaded into rail cars and rail-hauled to docks at Duluth and Two Harbors.

*Hematite is the mineral form of iron which is desired by the steel makers.

Water plays an extremely important role in the concentrating process. It is used to:

- -contol dust which forms when the ore is pulverized
- -provide a medium (the pulp) which allows efficient transportation of the concentrate and tailings.

The processing of each ton of crude ore requires 5,095 gallons of water (see the water balance, figure 8). By far the largest percentage of this water is recycled, by dewatering the tailings. Only about 146 gallons are supplied by new water, from the St. St. Louis River. Recycling, meanwhile, accounts for 4,950 gallons.

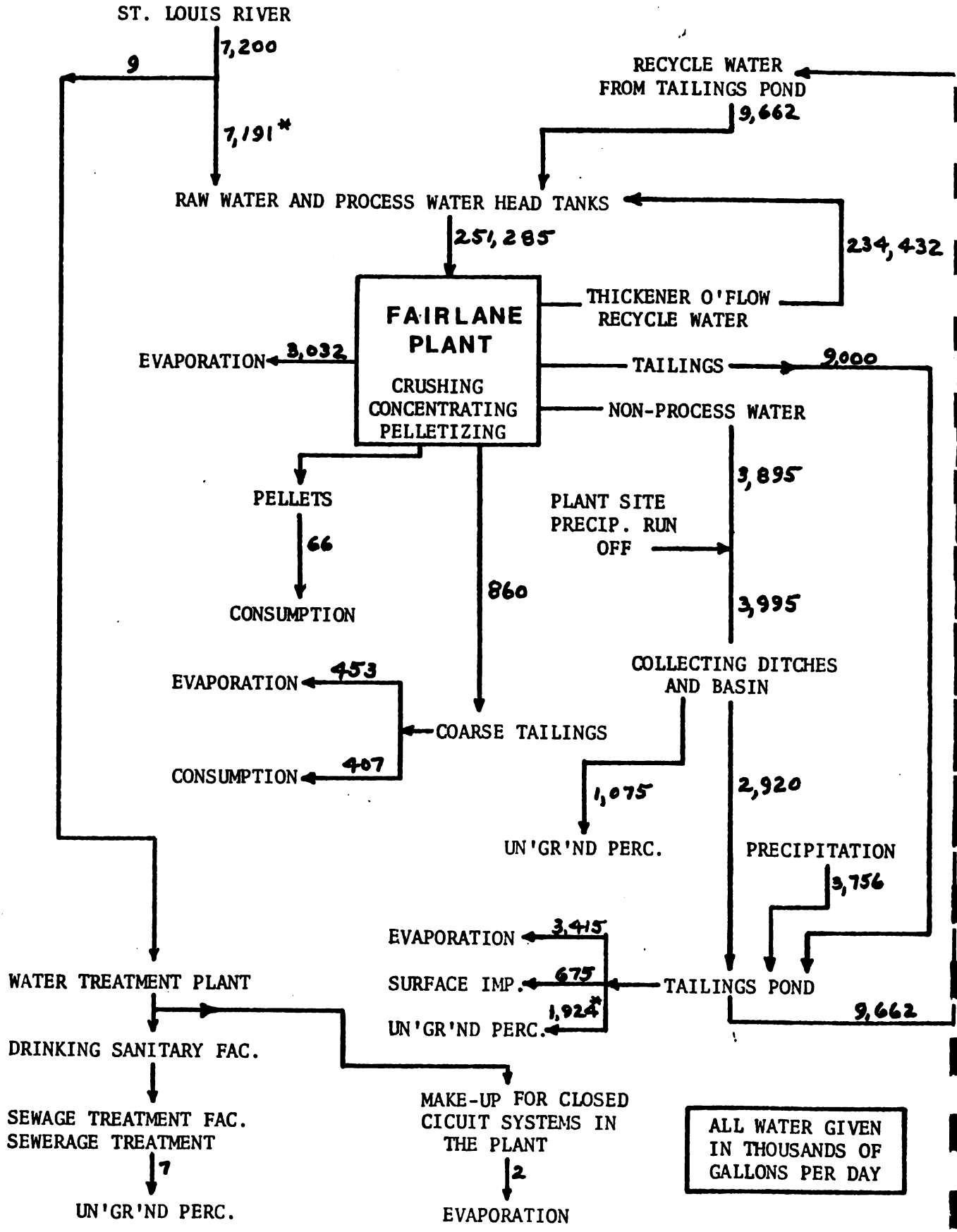
To accomplish the recycling, two failities are required:

1. a thickener and
2. the tailings basin.

A thickener is an open circular tank-like structure about 300 feet in diameter and 20 feet deep. Pulp, consisting of water and tailings, rejected by the magnetic separators, is fed from a central feed well located on the surface of the filled thickener. Because the thickener has a very large surface area the pulp is relatively still. In this unadgitated environment the tailings particles settle to the bottom; the larger particles first, followed by the smaller ones. To aid this process a chemical called a flocculent is often added. Flocculents cause small particles to adhere to one another, thus artificially creating larger particles that settle faster. A raking mechanism at the bottom of the thickener directs the particles to a

APPENDIX A (CONTINUED)

FIGURE B: WATER FLOW SHEET



NOTE: ALL PROCESS SPILLS ARE CONTAINED AND RETURNED TO THE TAILINGS POND
*AFTER POND STABILIZATION

Source: Arthur G. McKee & Company

Figure 46 SCHEMATIC OF WATER FLOW - EVELETH EXPANSION CO.

central bottom opening for discharge through a pipe. The bottom discharge is maintained at a rate less than the pulp input at the surface. Therefore, the tank is forced to constantly overflow at the edges. This overflow consists of relatively clear water since the majority of particles have settled out and are carried away. This "clean" overflow water is returned to the plant where it again enters the concentrating system. About 4,750 gallons of the 4,950 gallons of water that is recycled is produced by the thickener.

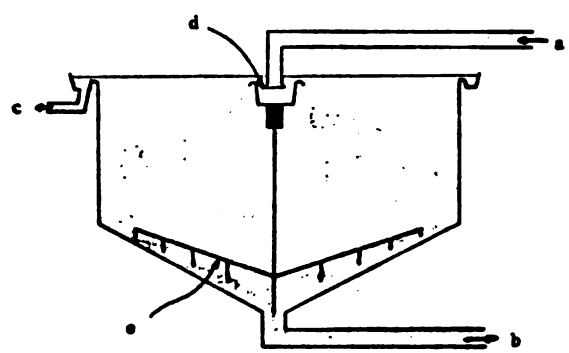
The partially dewatered pulp which is discharged from the bottom of the thickener, is sent to the tailings basin where additional settling occurs. The tailings basin provides the solution for two basic problems that arise when magnetic taconite is concentrated;

-it provides a way of recycling, and thus conserving water which is essential for the concentrating process and

-it provides a place to store the rejected iron-poor tailings.

The tailings pond provides an extremely large water area from which the very fine suspended particles can bettle. The water in the pond is allowed to clarify for several days before the clean water is pumped back to the plant where it reenters the concentrating system. The tailings basin provides approximately 200 gallons of water per ton of crude ore, that is processed.

THICKENER



a. pulp feed
b. thickened underflow
c. clarified water
d. central feed well
e. raking mechanism

In many areas along the range the magnetic taconite mining companies can use the topography of an area to partially contain the tailings. For instance, a valley may be dammed at two places to form a trough into which the tailins can be placed, or the side of a hill plus a series of dikes might be used to contain the material. Because these types of tailings disposal systems require a minimum amount of dam building they are usually used, if the topography permits.

The only feasible area available to Oglebay Norton however are areas with little or no topography consisting of nearly flat bogs. Because of this the tailings basin - constructed by the company will be developed by building a closed dike system made of coarse tailings, which are placed into position by trucks. The finer tailings which are pumped from the plant are then spigatted from the top of the dike toward the interior of the basin. As in the thickener, the fine particles settle and thus clarify the water. The clear water is pumped from the center of the basin and returned to the plant. As the basin fills the dikes are raised until the designed height is reached.

APPENDIX B

MINERALOGY OF THE THUNDERBIRD MINE AND THE EXPANSION AREA MAGNETIC TACONITE DEPOSIT

The minerals present in the iron formation of this portion of the Mesabi Range are well known from petrographic studies carried out by geologists for U. S. Steel Corporation at Mountain Iron, Inland Steel Company at Virginia, Eveleth Taconite Company at Eveleth and Jones and Laughlin Steel Corporation at Gilbert - Biwabik.

Many reports by geologists for the United States and the Minnesota Geological Surveys and other governmental agencies or universities have identified the existance of certain minerals in the Eveleth and adjoining areas.

The above efforts have proven that the most abundant minerals in the ore layers are the iron oxides consisting mainly of magnetite and to a lesser extent, martite, hematite, goethite and limonite. Chert or jasper which are microcrystalline quartz are the most common accessory minerals along with three silicate minerals, the most common of which is minnesotaite, stilpnomelane and minor amounts of greenalite. Smaller amounts of various carbonate minerals and traces of pyrite and graphite may be present. The silicate minerals mentioned above comprise only about 13% of the minerals present and contain various amounts of the oxides of silica, iron, aluminum, magnesium, manganese, calcium, sodium, potassium, titanium, and water.

The iron formation west of Aurora has been regionally metamorphosed to the "greenshist facies" as evidenced by the above low temperature minerals and fine grained textures. The regional development of a 6 - 9 degree dip to the south or west and the broad open fold in the area between Virginia and Gilbert has produced only minor rolls (monoclines) in the sedimentary beds and a few fractures or faults with slight displacements. These structures played a part in the development of natural ore through the process of oxidation and leaching in restricted areas most of which have been mined out.

The detailed drilling which has been carried out in the Eveleth area by several companies has clearly identified the characteristics of the iron formation present, and there is no evidence of any high-temperature activity, high-temperature silicates, or asbestos-like amphiboles in the Eveleth area. The writer has classified and studied all of the Oglebay Norton Company drill core from 29 holes in the expansion area and has studied all of the drilling data from the Thunderbird Mine and the area extending to southeast of Eveleth to positively correlate the geology and mineralogy of all the iron formation layers.

Dated: August 20, 1974

Jack V. Everett
Consulting Mining Geologist
A.I.P.G. Certificate #1345
511 Torrey Building
Duluth, Minnesota 55802

APPENDIX C

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL WATER QUALITY LABORATORY
6201 CONGDON BOULEVARD
DULUTH, MINNESOTA 55804

6 August 1975

Mr. Paul Eger
Division of Water & Soils
Department of Natural Resources
345 Centennial Office Building
St Paul MN 55155

Dear Paul:

Attached is a table which contains the results of the X-ray diffraction analysis of six water samples collected on 27 June 1975 by the Minnesota Department of Natural Resources. These samples were analyzed without size separation so the small amphibole concentrations reported for three samples could slightly overestimate the amphibole concentration. No cummingtonite-grunerite was detected.

The tailings basin sample contained major amounts of talc, quartz and minnesotaite. The Spruce and Fayal samples contained quartz and hematite. Troy and Pearsall contained clay minerals and quarts. Talc and minnesotaite can have a fibrous habit.

Sincerely yours,

Philip M. Cook

Philip M. Cook, Ph.D.
Research Chemist

Atch a/s

cc: Dr. Donald I. Mount, Director, NWQL
Dr. Gary E. Glass, NWQL

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OGLEBAY NORTON SAMPLES

Location	Total Suspended Solids (mg/l)	Amphibole Concentration (mg/l)	Cummingtonite-Grunerite (mg/l)
Little Tony	2.19	<.008	<.008
Pearsall	1.03	.006	<.008
Troy	2.29	.01	<.01
Fayal #3	2.08	<.008	<.008
Spruce	2.54	.003	<.007
Tailings Basin	2.20	<.008	<.008

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL WATER QUALITY LABORATORY
6201 CONGDON BOULEVARD
DULUTH, MINNESOTA 55804

21 October 1975

Mr. Paul Eger
Division of Water & Soils
Department of Natural Resources
345 Centennial Office Building
St Paul MN 55155

Dear Paul:

Qualitative transmission electron microscope examination of suspended solids filtered from a water sample collected on 27 June 1975 from the Ogleby Norton tailings basin revealed platey mineral particles (probably talc and minnesotaite) and diatom fragments. No amphibole fibers were observed. This observation is consistent with the X-ray diffraction examination reported to you on 6 August 1975.

Sincerely yours,

Philip M. Cook

Philip M. Cook, Ph.D.
Research Chemist

cc: Dr. Donald I. Mount
Dr. Gary E. Glass

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OCT 23 1975
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APPENDIX D

Thunderbird South Project

The purpose of this project was to confirm the basic geology and mineralogy of the proposed Thunderbird South open pit iron mine as they were presented in a report by Jack Everett for Eveleth Taconite. The tailings were also examined in an attempt to determine the morphology of the grains.

The samples and information used in this study were obtained from Jim Tusa of Eveleth Taconite, except for two drill core samples which were stored in this office. The information received included:

1. 2 maps showing drill hole locations
2. 2 geologic cross sections
3. drill core log and Davis Tube results for hole ST-18
4. drill core log and Davis Tube results for hole ST-27
5. 45 thin sections and heels from drill cores ST-18 and ST-27
6. 14 polished sections from drill cores ST-18 and ST-27
7. Davis Tube long grind tails from 19 drill holes in the initial pit area
8. samples of the tailings of the current operation collected from 7/06/75 to 7/15/75

Drill cores ST-18 and ST-27 were selected for study because they intersect all of the ore horizons which will be mined during the life of this operation. The drill core samples from hole #122, which is located on the west side of the Thunderbird North mine, were taken from core stored in the Hibbing office.

All of the thin sections, some of the polished sections, two of the tailings samples, four of the Davis Tube tailings samples, and the two crushed drill core samples were examined under the microscope during this study. The thin and polished sections were examined with a Zeiss Universal Research microscope, which has a magnification range of 25X to 1000X. An Olympus SZIII stereo binocular microscope was used to observe coarser features in thin sections. It has a magnification range of 7X to 40X. All of the other samples were in a crushed form and had to be separated into various size fractions to facilitate examination. A two gram sample was screened using an Allen-Bradley Sonic Sifter. The screens used were a 200 mesh, 325 mesh, 20 micron, and 10 micron. Portions of the resulting fractions were then mounted in an oil media between a glass microscope slide and a 22 millimeter coverslip. The mounting oil has a refractive index of 1.515. These slides were then examined, looking for elongate or fibrous grains. Photographs of some of the fractions were taken with a Canon TLb 35mm camera which is mounted on the microscope.

The examination of the data and samples has shown that the report by Jack Everett is correct. The mineralogy of the Biwabik Iron Formation, as observed in these samples, is magnetite, quartz, minnesotaite, stilpnomelane, hematite, and carbonates as major constituents and goethite-limonite, greenalite, pyrite, and chalcopyrite in minor to trace amounts. It appears that the Thunderbird South ore body is very similar to the Thunderbird North ore body in mineralogy and in the morphology of the tailings materials. No significant amounts of elongate, rod-like, or asbestiform minerals were observed in any of the samples examined.

RECEIVED
OCT 31975
DIVISION OF MINERALS

William H. Listerud
Geologist

APPENDIX E

Data in Support of Application for Permits for Appropriation, Use & Diversion of Water

Attached to and thereby made a part of Oglebay Norton's Application for Appropriation, Use and Diversion of Waters submitted to the Commissioner on the 11th day of November, 1974 were eight sections of supporting data that may be condensed, abstracted and/or recapitulated as follows:

Extent of Appropriation, Use and Disposal of Mine Pumpage

The term "mine water" for the purpose of Oglebay Norton Company's Application for Permit includes, or is apt to include, direct precipitation within the crest of the open pit excavations; surface runoff from adjacent lands that cannot reasonably be diverted from flowing directly into the pits; and ground water seepage or flows from aquifers penetrated or intercepted by open pit operations.

Although the water impounded in the open pits undoubtedly does include direct precipitation and surface runoff, OGLEBAY NORTON Company's Consultant is of the opinion that the lion's share of that water is ground water intercepted by the mine openings from either flows along the surface-to-formation contact or from flows through the fractured or porous layers or strata of the Biwabik Iron Formation and its underlying Pokegama Quartzite.

As may be anticipated from the bedrock contours on Exhibit E-1, the flow of ground waters at the surface-to-formation contact would be due westerly north of

Eveleth, southwesterly south of Eveleth, and southeasterly east of Eveleth, or, in effect, the direction of flow would be down grade approximately normal to the strike of the Biwabik Iron Formation. In addition, since the formation dips from 6 to 10° downward from its north limit of the outcrop area, any flow of water within or immediately under the formation would be down-dip normal to the strike. However, as may be noted from the Exhibit, the chain of natural ore mines extending from the Fayal Extension on the east to the Leonidas on the West serves as an interceptor ditch to divert a substantial portion of the ground water to a northwesterly flowage through the open pits and their interconnecting underground workings or oxidized iron formation. Longitudinal Section M-M', bound herein as Exhibit E-2 substantiates this premise in that the elevation of the impounded water indicates that the hydraulic gradient slopes off to the northwest.

The Consultant anticipates that the only ground water flowage down-dip from the natural ore mines in all likelihood would be flowage in porous layers under the open pits or along faults extending southwesterly from the north edge of the formation as evidenced by the drop in water elevation from the Troy to the Pearsall Mine as shown on Section N-N' bound in as Exhibit E-3. The Pearsall, Troy and Fayal No. 3 Mines all lie along a major fault extending completely across the outcrop of the Biwabik Formation.

Section N-N' or Exhibit E-3 also illustrates how the Expansion Open Pit will include the Pearsall, Troy and a portion of the Fayal No. 3 Mines to make available the underlying taconite, thus ruling out at some future date the continuation of the water pools within these mines as part of the mine dewatering system. Also depicted on Section N-N' are the tentative limits of the waste disposal area within a mined-out portion of the Fayal No. 3 Open Pit.

Dewatering of the natural ore mines during their development was accomplished by pumping from the sumps in the Fayal, Spruce and Leonidas underground

mine shafts and from pit sumps in the Troy and Pearsall Mines. The Consultant was successful in acquiring the following data on pumpage and water levels from and in the various open pits and mine shafts:

1. Fayal Pit Pumping - June 24, 1943 through February 7, 1944
2. Pumping Record, Fayal & Spruce - January 1950 through January 1959
3. Water Pumped from Troy Mine - January 1952 through July 1962
4. Water Pumped from Pearsall Mine - August 1958 through October 1961
5. Water Log of Leonidas Shaft - April 26, 1960 through April 3, 1961
6. Log of Fayal Pumping - February 14, 1961 through August 19, 1964
7. Water Data Eveleth District as of March 9, 1961
8. Pumping Record Leonidas Shaft - May 9, 1961 through August 3, 1961
9. Water Sample Analysis of Open Pit Mine Ponds as of May 24, 1974

Copies of each of the above listed items are bound in Section 7 of Oglebay Norton Company's Application for Permit, and designated as Exhibits J-1 through J-9.

Study of the pumping records indicated that the North Range Mining Company stopped pumping at the Leonidas Shaft on April 13, 1960 (Exhibit J-5). Following that date, Rhude & Fryberger, as the sole operator on the Eveleth Group of mines, assumed responsibility for mine dewatering. Its records indicate that on April 26, 1960, the elevation of the water in the Leonidas Shaft was 298.2 feet, which elevation is well below the bottom of any of the open pits. Since then, the records indicate that Rhude & Fryberger pumped:

198.2 million gallons from the Pearsall Mine
450.7 million gallons from the Troy Mine
270.0 million gallons from the Leonidas Mine
634.1 million gallons from the Fayal Mine

for a total withdrawal of 1,553 million gallons or 4,765 acre feet of water from the group of mines which as of May 4, 1974 contained the following estimated quantities of water (see Depth-Volume Curves bound in Section 7 of the Application and designated as Exhibits C-1 through C-6).

Table 4

	Acre Feet of Water
Pearsall Mine	1,012
Troy Mine	2,700
Fayal Extension Open Pit	193
Fayal No. 3 Open Pit	5,200
Alice & Fayal No. 2 Open Pits	380
Leonidas-Spruce Group	18,200
Leonidas Underground	3,265
Total Volume	30,950

The 30,950 acre feet of water impounded within the mine workings together with the 4,765 acre feet removed by Rhude & Fryberger represent a net gain of inflow over outflow since April 13, 1960 of 35,715 acre feet. Dividing this total by the 5,132 days of build-up indicates that the net gain was 6.96 acre feet per day or an average rate of 1575 gallons per minute. From this and the combined pumping rate of 1700 gallons per minute required to keep the group of mines dewatered in the fifties, Oglebay Norton Company's Consultant estimates the current rate of accumulation of water in the open pits is 1450 Gallons per minute.

From this study the Consultant anticipates that initial dewatering for development of the Expansion Open Pit will be at an average rate of 3,000 gallons per minute for a three year period; will drop back to a probable low of 1,500 gallons per minute for a short period following initial dewatering; and will then gradually increase to a probable maximum average rate of 4,000 gallons per minute as the pit expands in area and increases in depth. These are average rates, however, and to be realized the actual combined pumping rates may at time approach the total capacity of the pumps at each of the following pump stations:

Pump Station No. 1 - Development of the pump station will involve mounting of three 1500 gallon per minute split case centrifugal pumps on a raft to be placed on the water pool in the Fayal No. 3 Open Pit. The

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discharge pipe line from the raft will be mounted on floats with a flexible coupling at the shore line to effect a connection to a fixed pipe line leading to the Troy Mine.

Pump Station No. 2 - This pump Station will be a portable skid-mounted structure with two 2000 gallon per minute split case centrifugal pumps to be located at the sump in the Expansion Open Pit. The discharge line from the pump station will lead initially to the pool in the Fayal No. 3 Pit and ultimately to the Settling Basin.

Pump Station Nos. 3 & 4 - Each of these fixed pump stations, located on the Spruce and Leonidis U.G. mine shafts will have two 1,000 gallon per minute line shaft vertical turbine pumps installed in two of the three shaft compartments with discharge piping leading to the receiving streams.

The combined pumping capacity for the mine dewatering system for the Expansion Open Pit will be as follows:

Table 5

Mine Development Stage	Operative Pump Stations	Maximum Discharge to St. Louis River Via Long Lake Creek GPM	CFS	Via Elbow Lake GPM	CFS	Via Manganika Lake GPM	CFS	Total Discharge GPM	CFS
I	No. 1	4,500	10.0	-	-	-	-	4,500	10.0
II-Initial	No. 1 & No. 2	4,500	10.0	-	-	-	-	4,500	10.0
II-Final	No. 2	4,000	8.9	-	-	-	-	4,000	8.9
III	No. 2 & No. 3	4,000	8.9	2,000	4.5	-	-	6,000	13.4
IV	No. 2 & No. 3 & No. 4	4,000	8.9	2,000	4.5	2,000	4.5	8.000	17.8

In actuality, the rate of discharge at any point in time must be governed by the ability of the designated water courses to receive that discharge. As indicated

by the map designated as Exhibit F and entitled "Location Map for Hydrological Study, Evaluation of Drainage Structure Capacities on Receiving Streams" each of the receiving streams involved drainage structures under the railroad tracks, roads and highways that cross those streams. Field examination of the structures provided the data for the following determination of capacities:

Table 6

From Pump Stations Nos. 1 & 2 to the St. Louis River

Structure Location	Drainage Area Acres	Sq.Mi.	Average Flow C.F.S. Dry Yr.	Avg. Yr.	Wet Yr.	Peak Flowage C.F.S. 50 Year	100 Year	Peak Capability C.F.S.
1	364	0.57	0.23	0.40	0.80	144	173	52
2	411	0.64	0.26	0.45	0.90	154	185	100
3	771	1.21	0.48	0.85	1.69	223	268	35
4	1301	2.03	0.81	1.42	2.84	302	362	36
5	1407	2.20	0.88	1.54	3.08	316	379	45
6	5331	8.33	3.33	5.83	11.66	513	616	136
7	5388	8.42	3.37	5.89	11.79	516	619	330
8	5630	8.80	3.52	6.16	12.32	530	635	87
9	7081	11.06	4.42	7.75	15.48	605	726	1240

From Pump Stations No. 3 to Elbow Lake

Structure Location	Drainage Area Acres	Sq. Mi.	Average Flow C.F.S Dry Yr.	Avg. Yr.	Wet Yr.	Peak Flowage C.F.S. 50 Year	100 Year	Peak Capability C.F.S
1	1155	1.80	0.72	1.26	2.52	316	380	290
2	1155	1.80	0.72	1.26	2.52	316	380	156
3	1377	2.15	0.86	1.51	3.01	351	421	180
4	1384	2.16	0.86	1.51	3.01	352	422	650
5	1502	2.35	0.94	1.65	3.29	361	433	1040
6	1681	2.63	1.05	1.84	3.68	377	452	70
7	1905	2.98	1.19	2.09	4.17	396	475	1050
8	2005	3.13	1.25	2.19	4.38	397	477	500
9	2164	3.38	1.35	2.37	4.73	405	486	1080
10	2499	3.90	1.56	2.73	5.46	418	502	560

From Pump Station No. 4 to Manganika Lake

1	440	0.69	0.28	0.48	0.97	121	145	125
2	445	0.70	0.28	0.49	0.98	122	146	90

Even at maximum, the flowage resulting from discharge of mine waters is insignificant during dry weather or periods of low runoff. However, as may be noted by comparison of the Peak Capability of the various structures with the Peak Flowage resulting from either the 50 Year or 100 Year frequency storms, some of the structures are inadequate by present day design standards and should be replaced or augmented by additional facilities for drainage at those locations. Toward that end, Oglebay Norton Company anticipates that it shall effect such changes as are necessary to enable the receiving streams to carry both mine pumpage and 10 year frequency storm runoff without flooding on township roads, 50 year or 100 year frequency storms on county roads, and 100 year frequency storms on state highways and common carrier railroad main lines.

However, not all of the waters appropriated for mine dewatering will be released to the receiving streams, for a portion will be utilized as process water for mine operations. During Stages I and II of the open pit development, mine waters stored for clarification in the Pearsall Mine will be pumped out by Pump Station No. 5 and piped to an elevated tank or standpipe for filling of tank trucks. The trucks in turn would then be utilized to spray the mine roads for dust control and for stabilization of the road surface or to transport the water to the jet piercing blast hole drills for use as cooling water for the jet piercers. During Stages III and IV the process water would be obtained from the settling basin dam with pumpage to the standpipe from Pump Station No. 6. In addition to serving as a source of process water for road maintenance and drilling operations, Pump Stations 5 and 6 could be a standby source of water for fire protection. However, the Consultant's estimate of the quantity of water required on a continuing basis for mine process water is bound herein designated as Figures IV through VIII and may be recapitulated as follows:

Table 7

Consumptive Use	Average in Thousands of Gallons per Day				
	Stage I	Stage II -Initial	Stage II -Final	Stage III	Stage IV
For Cooling Jet Burners	9	13	13	17	17
For Sprinkling Mine Roads	17	26	26	35	52
Total	26	39	39	52	69
Available from Pumpage	4,320	2,160	2,160	4,320	5,760
Surplus Mine Pumpage	4,294	2,121	2,121	4,268	5,691

The excess of available over required water shall be discharged into the receiving streams as follows:

Dewatering operations in the past have indicated that the water pumped from the Spruce and Leonidas Underground Shafts is clear in that it had been filtered through the formation or cave materials before entering the shaft sump. Pumpage from the open pits, however, contains solids in suspension and must be clarified by detention in a settling pond prior to discharge into a receiving stream. Accordingly, during Stage I and II, pumpage from the No. 1 Pump Station will be discharged into the Troy Mine from which it will flow by gravity into the Pearsall Mine. Overflow from the Pearsall Mine will then enter the receiving stream.

At the planned overflow elevations, the Troy Mine will contain 2,910 acre feet and the Pearsall Mine 1,260 acre feet for a total combined volume of 4,170 acre feet of water. At the maximum rate of discharge from Pump Station No. 1 of 4,500 gallons per minute, the surplus mine pumpage waters will have a detention time of 210 days for clarification before released to the receiving stream.

Upon abandonment of the Troy-Pearsall clarification system in Stage III of mine development, the pipe line from Pump Station No. 2 will discharge into the settling basin. The basin will be created by the construction of the earth dam and outlet structure depicted by the preliminary design marked Exhibit G and bound herein. The basin at its overflow elevation will impound 290.4 acre feet of water which in turn will provide for a 16.4 day retention period for Pump Station No. 2 discharge at its maximum of 4,000 gallons per minutes.

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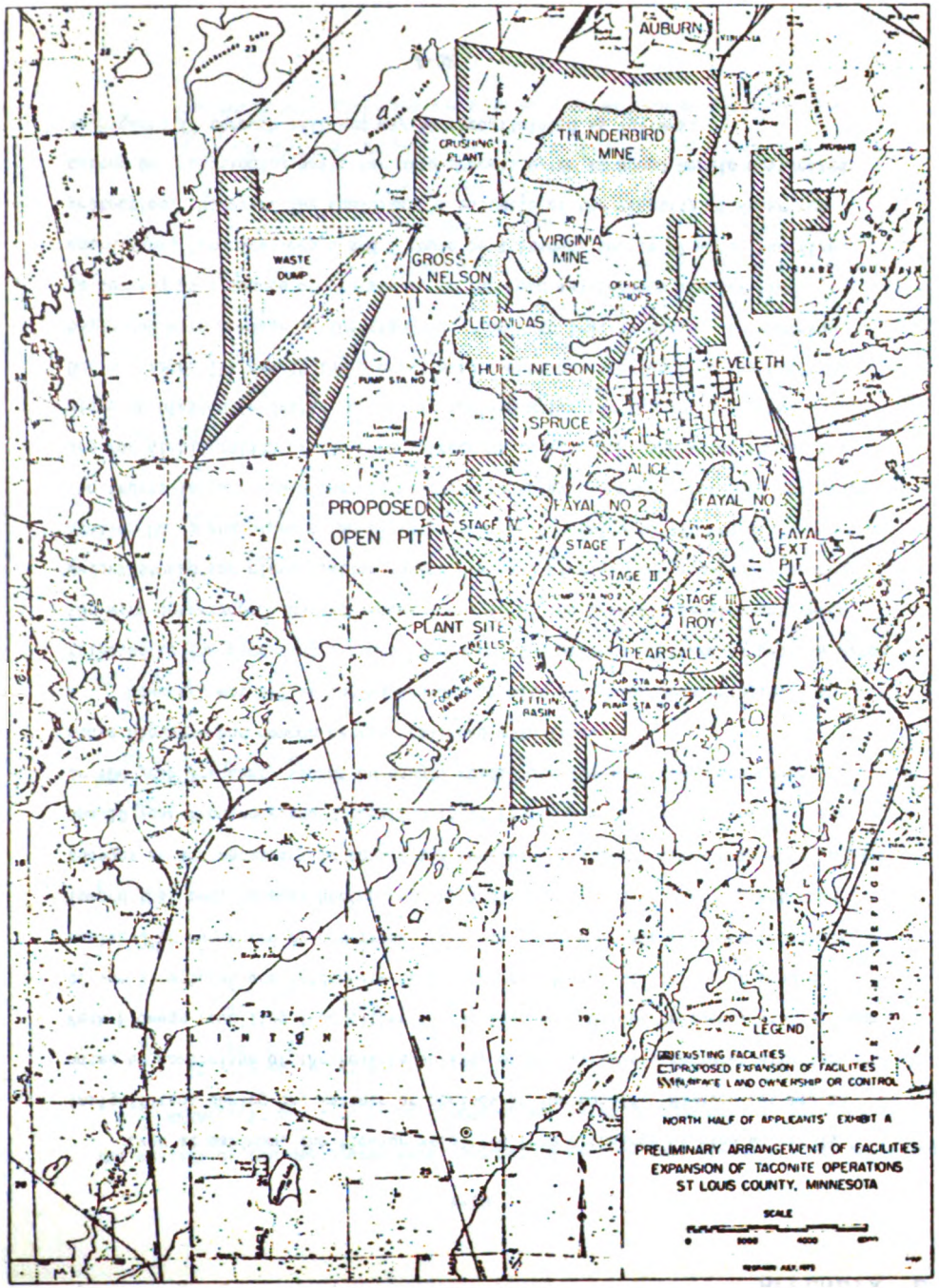
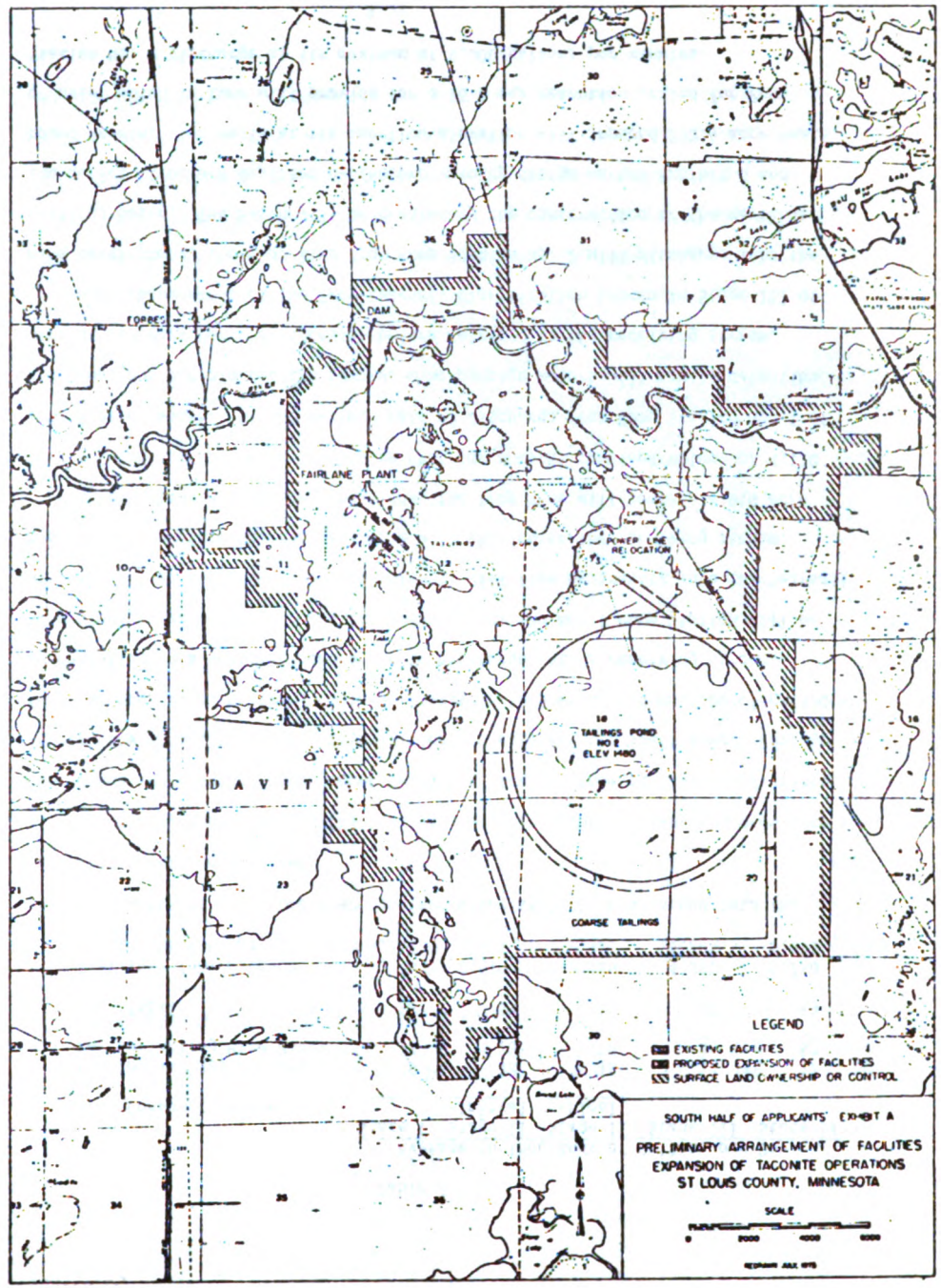
APPENDIX E (CONTINUED)



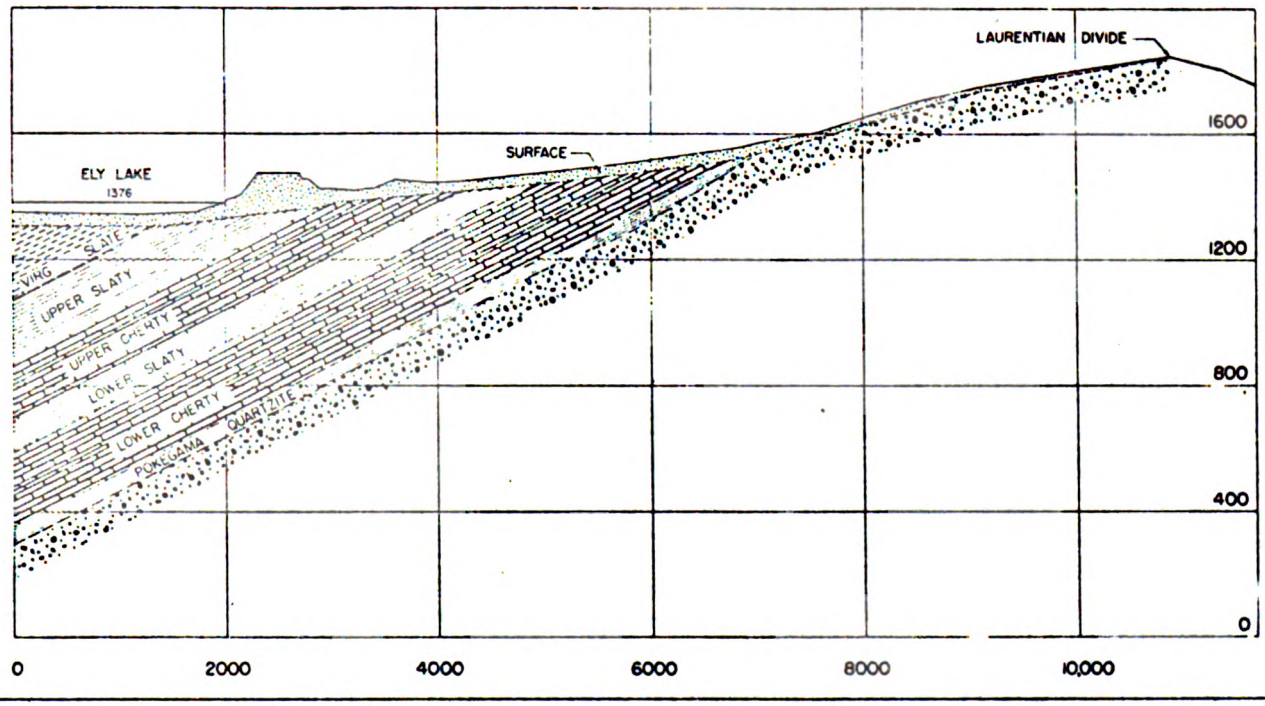


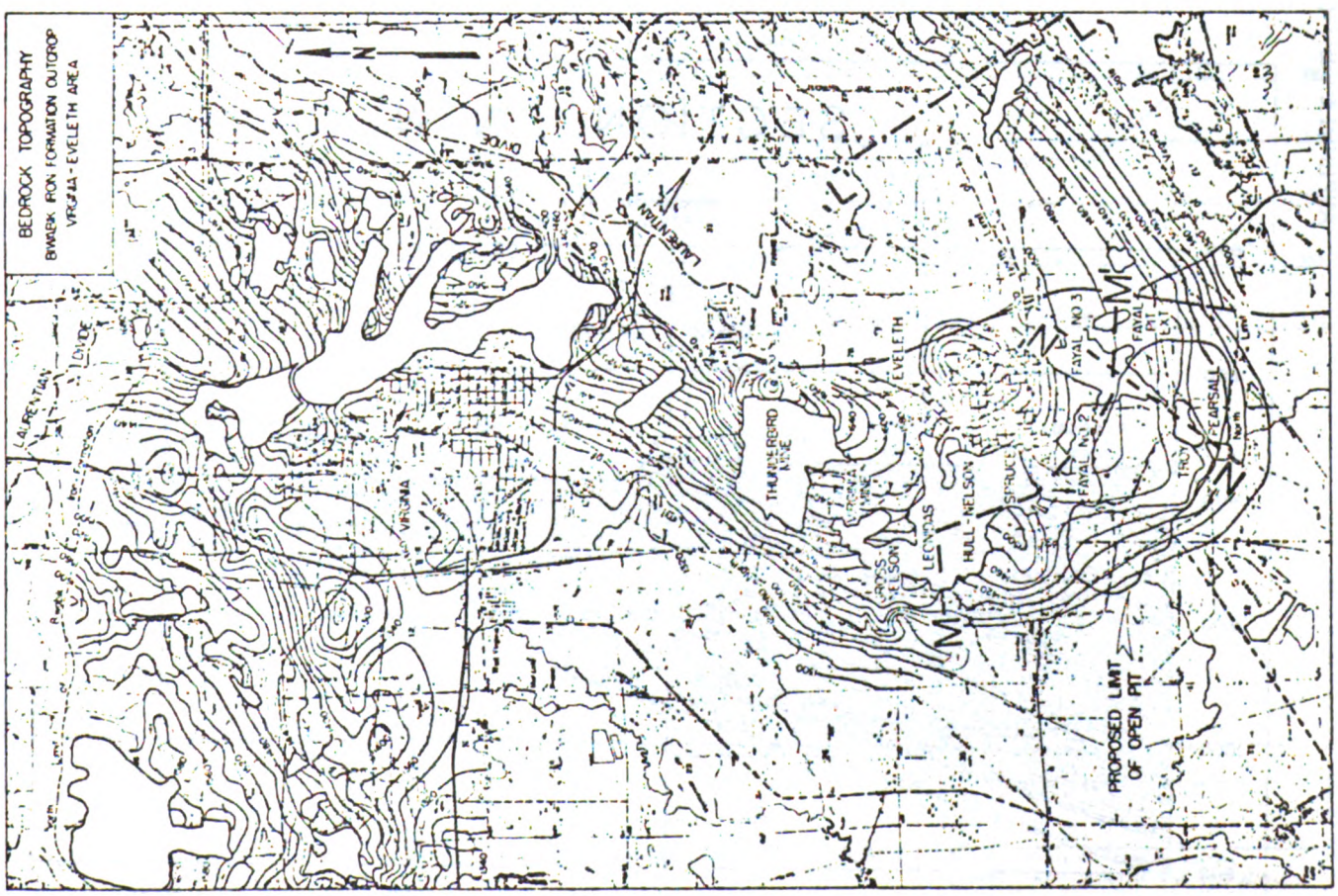
APPENDIX E (CONTINUED)

SECTION L-L'

LOOKING SOUTHWEST

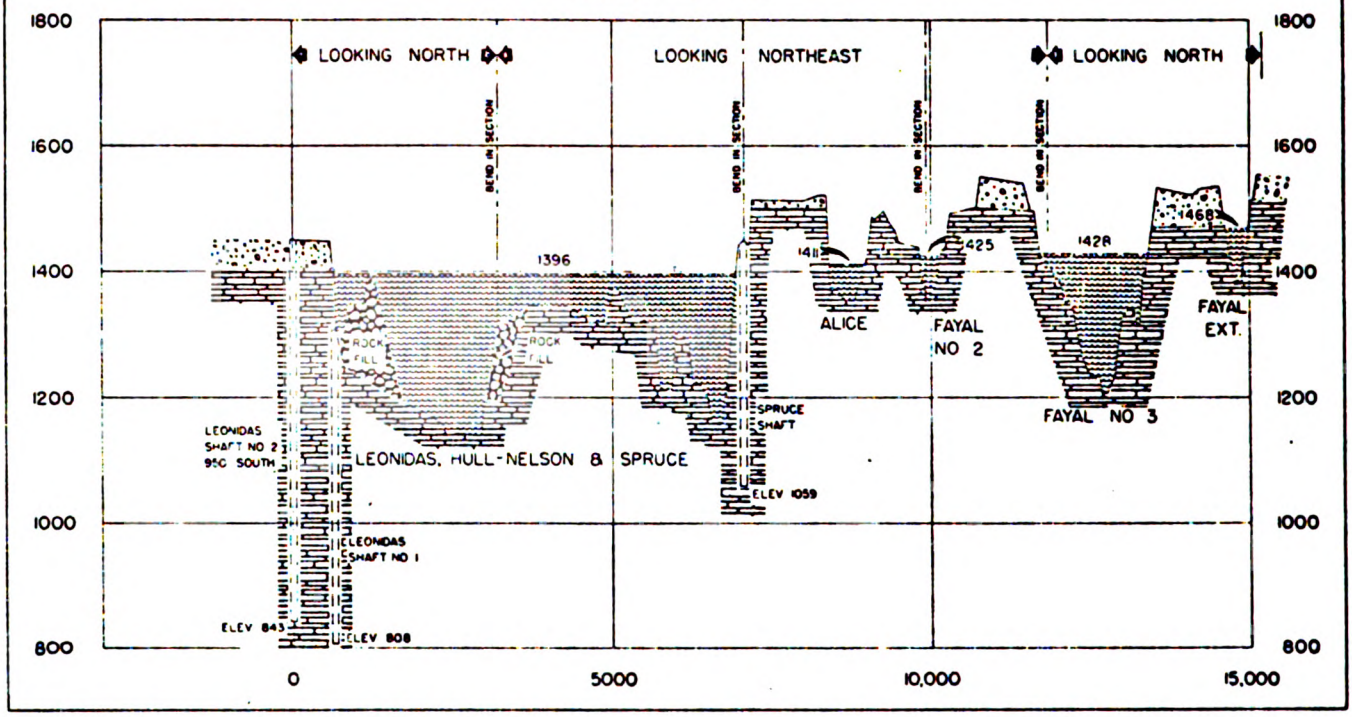
SCALE
HORIZONTAL 1" = 1200'
VERTICAL 1" = 400'





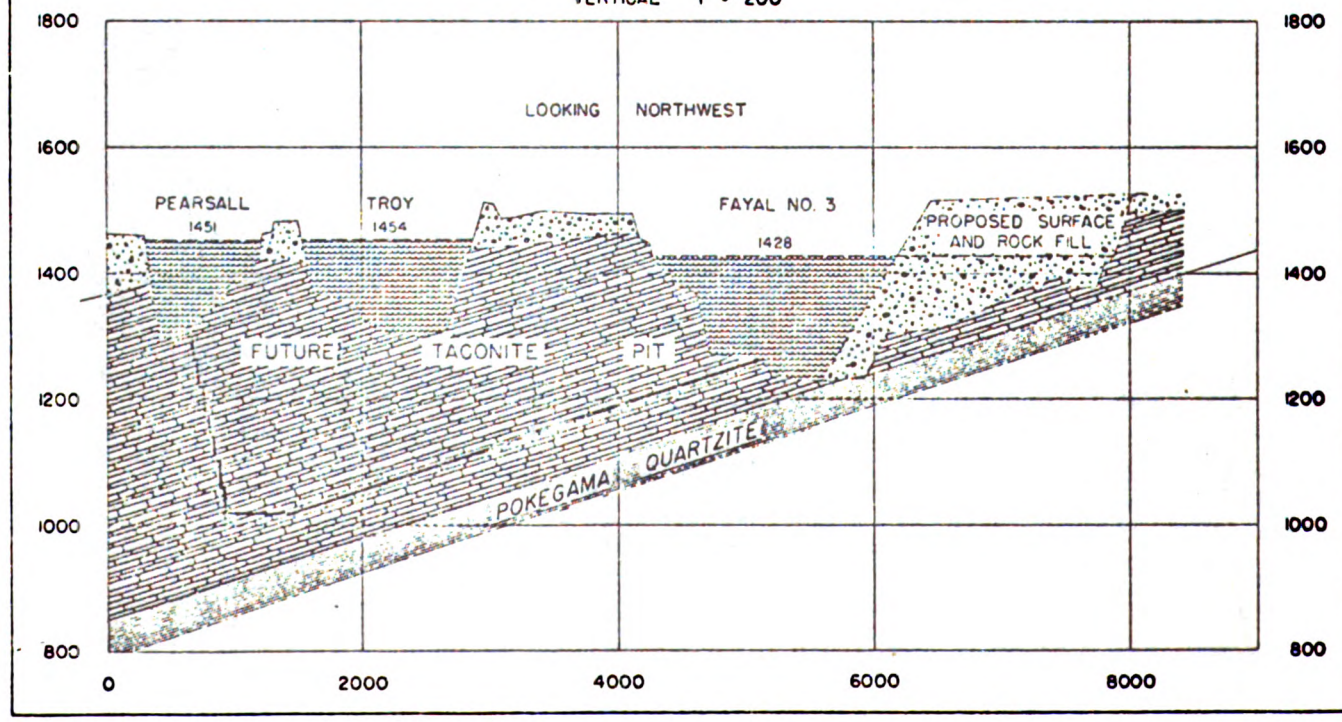
SECTION M-M'

SCALE
HORIZONTAL 1" = 2000'
VERTICAL 1" = 200'



SECTION N-N'

SCALE
HORIZONTAL 1" = 1000'
VERTICAL 1" = 200'



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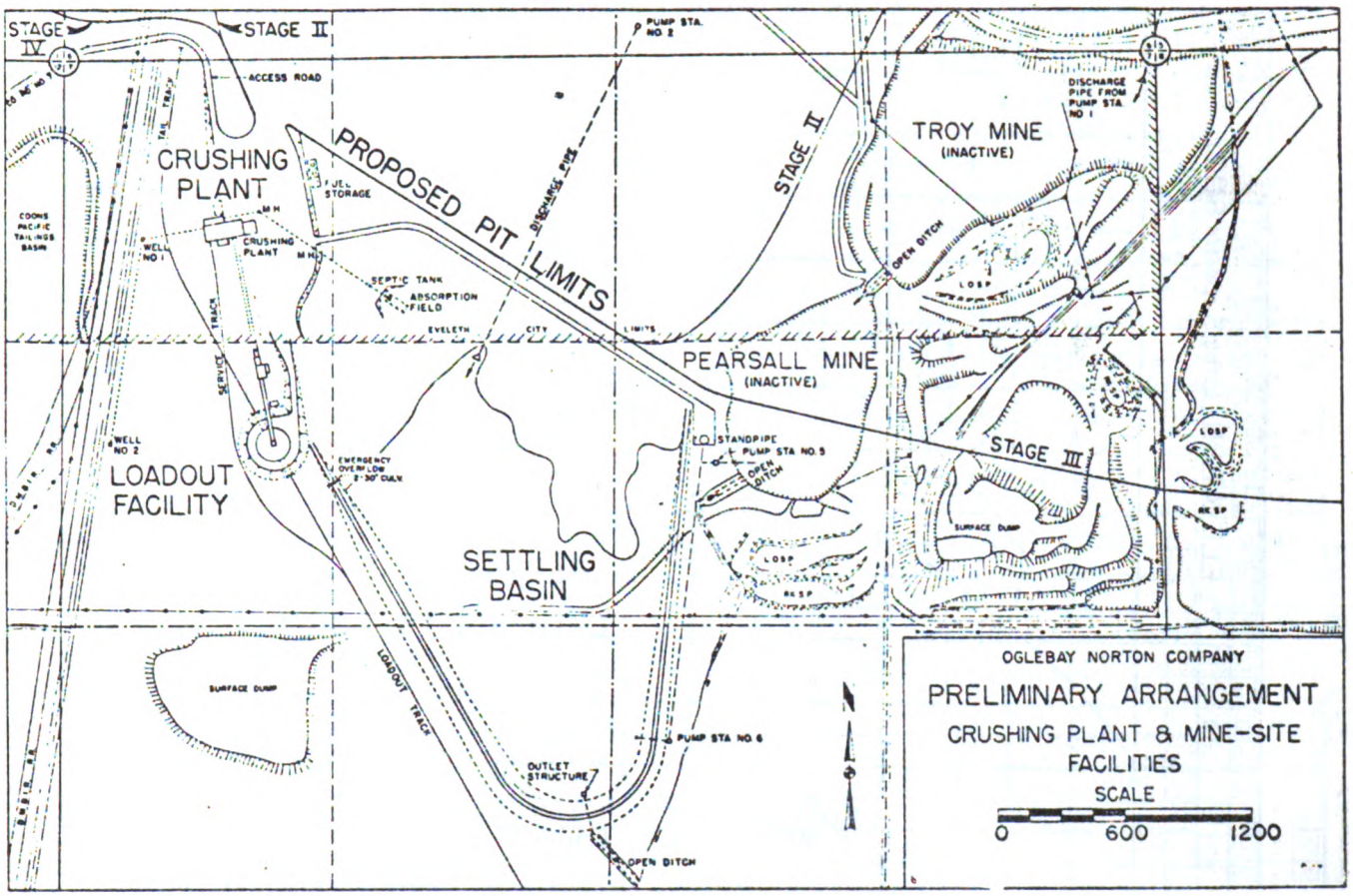
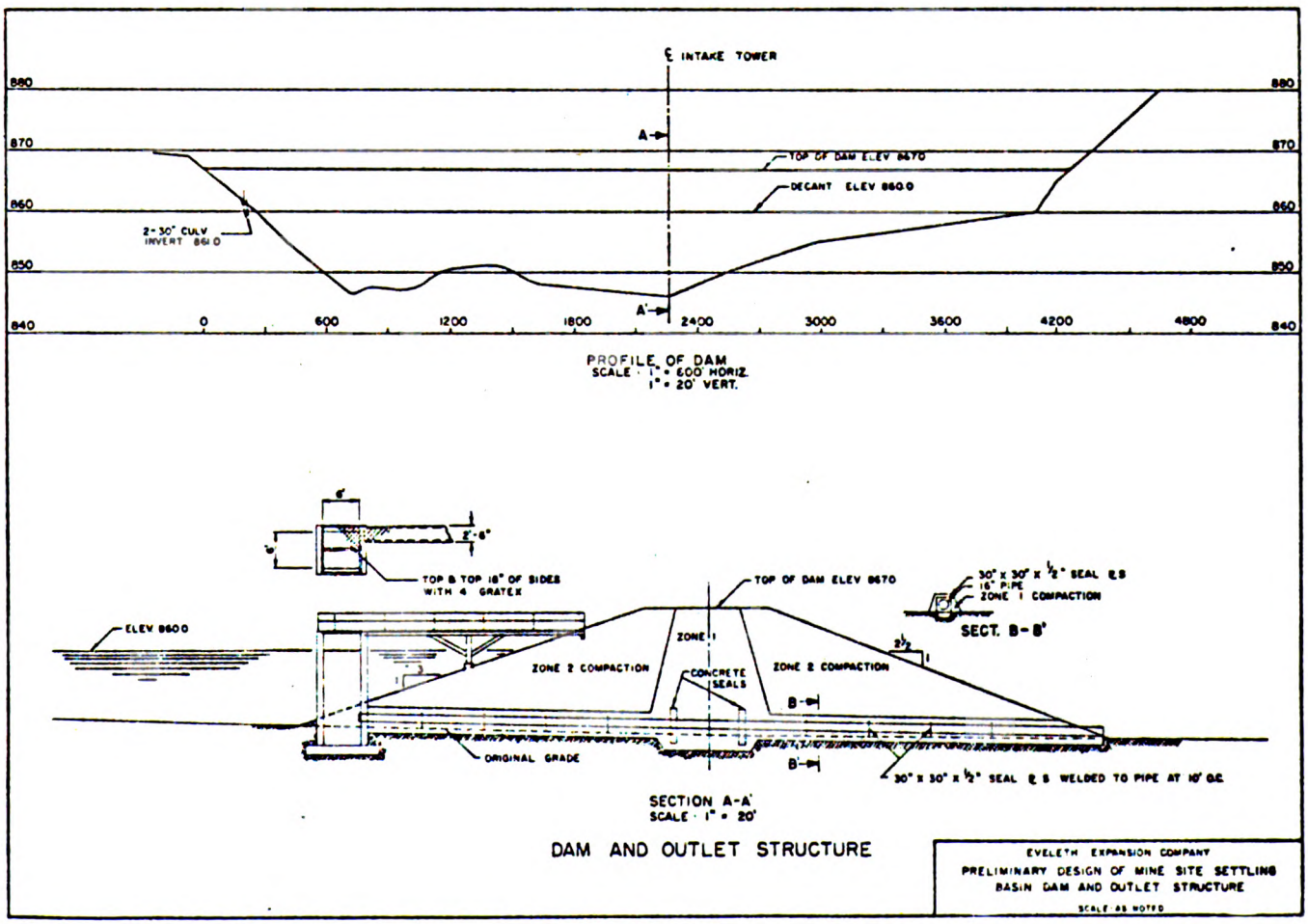

STAGE IV
STAGE II
ACCESS ROAD
CRUSHING PLANT
PROPOSED PIT LIMITS
DISCHARGE PIPE
PUMP STA. NO 2
STAGE II
TROY MINE
(INACTIVE)
DISCHARGE PIPE FROM PUMP STA NO 1
COOKS PACIFIC TAILINGS BASIN
FUEL STORAGE
WELL NO 1
CRUSHING PLANT
SEPTIC TANK
ABSORPTION FIELD
OPEN DITCH
EVELETH CITY LIMITS
PEARSALL MINE
(INACTIVE)
SERVICE TRACK
WELL NO 2
LOADOUT FACILITY
EMERGENCY OVERFLOW 2-30" CULV
STANDPIPE
PUMP STA NO 5
OPEN DITCH
STAGE III
SURFACE DUMP
SETTLING BASIN
LOSP
RR SP
SURFACE DUMP
LOADOUT TRACK
PUMP STA NO 6
OUTLET STRUCTURE
OPEN DITCH
OGLEBAY NORTON COMPANY
PRELIMINARY ARRANGEMENT
CRUSHING PLANT & MINE-SITE FACILITIES
SCALE
0
600
1200


℄ INTAKE TOWER
880
870
860
850
840
A
A'
TOP OF DAM ELEV 8670
DECANT ELEV 860.0
2-30" CULV INVERT 861.0
0
600
1200
1800
2400
3000
3600
4200
4800
PROFILE OF DAM
SCALE 1" = 600' HORIZ.
1" = 20' VERT.
TOP & TOP 18" OF SIDES WITH 4 GRATES
ELEV 860.0
ZONE 2 COMPACTION
ZONE 1
CONCRETE SEALS
ZONE 2 COMPACTION
TOP OF DAM ELEV 8670
30" x 30" x ½" SEAL & 18" PIPE ZONE 1 COMPACTION
SECT. B-B'
2½
1
B
B'
ORIGINAL GRADE
30" x 30" x ½" SEAL & 8 WELDED TO PIPE AT 10' O.C.
SECTION A-A'
SCALE 1" = 20'
DAM AND OUTLET STRUCTURE
EVELETH EXPANSION COMPANY
PRELIMINARY DESIGN OF MINE SITE SETTLING BASIN DAM AND OUTLET STRUCTURE
SCALE AS NOTED

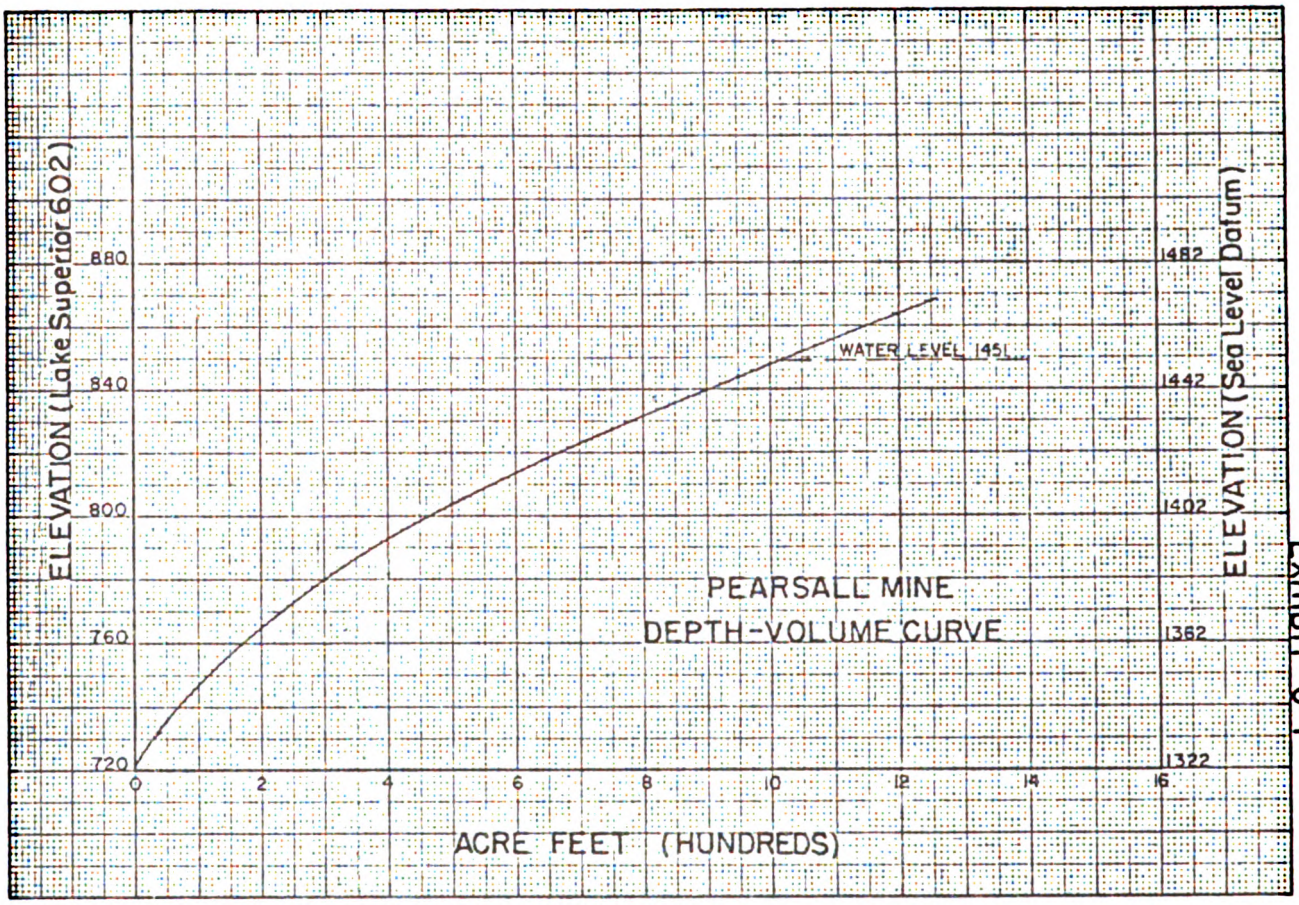


EXHIBIT C-1

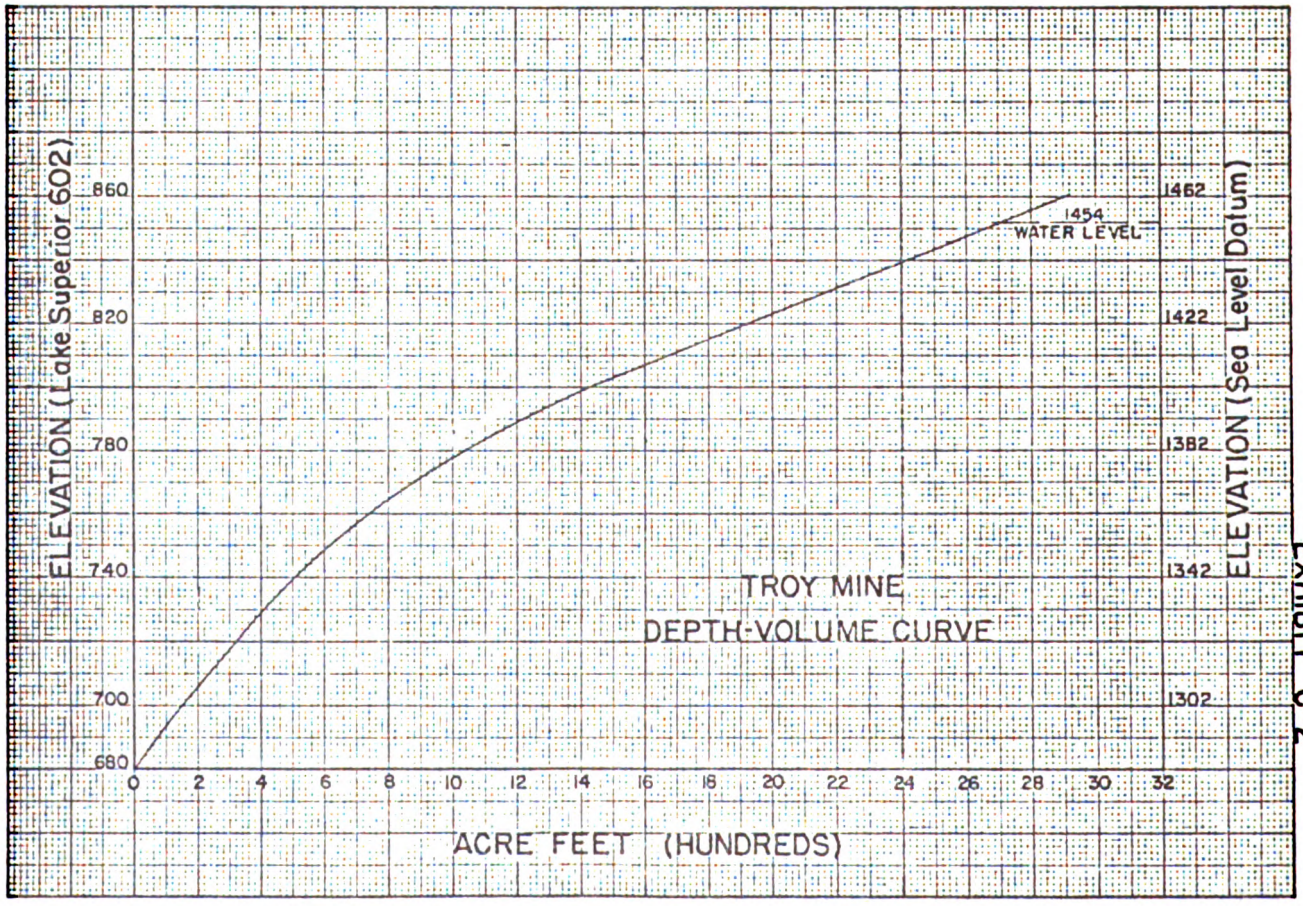


EXHIBIT C-2

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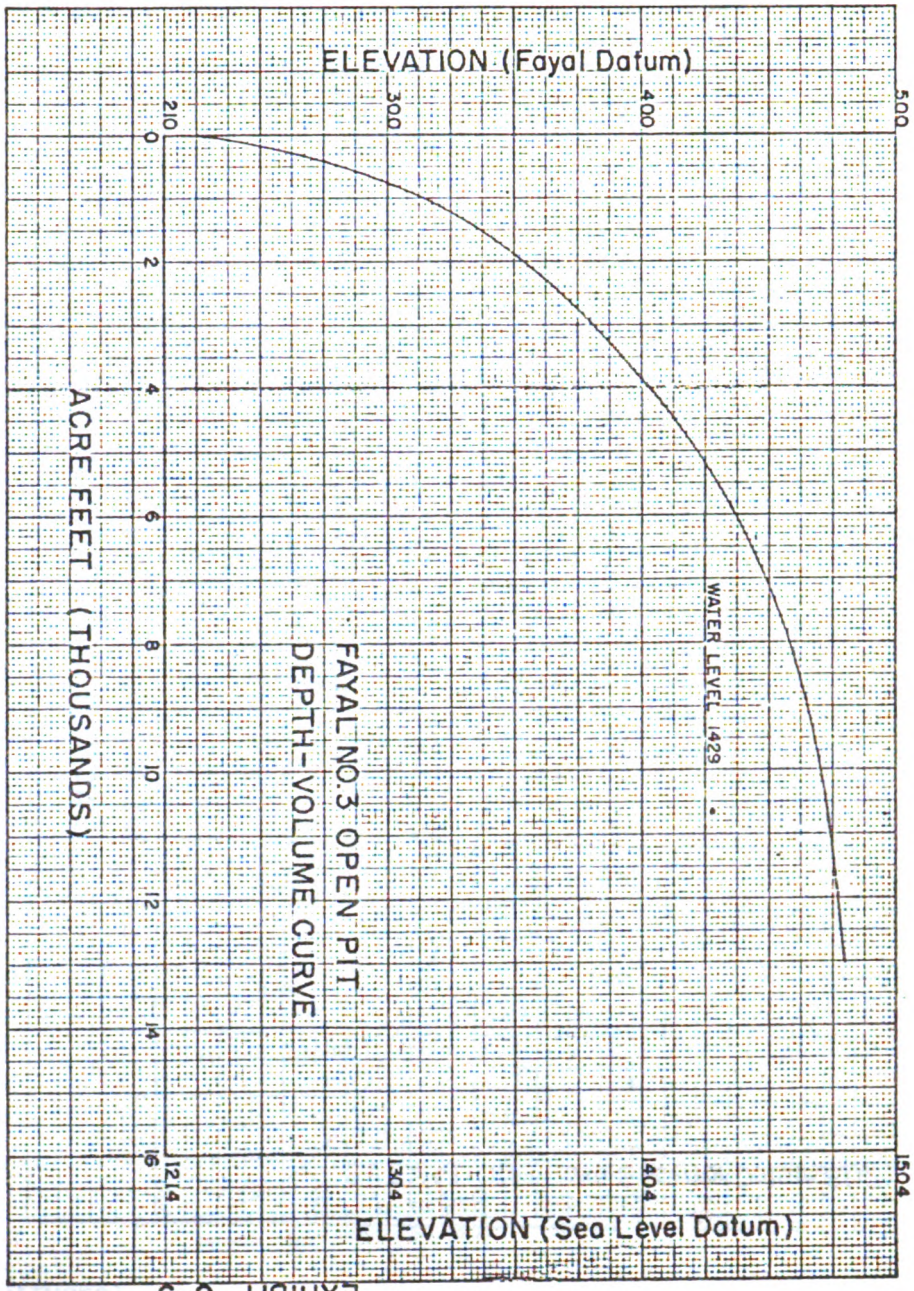

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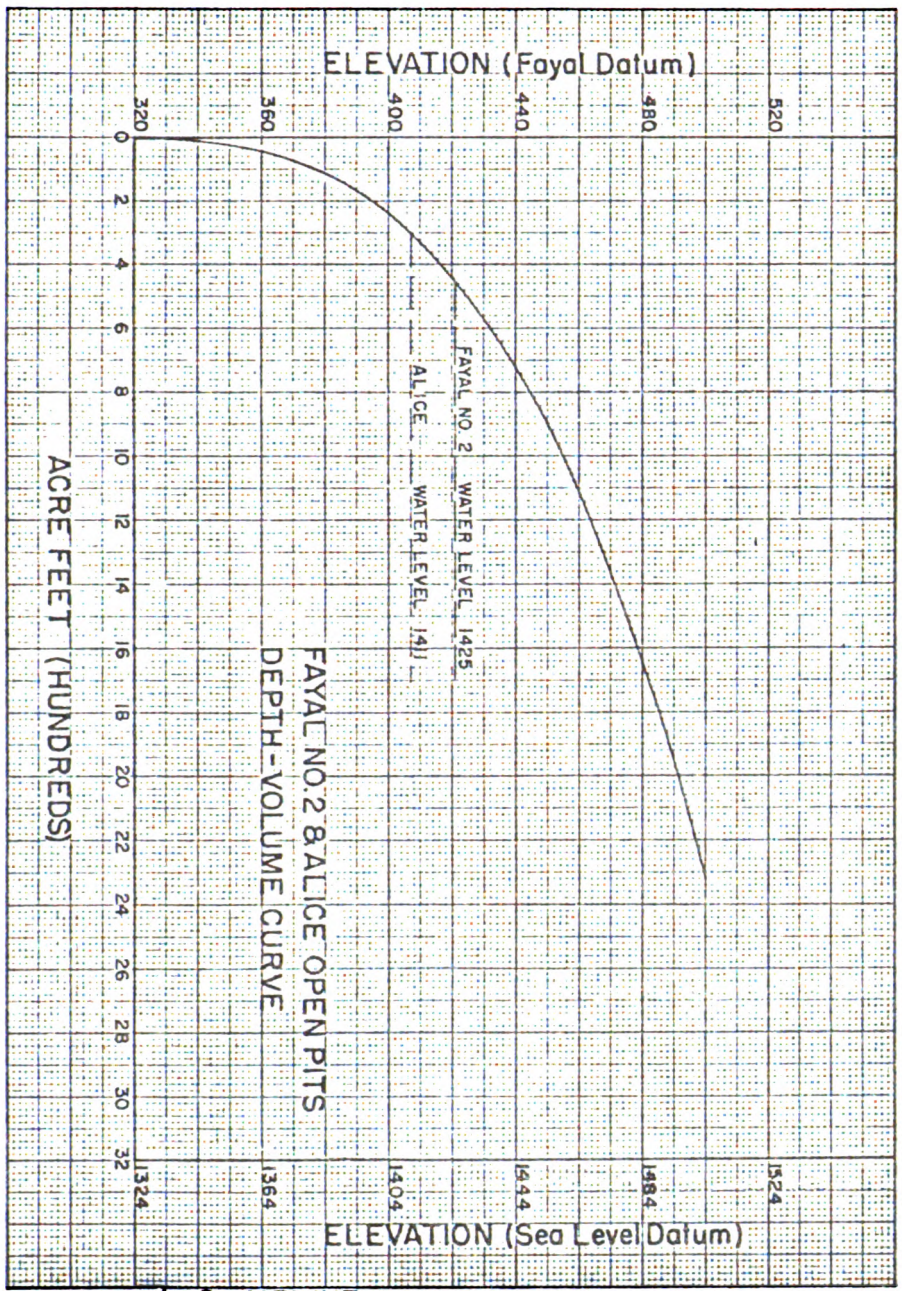

EXHIBIT C-4

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APPENDIX E (CONTINUED)

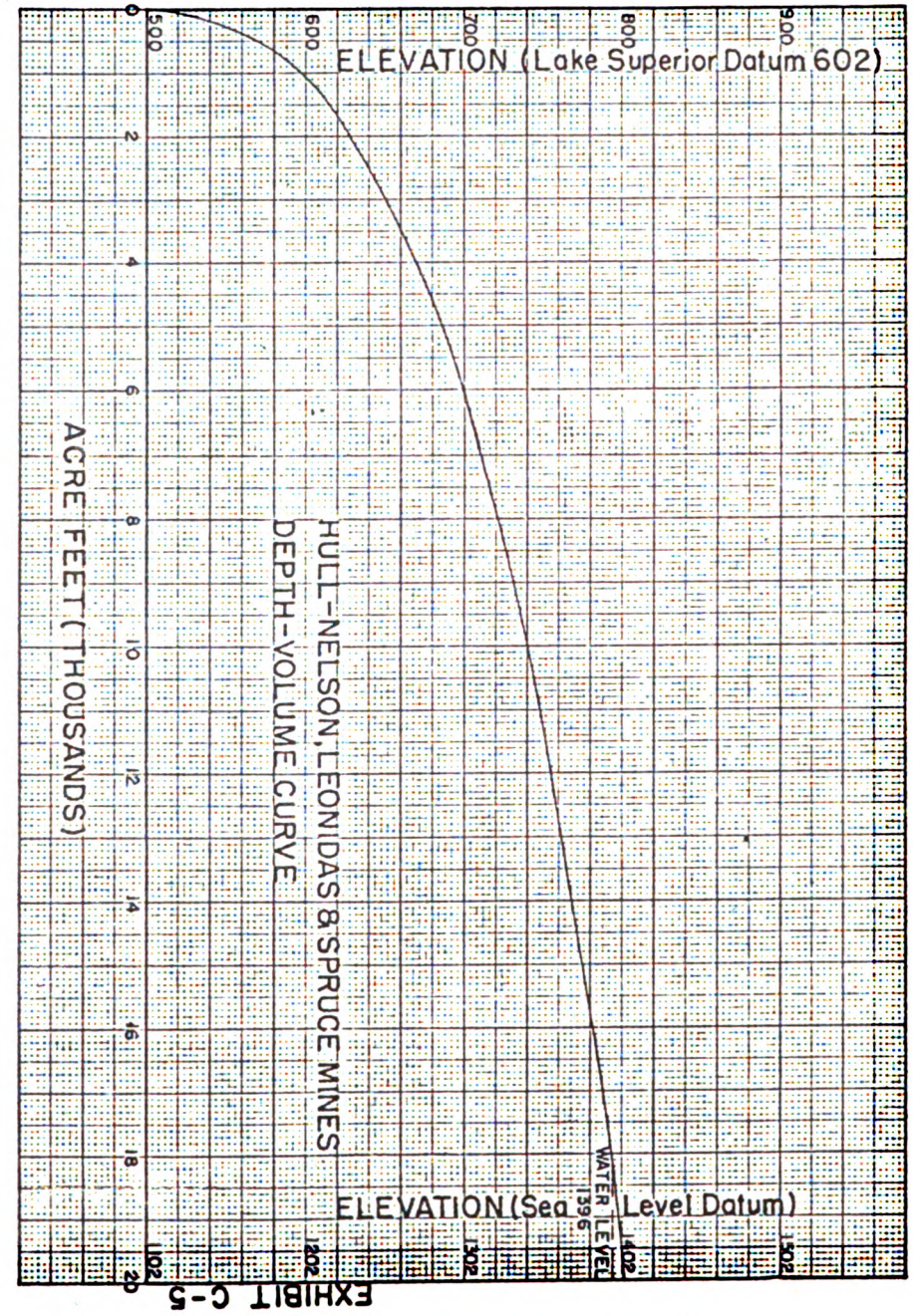

EXHIBIT C-5

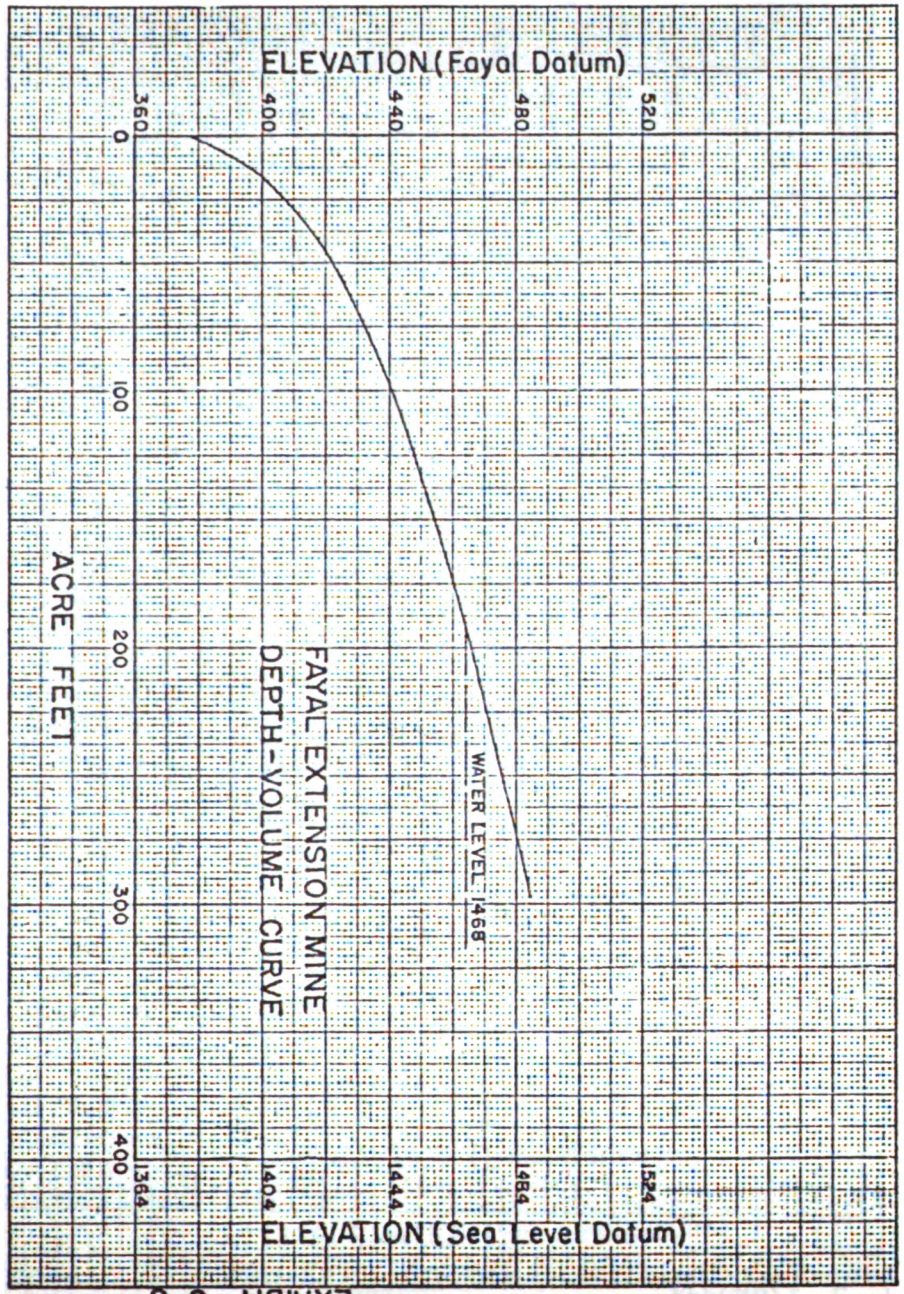

EXHIBIT C-6

APPENDIX E (CONTINUED)

Exhibit J-1

Date	Water Elevation	Drop in Water Elev.	Total Drop
June 24 1943	396.60	Began Pumping at 1:20 P.M.	4.77 Ft.
July 1, "	391.83	4.77 Ft.	9.83
" 8, "	386.77	5.06	14.74
" 15, "	381.86	4.91	19.74
" 22, "	376.86	5.00	
" 27, "		3PM - Pumping reduced to 5000 G.P.M.	
" 29, "	372.02	4.84	24.58
Aug. 2, "	369.77	2.25	26.83
" 9, "	366.07	3.70	30.53
" 16, "	362.36	3.71	34.24
" 23, "	358.15	4.21	38.45
" 30, "	353.74	4.41	42.86
Sept. 3, "		9A.M.-Pumping increased to 6000 G.P.M.	
" 7, "	348.94	4.80	47.66
" 13, "	342.79	6.15	53.81
" 20, "	336.96	5.83	59.64
" 27, "	330.63	6.33	65.97
Oct. 4, "	324.58	6.05	72.02
" 11, "	318.22	6.36	78.38
" 18, "	311.12	7.10	85.48
" 25, "	303.98	7.14	92.62
Nov. 1, "	296.41	7.57	100.19
" 8, "	287.89	8.52	108.71
" 15, "	279.48	8.41	117.12
" 22, "	271.80	7.68	124.80
" 29, "	262.70	9.10	139.90
Dec. 6, "	253.98	8.72	142.62
" 20, "	240.80	13.18	155.80
" 27, "	235.50	5.30	161.10
Jan. 4 1944	233.90	1.60	162.70

Date	Water Elevation	Drop in Water Elev.	Total Drop
Jan. 10, 1944	227.10	6.80	169.50
" 17, "	222.60	4.50	174.00
" 24, "	218.60	4.00	178.00
Feb. 1, "	216.90	1.70	179.70
" 7, "	216.70	.20	179.90
	Dewatering completed.		

Discharge over Weir - [illegible] G.P.M. - [illegible]

PROGRESS CHART
FAYAL PIT PUMPING

ENG. DEPT. VIRGINIA, MINN.
JUNE 14, 1943
C.W.A.
DRAWING No. 5153.

Exhibit J-2

2. PUMPING RECORD, FAYAL AND SPRUCE - JANUARY 1950 THROUGH JANUARY 1959

	FAYAL	SPRUCE
1950		
Avg.	784 GPM	458 GPM
Low	350	359
High	1200	853
1951		
Avg.	520	397
Low	390	376
High	745	526
1952		
Avg.	511	381
Low	350	367
High	765	436
1953		
Avg.	531	373
Low	410	200
High	846	530
1954		
Avg.	538	260
Low	240	184
High	1005	435
1955		
Avg.	497	277
Low	395	187
High	740	405
1956		
Avg.	419	255
Low	324	177
High	564	386
1957		
Avg.	358	372
Low	210	204
High	582	689
1958		
Stopped Pumping 1-14-58	Avg.	298
	Low	149
	High	438
1959		
	Jan.	379

Feb. Taken over by North Range Mag. Co.

Fayal Avg. 1950-1957 Incl. 520 GPM
Spruce Avg. 1950-1958 Incl. 341 GPM

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APPENDIX E (CONTINUED)

Exhibit J-3

3. WATER PUMPED FROM TROY MINE - JANUARY 1952 THROUGH JULY 1962

	GPM 1952	GPM 1953	GPM 1954	GPM 1955	GPM 1956	GPM 1957	GPM 1958	GPM 1959	GPM 1960	GPM 1961	GPM 1962
Jan.	250	250	250	250	None	225	300	300	400	400	None
Feb.	250	250	None	250	None	250	300	300	400	None	None
March	250	250	None	250	250	400	300	300	400	None	800
April	250	250	250	250	400	500	300	250	400	None	700
May	250	250	250	250	500	500	300	250	400	500	700
June	250	250	250	None	500	500	500	250	400	500	700
July	250	250	250	250	None	500	500	250	400	500	700 End of Mining
Aug.	250	325	250	250	None	450	500	400	400	500	
Sept.	250	325	250	600	400	500	500	400	400	500	
Oct.	250	250	250	500	400	300	450	400	400	500	
Nov.	250	250	250	250	300	300	300	None	400	None	
Dec.	250	250	250	250	250	300	300	600	400	None	
Avg.	250	270	200	280	250	390	380	310	400	280	510

Avg. 1952 - 1962 = 320 GPM

Exhibit J-4

4. WATER PUMPED FROM PEARSALL MINE - AUGUST 1958 THROUGH OCTOBER 1961

	GPM 1958	GPM 1959	GPM 1960	GPM 1961
January		225	400	200
February		225	200	200
March		225	200	200
April		250	200	200
May		250	200	350
June		250	200	350
July	None	250	200	350
August	200	400	200	350
September	200	400	200	350
October	200	400	200	350 End of Mining
November	225	None	200	
December	225	None	200	
Avg.	210	240	220	290

Avg. 1958 - 1961 = 240 GPM

APPENDIX E (CONTINUED)

Exhibit J-5

Exhibit J-5 (Cont'd)

5. WATER LOG OF LEONIDAS SHAFT - APRIL 26, 1960 THROUGH APRIL 3, 1961

Top of Shaft Set - 1st Pump 309.5' below Collar Elev. 531.7 Head GPM Elev.
Started 1st Pump - Peerless 250 HP, 3:30 P.M. May 9, 1961 216 1650 526.5

Top of Shaft Set - 2nd Pump 303.5' below Collar Elev. 538.7
Started 2nd Pump - Pamona 200 HP, May 13, 1961

Collar Elev. 841.2

Date	Water Elev.		
May 9, 1961	526.5	Started 1st Pump - 250 HP	
May 11	524.2		
" 12	523.6		
" 13		Started 2nd Pump 3: PM, 200 HP	
" 14	520.7	#2 Pump idle 3 PM 14th to 11 AM 15th	
" 16	519.5		
" 18	516.2		
" 19	513.2	328.0' below collar.	Measurement taken with new wire set up.
" 20	511.7	329.5	
" 21	510.3	330.9	
" 22	509.2	332.0	
" 23	507.1	334.1	
" 24	505.7	335.5	
" 25	504.0	337.2	
" 26	502.1	339.1	
" 27	500.3	340.9	
" 28	498.4	342.8	
" 29	496.4	344.8	
" 30	494.5	346.7	
" 31	492.6	348.6	
June 1	490.8	350.4	
" 2	488.9	352.3	
" 3	487.0	354.2	
" 4	485.0	356.3	
" 5	483.1	358.1	
" 6	481.2	360.0	
" 7	479.3	361.9	
" 8	477.3	363.9	
" 9	475.5	365.7	
" 10	473.7	367.5	
" 11	471.5	369.7	
" 12	469.7	371.5	
" 13	468.5	372.7	
" 14	467.0	374.2	
" 15	465.2	376.0	
" 16	463.2	378.0	
" 17	461.6	379.6	
" 18	459.8	381.4	
" 19	458.4	382.8	
" 20	457.8	384.2	
" 21	455.2	386.0	
" 22	453.4	387.8	
" 23	452.0	389.2	
" 24	450.0	391.2	
" 25	448.7	392.5	

5. WATER LOG OF LEONIDAS SHAFT - APRIL 26, 1960 THROUGH APRIL 3, 1961 (Cont'd)

Date	Water Elev.		
June 26, 1961	446.8	394.4' below collar	
" 27	445.0	396.2	
" 28	443.1	398.1	
" 29	441.0	400.2	
" 30	439.1	402.1	
July 1	437.4	403.8	
" 2	435.5	405.7	
" 3	433.7	407.5	
" 4	431.7	409.5	
" 5	430.0	411.2	
" 6	428.2	413.0	
" 7	426.6	414.6	
" 8	424.8	416.4	
" 9	423.1	418.1	
" 10	421.7	419.5	
" 11	420.0	421.2	
" 12	420.5	420.7	1 Pump
" 13	421.7	419.5	1 Pump
" 14	420.8	420.4	
" 15	418.4	422.8	
" 16	416.7	424.5	
" 17	415.3	425.9	
" 18	415.2	426.0	
" 19	413.5	427.7	
" 20	411.6	429.6	1 Pump
" 21	413.0	428.2	
" 22	414.4	426.8	
" 23	415.4	425.8	
" 24	415.7	425.5	
" 25	416.0	425.2	Running 1 Pump Alternating 12 hours each pump
" 26	416.4	424.8	
" 27	416.6	424.6	
" 28	416.7	424.5	
" 29	416.7	424.5	
" 30	417.0	424.2	
" 31	417.2	424.0	
Aug. 1	417.4	423.8	
" 2	417.8	423.4	
" 3	417.8	423.4	

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APPENDIX E (CONTINUED)

Exhibit J-6

6. LOG OF FAYAL PUMPING - FEBRUARY 14, 1961 THROUGH AUGUST 19, 1964

Troy Elevations Fayal = Troy-502.14

Date	Water Elev.	Rise of Water
2-14-61	847.7	
5-29-61	854.1	6.4 ft.
9-12-61	856.8	2.7 "
12-20-61	858.7	1.9 "
3- 7-62	859.1	0.4 "
6-18-62	862.0	2.9 "
7-20-62	862.4	0.4 "

Pumping Started by R. & F.

Date	Water Elev.	Drop in Water	Pumps
7-20-62	862.4		1
7-23-62	861.7	0.7 ft.	2
7-24-62	861.2	0.5 "	2
7-25-62	860.7	0.5 "	2
7-26-62	860.3	0.4 "	2
7-27-62	859.8	0.5 "	2
7-30-62	858.1	1.7 "	2
7-31-62	857.7	0.4 "	2
8- 1-62	857.2	0.5 "	2
8- 2-62	856.8	0.4 "	2
8- 3-62	856.3	0.5 "	2
8- 6-62	854.2	2.1 "	2
8- 7-62	853.8	0.4 "	2
8- 8-62	853.4	0.4 "	2
8- 9-62	853.0	0.4 "	2
	NO PUMPING		
8-15-62	853.3		2
8-16-62	852.8	0.5 "	2
8-17-62	852.3	0.5 "	2
8-20-62	850.3	2.0 "	2
8-21-62	849.9	0.4 "	2
8-22-62	849.5	0.4 "	2
8-23-62	849.1	0.4 "	2
8-24-62	848.8	0.3 "	1
8-27-62	848.0	0.8 "	1
8-28-62	847.8	0.2 "	1
8-29-62	847.6	0.2 "	1
8-30-62	847.4	0.2 "	1
8-31-62	847.1	0.3 "	1
9- 4-62	845.7	1.4 "	1
9- 5-62	845.5	0.2 "	1
9- 6-62	845.1	0.4 "	2
9- 7-62	844.6	0.5 "	2
9-10-62	842.8	1.8 "	2
9-11-62	842.4	0.4 "	2
9-13-62	841.9	0.5 "	2
9-17-62	840.0	1.9 "	2
9-21-62	838.9	1.1 "	2
9-24-62	837.3	1.6 "	2
9-27-62	836.5	0.8 "	2
	-502.1		
Fayal Elev.	334.4		

Exhibit J-6 (Cont'd)

6. LOG OF FAYAL PUMPING - FEBRUARY 14, 1961 THROUGH AUGUST 19, 1964

Date	Water Elev.	Pumps
10-26-63	353.0	1-200 HP
10-28-63	352.4	1-200 Hp
10-31-63	351.6	1-200 HP; 1-250 HP
11- 1-63	350.9	
11- 8-63	346.0	
11-15-63	341.1	
11-21-63	336.9	
11-29-63	331.3	
12- 2-63	329.2	1-200 HP; 1-250 HP
12- 3-63	328.9	1-200 HP
12- 5-63	328.2	1-200 HP
12- 6-63	327.5	1-200 HP; 1-150 HP
12-13-63	322.8	
12-20-63	317.4	
12-30-63	309.0	
1- 6-64	302.6	
1-13-64	295.5	1-200 HP; 1-150 HP
1-17-64	291.4	Stopped Pumps
1-31-64	293.3	
2-14-64	294.82	
2-28-64	296.1	
3-13-64	297.5	
3-31-64	299.3	
4- 2-64	299.5	1-200 HP
4- 7-64	297.1	1-200 HP
4-13-64	294.4	
4-20-64	290.0	Stopped Pump
4-20-64	290.9	
4-24-64	292.0	
5- 5-64	294.4	
5-11-64	296.2	
5-20-64	297.9	1-200 HP
5-26-64	295.0	
6- 1-64	291.8	
6- 2-64	291.3	Stopped Pump
6-15-64	294.0	
6-22-64	294.9	
6-25-64		1-200 HP
6-29-64	295.0	Stopped Pump
7- 3-64		1-200 HP
7- 6-64	294.6	No Pumping
7-10-64	295.3	1-200 HP
7-12-64		No Pumping
7-17-64		1-200 HP
7-20-64		Stopped Pump
7-22-64	293.1	
7-27-64	294.1	
8- 5-64	295.8	
8-12-64		1-200 HP
8-19-64		Stopped Pump

Exhibit J-7

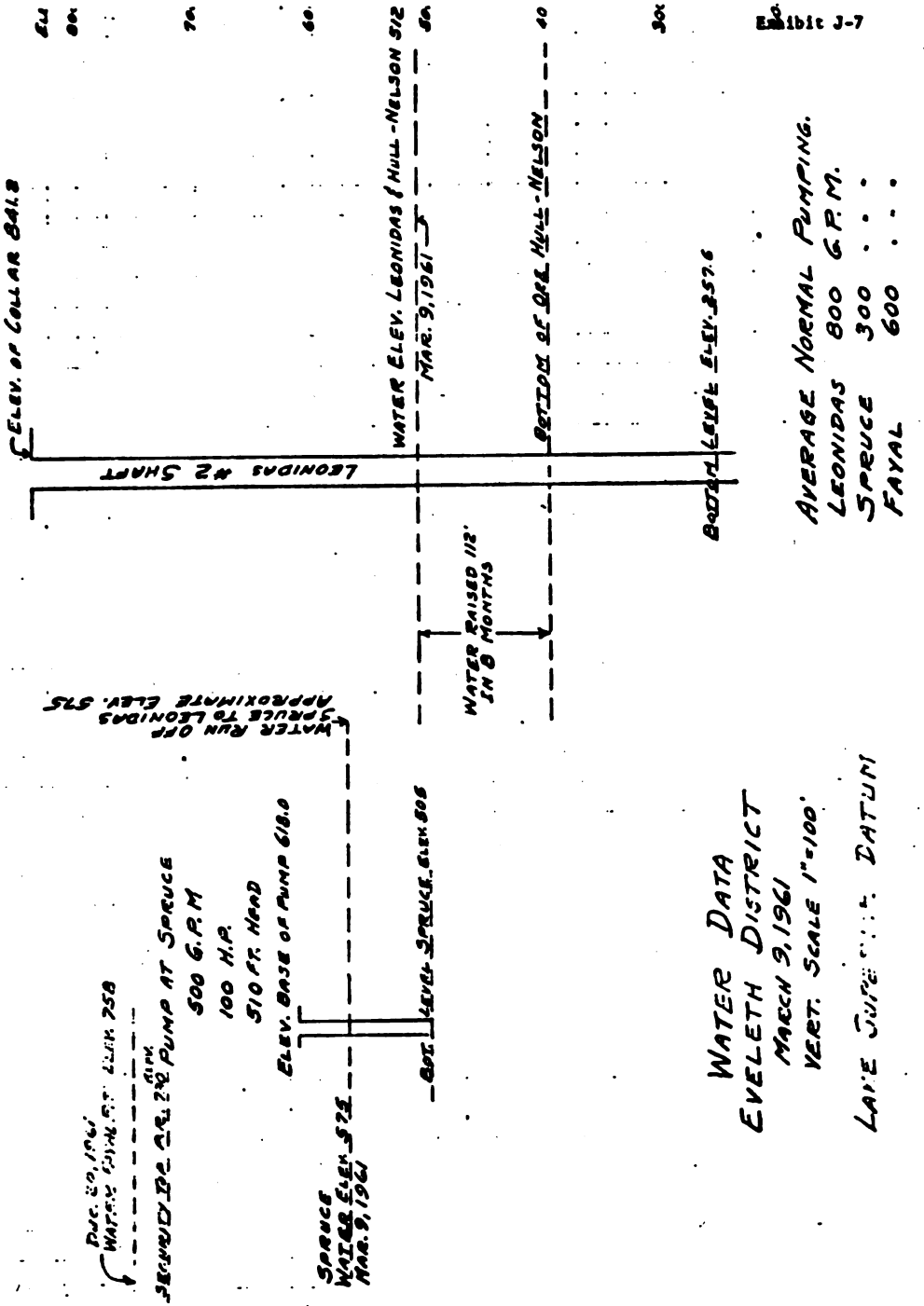

Exhibit J-8

8. PUMPING RECORD LEONIDAS SHAFT - MAY 9, 1961 THROUGH AUGUST 3, 1961

Top of Shaft Set - 1st Pump 309.5' below Collar Elev. 531.7 Head GPM Elev.
Started 1st Pump - Peerless 250 HP, 3:30 P.M. May 9, 1961 216 1650 526.5

Top of Shaft Set - 2nd Pump 303.5' below Collar Elev. 538.7
Started 2nd Pump - Pamona 200 HP, May 13, 1961

Collar Elev. 841.2

Date	Water Elev.		
May 9, 1961	526.5	Started 1st Pump - 250 HP	
May 11	524.2		
" 12	523.6		
" 13		Started 2nd Pump 3: PM, 200 HP	
" 14	520.7	#2 Pump idle 3 PM 14th to 11 AM 15th	
" 16	519.5		
" 18	516.2		
" 19	513.2	328.0' below collar.	Measurement taken with new wire set up.
" 20	511.7	329.5	
" 21	510.3	330.9	
" 22	509.2	332.0	
" 23	507.1	334.1	
" 24	505.7	335.5	
" 25	504.0	337.2	
" 26	502.1	339.1	
" 27	500.3	340.9	
" 28	498.4	342.8	
" 29	496.4	344.8	
" 30	494.5	346.7	
" 31	492.6	348.6	
June 1	490.8	350.4	
" 2	488.9	352.3	
" 3	487.0	354.2	
" 4	485.0	356.3	
" 5	483.1	358.1	
" 6	481.2	360.0	
" 7	479.3	361.9	
" 8	477.3	363.9	
" 9	475.5	365.7	
" 10	473.7	367.5	
" 11	471.5	369.7	
" 12	469.7	371.5	
" 13	468.5	372.7	
" 14	467.0	374.2	
" 15	465.2	376.0	
" 16	463.2	378.0	
" 17	461.6	379.6	
" 18	459.8	381.4	
" 19	458.4	382.8	
" 20	457.0	384.2	
" 21	455.2	386.0	
" 22	453.4	387.8	
" 23	452.0	389.2	
" 24	450.0	391.2	
" 25	448.7	392.5	

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APPENDIX E (CONTINUED)

Exhibit J-8
(Cont'd)

8. PUMPING RECORD LEONIDAS SHAFT - MAY 9, 1961 THROUGH AUGUST 3, 1961

Date	Water Elev.		
June 26, 1961	446.8	394.4' below collar	
" 27	445.0	396.2	
" 28	443.1	398.1	
" 29	441.0	400.2	
" 30	439.1	402.1	
July 1	437.4	403.8	
" 2	435.5	405.7	
" 3	433.7	407.5	
" 4	431.7	409.5	
" 5	430.0	411.2	
" 6	428.2	413.0	
" 7	426.6	414.6	
" 8	424.8	416.4	
" 9	423.1	418.1	
" 10	421.7	419.5	
" 11	420.0	421.2	
" 12	420.5	420.7	1 Pump
" 13	421.7	419.5	1 Pump
" 14	420.8	420.4	
" 15	418.4	422.8	
" 16	416.7	424.5	
" 17	415.3	425.9	
" 18	415.2	426.0	
" 19	413.5	427.7	
" 20	411.6	429.6	1 Pump
" 21	413.0	428.2	
" 22	414.4	426.8	
" 23	415.4	425.8	
" 24	415.7	425.5	
" 25	416.0	425.2	
" 26	416.4	424.8	
" 27	416.6	424.6	
" 28	416.7	424.5	
" 29	416.7	424.5	
" 30	417.0	424.2	
" 31	417.2	424.0	
Aug. 1	417.4	423.8	
" 2	417.8	423.4	
" 3	417.8	423.4	

Running 1 Pump
Alternating 12 hours each pump

Exhibit J-9

WATER SAMPLE ANALYSES OF OPEN PIT MINE PONDS

Grab Samples Taken May 24, 1974, by Oglebay Norton Company
Analyses by Lerch Brothers, Inc., Hibbing, Minnesota

	Spruce Hull-Nelson Leonidas	Pearsall	Troy	Fayal Exten.	Fayal No. 3	Fayal No. 2	Alice
pH	7.6	8.1	8.1	8.2	7.9	7.9	7.8
Tot.Alkal'y, mg/l (as $CaCO_3$)	175	130	138	101	139	267	271
Ca Hardness, mg/l "	394	130	194	74	134	174	166
Total Hardness, mg/l "	1,044	270	414	142	298	424	434
Sulfide, mg/l (S)	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Sulfate, mg/l (SO_4)	710	170	385	30	195	145	180
Chloride, mg/l	13	3	5	16	10	7	7
Bromide, mg/l	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Fluoride, mg/l	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Nitrate, mg/l (NO_3 as N)	.59	.02	<.01	.01	.04	<.01	.07
Nitrite, mg/l (NO_2 as N)	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Ammonia, mg/l (NH_3 as N)	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Oil & Grease, mg/l	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Color, Pt-Co units	< 5	< 5	5	15	5	10	5
Turbidity, J.T.U.	4	3	5	4	3	5	3
B.O.D., mg/l	< 1	< 1	< 1	3	2	2	2
Dissolved Oxygen, mg/l	9.6	10.1	10.0	10.2	10.3	9.9	9.8
Total Bacteria, per ml	4	10	45	62	71	53	61
Total Coliform, MPN/100 ml	2.2	5	15	38	38	8.8	8.8
Suspended Solids, mg/l	8	10	8	9	5	4	2
Total Solids, mg/l	433	354	607	186	423	496	491
Dissolved Solids, mg/l	425	344	599	177	418	492	489
Phosphate, mg/l	<.01	<.01	<.01	.02	<.01	<.01	.02
Mercury, ug/l	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Aluminum, ug/l	< 100	< 100	< 100	< 100	< 100	< 100	< 100
Chromium, ug/l	< 100	< 100	< 100	< 100	< 100	< 100	< 100
Copper, ug/l	3	3	3	3	2	3	4
Iron, ug/l	30	31	33	33	40	79	121
Lead, ug/l	5	6	5	6	5	5	5
Manganese, ug/l	400	10	28	15	122	2,600	2,700
Nickel, ug/l	11	6	6	7	10	12	11
Zinc, ug/l	8	7	6	8	6	8	8
Tannins & Lignins	INSUFFICIENT	SAMPLE		-	-	-	-

APPENDIX F

Extent of Appropriation, Use & Disposal of Well Pumpage

The corase crushing plant located in the NW¼ of Section 7, Township 57, North, Range 17 West will reduce Expansion Open Pit run-of-mine crude ore by two stages of crushing to the nominal top size of 3 inches for rail transportation to the Fairlane Plant for co-mingling with Thunderbird Mine crude ores and beneficiation in the crushing, concentrating and agglomeration facilities. Operation of the coarse crushing facility will create a demand for water for consumptive use as potable water for plant and mine personnel; water for collection, transportation and treatment of sanitary sewage; and boiler feed water for the crushing plant heating system. In addition, low temperature waters will be required for cooling of the aircompressors and crusher bearing oil and for reuse in floor wash and miscellaneous housekeeping functions. When the facility gets into full production the average demand for water for both consumptive and non-consumptive uses will be about 75,000 gallons per day that will be met by the production of two wells - one of which is 300 feet due west of the crushing plant and the other 1,000 feet due south of the west well. (See Exhibit H, bound herein.)

In December of 1973, the Soil Engineering Services, Inc. of Minneapolis, Minn., was retained by Oglebay Norton Company to put down a number of penetration test borings and observation and test wells to identify the soil and water conditions at the Crushing Plant site. After analysis of the data on the soil characteristics and the results of pumping tests as reported by S.E.S., the Consultant developed the preliminary design for the two production wells to meet the requirements for ground water at the mine-site coarse crusher. That design for each well involves placement of 80 feet of 8-inch ID single casing A53B schedule 40 pipe with welded connections, and then installation of a 20-foot 8-inch stainless steel screen with a 2-foot seal of neoprene packing at the juncture of the casing and screen. The pump will be a line shaft water-lubricated vertical turbine pump with a 4-inch column pipe capable of delivering 75 gallons per minute with a 60 psi discharge

pressure at the well head with the bowl set immediately above the screen. The pump will be powered by a 5 HP vertical hollow shaft NEMA Type 1, weather-protected motor with a non-reversible ratchet, set not less than 2 feet above the floor of the pump house. The piping within the pump house shall include air release valves, check valve, gate valve and meter, and a pre-lube line. The pump house shall be electrically heated.

The Consultant's estimate of the water required from the two wells during the various phases of open pit development may be recapitualted as follows:

Table 8

	Average in Thousands of Gallons per Day				
	Stage I	Stage II -Initial	Stage II -Final	Stage III	Stage IV
Consumptive Use of Water					
Potable & Sanitary Water	1	2	2	3	3
Boiler Feed Water	1	2	2	3	3
Total	2	4	4	6	6
Non-consumptive Use of Water					
Cooling Air Compressors	None	4	4	4	4
Cooling Crusher Bearing Oil	"	30	30	65	65
Floor Wash & Misc. Use	"	Reuse	Reuse	Reuse	Reuse
Total	None	34	34	69	69

After partial reuse as floor wash and for miscellaneous housekeeping functions, the non-consumed waters will be discharged into the crushing plant settling basin as an effluent where it will be diluted by impounded surface runoff, cooled and clarified before being released to the unnamed stream flowing southerly to the St. Louis River.

Total Appropriation, Use & Disposal of Water

The extent of the appropriation, use and disposal or release of waters in the mine and plant areas involved in the expansion of the taconite operation may be recapitulated as follows:

APPENDIX F (CONTINUED)

THUNDERBIRD MINE

Appropriation of Water	Average in Thousands of Gallons per Day: Current Operation	Expanded Operation: Initial	Expanded Operation: Final
Surface Runoff	35.9	35.9	35.9
Mine Water	283.1	400.0	1,150.0
Ground Water	14.4	14.4	14.4
Purchase from Municipal Supply	82.0	145.0	151.5
Total Appropriated	415.4	595.3	1,351.8
Consumptive Use			
Cooling Water - Drills	13.5	17.0	17.0
Dust Control - Roads	26.5	33.0	39.5
Boiler Feed Water	22.0	60.0	60.0
Steam Room Floor Wash	1.0	4.0	4.0
Crushing Plant Sanitary Sewage	0.6	1.0	1.0
Total Consumption	63.6	115.0	121.5
Release of Water			
Release to Elbow Lake	22.6	25.2	25.2
Release to Manganika Lake	329.2	455.1	1,205.1
Total Release	351.8	480.3	1,230.3
% Release	84.7%	80.7%	91.0%

EXPANSION OPEN PIT

Appropriation of Water	Average in Thousands of Gallons per Day: Stage I	Stage II -Initial	Stage II -Final	Stage III	Stage IV
Surface Runoff	226	149	72	72	72
Mine Water	4,320	2,160	2,160	4,320	5,760
Ground Water	2	38	38	75	75
Total Appropriated	4,548	2,347	2,270	4,467	5,907
Consumptive Use					
Cooling Water - Drills	9	13	13	17	17
Dust Control - Roads	17	26	26	35	52
Boiler Feed Water	1	2	2	3	3
Crushing Plant Sanitary Sewage	1	2	2	3	3
Total Consumption	28	43	43	58	75

Release of Waters	Average in Thousands of Gallons per Day: Stage I	Stage II -Initial	Stage II -Final	Stage III	Stage IV
Release to St. Louis River	4,520	2,304	2,227	2,969	2,952
Release to Elbow Lake	None	None	None	1,440	1,440
Release to Manganika Lake	None	None	None	None	1,440
Total Released	4,520	2,304	2,227	4,409	5,832
% Released	99.4%	98.2%	98.1%	98.7%	98.7%

FAIRLANE PLANT

	Average in Thousands of Gallons per Day: Current Operation	Proposed Expansion
Total Appropriated	3,038	8,227
Consumptive Use - All Purposes	3,038	8,227
Total Released	None	None
% Released	0.0%	0.0%

TOTAL OPERATION

Appropriation of Water	Average in Thousands of Gallons per Day: Current Operation	Expanded Operation: Initial	Expanded Operation: Final
Thunderbird Mine	415.4*	595.3**	1,351.8***
Expansion Open Pit	None	2,347.0	5,907.0
Fairlane Plant	3,038.0	8,227.0	8,227.0
Total Appropriated	3,453.4	11,169.3	15,485.8
Consumptive Use			
Thunderbird Mine	63.6	115.0	121.5
Expansion Open Pit	None	43.0	75.0
Fairlane Plant	3,038.0	8,227.0	8,227.0
Total Consumptive	3,101.6	8,385.0	8,423.5

	Average in Thousands of Gallons per Day: Current Operation	Proposed Expansion: Initial	Proposed Expansion: Final
Release of Water			
Release to Manganika Lake			
Thunderbird Mine	329.2	455.1	1,205.1
Expansion Open Pit	None	None	1,440.0
Total	329.2	455.1	2,645.1

Release of Water Continued	Average in Thousands of Gallons per Day Current Operation	Proposed Expansion Initial	Proposed Expansion Final
Release to Elbow Lake			
Thunderbird Mine	22.6	25.2	25.2
Expansion Open Pit	None	None	1,440.0
Total	22.6	25.2	1,465.2
Release to St. Louis River			
Expansion Open Pit	None	2,304.0	2,952.0
Fairlane Plant	None	None	None
Total	None	2,304.0	2,952.0
Total Release of Water			
St. Louis River via Manganika Lake	329.2	455.1	2,645.1
St. Louis River via Elbow Lake	22.6	25.2	1,465.2
St. Louis River via Fairlane Plant	None	None	None
Sub Total	351.8	480.3	4,110.3
St. Louis R. via Long Lake Creek	None	2,304.0	2,952.0
Grand Total	351.8	2,784.3	7,062.3

* Includes 82,000 Gallons per Day from City of Eveleth Municipal Water System

** Includes 145,000 Gallons per Day from City of Eveleth Municipal Water System

*** Includes 151,500 Gallons per Day from City of Eveleth Municipal Water System

APPENDIX G

Acquisition of State & Federal Permits

Process water to serve the expanded Fairlane Plant operations will be available from the St. Louis River within the limitations of the existing permit from the Department of Conservation, now the Department of Natural Resources, (P.A.63-691), dated the 11th day of December, 1963; and additional water required to serve the accelerated Thunderbird Mine and Shop operations will be available from the City of Eveleth municipal system. However, development of the taconite reserve on the aforementioned mineral lands south of Eveleth will require dewatering of the mine area and its environs to the extent necessary to permit removal of the iron formation materials and the overlying glacial drfit by open pit mining methods. In addition thereto, the mining and mine site coarse crushing operations cannot be initiated without acquisition of the right to utilize surface runoff or ground water as a cooling agent for air compressors, crusher bearing oil, and the burners on the jet-piercing blast hole drills; boiler feed water; spraying of mine haulage roads for dust control and stabilization of the wear course; fire protection; sewage disposal; potable water for plant and mine personnel; and floor wash and miscellaneous housekeeping functions. Then, too, expansion of the open pit to its ultimate limits will, in time, require the relocation of a portion of the stream beds of two unnamed streams that cross the proposed open pit area to flow southerly and southwesterly to Mud and Elbow Lakes respectively.

Accordingly, Oglebay Norton Company acting for the Applicants, i.e., Eveleth Taconite Company and Eveleth Expansion Company, by Application filed on November 9, 1974 (a revision of the original Application filed May 13, 1974, and supplemented in July 1974), requested the issuance of permits (some of which pertain to the

existing operation as expanded) under Minnesota Statutes, Chapter 105, to appropriate, use and/or divert both surface and ground water from the locations described as follows and depicted on Applicants' Exhibit A and C.

1. Appropriation of Water

(a) The right to appropriate the mine water that has accumulated and will accumulate in the existing natural ore mines and, eventually in the Expansion Open Pit at a rate established by the capabilities of the installed equipment to the extent necessary to permit stripping of the overburden and mining of the underlying iron formation materials.

Appropriation of said mine water will be both by pumpage from the water pools within the natural ore mines or within future open pit mine sumps (Pump Stations No. 1 and No. 2), and by pumpage from the Spruce and Leonidas Underground Shafts of ground water flow or seepage (Pump Stations No. 3 and 4, respectively). The average rate of such pumpage is expected to range from 2,160,000 to 5,760,000 gallons per day but in no event shall the combined pumpage from all stations exceed 10,000 acre feet of water per year. The term "mine water" as used in this paragraph (a) and in paragraph (b) following, and elsewhere in this Application, includes direct precipitation within the crests of the open pit excavation; surface runoff from adjacent lands that cannot reasonably be diverted from flowing directly into the pits; and ground water seepage or flows from aquifers penetrated or intercepted by open pit operations.

(b) The right to appropriate the mine water that has accumulated and will accumulate in the Thunderbird Mine at a rate established by

the capability of the installed equipment to the extent necessary to permit stripping of overburden and the mining of the iron formation materials.

It is anticipated that the average rate of such appropriation shall range from 400,000 to 1,150,000 gallons per day, but in no event, shall such appropriation exceed 5,000 acre feet of water per year.

(c) The right to appropriate ground water from two shallow wells (Wells No. 1 and No. 2) located near the Expansion mine-site coarse crushing plant at an average rate of 75,000 gallons per day to supply both potable andprocess water for both consumptive and non-consumptive use in the coarse crushing plant. In an emergency, the Applicants should also have the right to increase the rate of appropriation to the capacity of the installed equipment but with the stipulation that the total appropriation from the wells would not exceed 100 acre feet per year.

(d) The right to appropriate water from the coarse crushing plant settling basin for consumptive use as mine process water.

Such waters will include cooling water and floor wash effluent from the coarse crushing plant; direct precipitation on the impounded water surface; surface runoff from the watershed area tributary to the basin; and, during Stage III and Stage IV of the open pit development, mine water discharge from Pump Station No. 1 and No. 2.

(e) The right to appropriate ground water from a shallow well located

in the Northwest Quarter of the Northeast Quarter, Section 11, Township 56, Range 18, at the Fairlane Plant, at an average rate of 3,000 gallons per day for the mixing of concrete and other construction purposes with the stipulation that the total appropriation for such purposes will not exceed 5 acre feet of water per year.

2. (a) The right to make consumptive use of that portion of the ground water appropriated from the wells described at 1(c) above for potable water for mine and mine-site coarse crushing plant personnel; sanitary sewage collection, treatment and disposal; and, boiler feed water for the crushing plant heating system.

It is anticipated that the amount of water so consumed will average 6,000 gallons per day (6.7 acre feet/year); however, the Applicants request the right to make consumptive use of ground water from the wells to the extent desired up to a maximum limitation of 10 acre feet per year.

(b) The right to make consumptive use of water from either the Pearsall Mine or the coarse crushing plant settling basin for spraying of mine haul roads for dust control and stabilization of the wear course, and, for cooling of the burners on the jet-piercing blast hole drills.

It is anticipated that the amount of water so appropriated and consumed will average 69,000 gallons per day (77.3 acre feet/year); however, the Applicants request the right to appropriate waters from the settling basins to the extent desired up to a maximum limitation of 90 acre feet per year.

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(c) The right to make non-consumptive use of a portion of the ground water appropriated from said wells for the cooling of air compressors and crusher bearing oil and for partial reuse for floor wash and for miscellaneous housekeeping functions in the mine-site coarse crushing plant.

It is anticipated that the amount of water so appropriated for nonconsumptive use will average 69,000 gallons per day (77.3 acre feet/year); however, the Applicants request the right to appropriate and make non-consumptive use of ground water to the extent desired up to a maximum limitation of 90 acre feet of water per year.

(d) The right to make consumptive use of the water from said well in the Northwest Quarter of the Northeast Quarter, Section 11, Township 56, Range 18, for the mixing of concrete and other construction purposes.

It is anticipated that the amount of water so consumed will average 3,000 gallons per day (3.4 acre feet/year) and will not exceed a maximum of 5 acre feet per year.

3. Diversion of Water

(a) The right to convert subterranean flow of water to surface runoff, including: (1) mine pumpage described in 1(a) and 1(b) above, not required for consumptive use as mine process water; (2) well water described in 1(c) above, utilized for cooling water and other non-consumptive uses in the mine-site crushing plant; and (3) the right to divert the flow of surface runoff and precip-

itation impounded by the coarse crushing plant settling basin, described in 1(d) above.

(b) The right to relocate that portion of the unnamed stream flowing southerly from Fayal Pond to Mud Lake that crosses and thereby encumbers the iron formation materials within the Stage III limits of the Expansion Open Pit. The proposed relocation would be to the realignment in Sections 5 and 8, Township 57 North, Range 17 West paralleling the easterly limit of the Expansion Open Pit as depicted on Applicants' Exhibit A.

(c) The right to relocate that portion of the unnamed stream flowing southwesterly from the platted portion of Eveleth to Elbow Lake that crosses and thereby encumbers the iron formation materials within the Stage IV limits of the Expansion Open Pit. The proposed relocation would be to a realignment in Section 6, Township 57 North, Range 17 West and Section 1, Township 57 North, Range 18 West established on a berm in the surface overburden at the Westerly limit of the Expansion Open Pit as depicted on Applicants' Exhibit A.

In addition thereto, Oglebay Norton Company respectfully requested that the Commissioner of Natural Resources take such action as is necessary to effect the following amendments to the existing Permits for Fairlane Plant operations issued by the Department of Conservation:

1. P.A. No. 63-691, Dated the 11th day of December, 1963.

(a) An amendment to authorize the consumptive use of water from the St. Louis River for domestic and laboratory use within the present quantity limitation for make-up water of seventeen (17) cubic feet per second.

(b) If required, an amendment to reflect the increase in plant capacity to approximately 6.0 million tons of concentrates per year.

(c) An amendment granting consent and concurrence in the assignment of an undivided interest in said permit by Eveleth Taconite Company to Eveleth Expansion Company.

2. P.A. No. 63-1089, Dated the 21st day of January, 1964

(a) An amendment to change the location of the well for appropriation of groundwater from the Northwest Quarter of the Southwest Quarter of Section 12, Township 56 North, Range 18 West of the Fourth Principal Meridian to the Northwest Quarter of the Northwest Quarter of Section 1 in the same Township and Range.

The studies made by Oglebay Norton Company and/or its consultant indicate that the appropriation, use, and/or diversion of surface and ground waters within the maximum limitations requested, should not have a significant adverse effect on present and/or potential future users of water within the drainage areas involved with the proposed expansion of the taconite operation.

Besides preparing and submitting the above described application for permits for appropriations, use and diversion of waters, Oglebay Norton, in accordance with the applicable provisions of the State of Minnesota Pollution Control Statutes, as amended, has either already applied for, or is in the process of preparing and applying for, permits for construction or installation andoperation of (1) air pollution control equipment at the new Expansion Open Pit crushing plant and at the additions to the Fairlane Plant; (2) facilities for storage and distribution of fuel oil; and (3) facilities for impoundment, clarification and release of waters from mine pumpage and plant usage.

In addition thereto, Oglebay Norton Company has applied for NPDES permits for the discharge of mine water including precipitation and surface water from both the Thunderbird Mine and the Expansion Open Pit plus discharge of miscellaneous wastes from the crushing plants at both locations. The status of all environmental permit matters may be summarized as follows:

Agency and Permit	Status
A. Department of Natural Resources Permits	
1. No. 63-691. Fairlane Plant Water Apropriation Permit. Provides for appropriation of amounts of water necessary to start operations and for makeup water at a rate not in excess of 17 cubic feet per second.	Granted 12/11/63. Amendment to authorize consumptive use for domestic and laboratory purposes and to reflect increase in plant capacity, and approval of assignment were applied for on 11/9/74
2. No. 63-691. Authorizes St. Louis River Dam and authorizes impoundment of water by a dam having a crest elevation of 1320.0, in the vicinity of the northwest corner of Section 1-57-18.	Granted 12/11/63. Federal consent granted by P.L. 88-322.
3. No. 63-691. Authorizes use of Big Tony (Allen) and Hammer Lakes for tailings disposal.	Granted 12/11/63. Correlary MPCA permit will require amendment as shown below.
4. Appropriation of Thunderbird mine water and surface runoff.	Applied for 11/9/74
5. Appropriation of Expansion Open Pit mine water and surface runoff.	Applied for 11/9/74
6. Alteration of flow in unnamed stream leading to Mud Lake, unnamed stream leading to Long Lake Creek, unnamed stream leading to Elbow Lake and unnamed stream leading to Manganika Lake and in Mud, Horseshoe, and Long Lakes, and in St. Louis River.	Applied for 11/9/74
7. Two crushing plant wells to be located in the SW¼ of NW¼, Section 7, Township 57, Range 17.	Applied for 11/9/74

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APPENDIX G (CONTINUED)

8.	Diversion of segment of unnamed stream from Fayal Pond to Mud Lake, Sections 5 and 8, Township 57, Range 17.	Applied for 11/9/74
9.	Diversion of segment of unnamed stream flowing to Elbow Lake in Section 6, Township 57, Range 17, and Section 1, Township 57, Range 18.	Applied for 11/9/74
10.	Well for water for construction purposes in the NW¼ of NE¼, Section 11, Township 56, Range 18.	Applied for 11/9/74
11.	No. 63-1089. Fairlane Plant Well.	Granted 1/20/63. Amendment to reflect change in location applied for 11/9/74
12.	Mine Land Reclamation Plan.	To be filed when regulations issued.

B. Pollution Control Agency Permits

1.	WPCC No. 428. Fairlane Plant Tailings Pond. Authorizes closed tailings basin system, pumps, pipelines, and other appurtenances, without discharge to waters of the state, in Township 56, Range 18, and Township 56, Range 17.	Granted 11/27/63. Amendment to reflect increased rate of flow and to authorize increase in area to be applied for concurrently herewith.
2.	WPCC No. 4747. Fairlane Plant Sewage System.	Granted 6/7/65. No amendment is necessary.
3.	NPDES Permit No. MN0044946. Discharge of mine water including precipitation and surface runoff from Thunderbird Mine and discharge of miscellaneous wastes from Thunderbird (existing) crusher.	Granted 5/23/75
4.	Discharge of mine water including precipitation and surface runoff from the Expansion Open Pit and discharge of miscellaneous wastes from mine site (new) crusher. (NPDES)	Applied for 9/13/74
5.	PCA No. 869-74-0-2. Existing Fairlane Plant Air Pollution Control Systems.	Granted 8/29/74
6.	PCA Installation Permit No. 869-74-1-1. New Fairlane Plant Air Emission Control Systems, including coal handling system.	Installation Permit granted 11/19/74
7.	Existing Thunderbird Crusher - air emissions.	Applied for 1/6/72
8.	Existing Thunderbird Crusher Boiler-air emissions.	Granted 4/4/74.
9.	PCA Installation Permit No. 869-74-1-1. New Expansion Open Pit Crusher - air emissions.	Installation Permit granted 11/19/74
10.	Various Liquid Storage	To be applied for as design becomes available.

APPENDIX H

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

4500

DNR Information (218)326-8307
Region II
Box 388, East Hwy. 2
Grand Rapids, MN 55744

October 20, 1975

City Clerk
City Hall
Eveleth, MN 55734

RE: St. Mary's Lake (69-651), St. Louis County

Dear Sir:

You have requested that we conduct an investigation of the cause of low water levels on St. Mary's Lake this past year. While we have not conducted a rigorous hydrologic analysis of St. Mary's Lake we have acquired some information which may help explain lake conditions.

We have analyzed climatological data in the Evelth area for the past ten years. Using this information we find that the average annual precipitation to the area is 27.89'. Runoff that reaches St. Mary's Lake from its 1000 acre drainage area can be estimated to be about 6" over the drainage area. Totaling these two direct sources of water supply to St. Mary's Lake equals a volume of about 1080 acre feet. Converting this to feet over the lake surface equals about 4.3 feet.

The withdrawal from St. Mary's Lake by the City of Eveleth converted to feet over the lake surface averages 3.79 feet annually over the last ten years. Additionally evaporation from the lake surface equals about 2.2 feet per year. The total of these two withdrawals equals about 6.0 feet per year.

Comparing the amount of direct water supply to the direct withdrawals (6.0' minus 4.3') leaves a deficit of 1.7' of water over the lake surface. This deficit must be made up from groundwater input to the lake.

The years of 1974 and 1975 to date have seen less than average rainfall which over this period will result in less than average goundwater inflow to the lake. Since the City of Eveleth's total amount of water appropriated from St. Mary's Lake has not increased this year over past years when relatively constant water levels were experienced the conclusion is that 1975 low water levels are a result of less than average amounts of precipitation the past two years.

RECEIVED
OCT 21 1975
DIVISION OF MINERALS

In summary, it is my feeling that there is no immediate cause of alarm; resumption of average or above average precipitation will cause lake levels to return to normal levels if the amount of water appropriated does not appreciably change.

This experience and the analysis we have done points out, however, that the water supply to and the withdrawals from St. Mary's Lake are at a delicate equilibrium. Any deviation from "average" conditions will result in deviations from normal water levels. For this reason the City must carefully consider any substantial increases in water use from urban or industrial expansion. If, in the future you anticipate increased water needs through this type of expansion you should also consider alternative sources of water supply.

Finally from the information which has been supplied to us by Eveleth Taconite toward the preparation of an Environmental Impact Statement the City is presently supplying 82,000 gallons per day to Eveleth Taconite. This amount is projected to increase to 145,000 gallons per day. The existing use is ten percent of the City's total use; the projected use if 17 percent of the City's use. Since only a small amount of the water supplied to Eveleth Taconite is for potable uses you may want to reconsider your sale of water for the non-potable uses.

If I can be of further assistance, or if further clarification of this information is desired, please advise.

Very truly yours,

DANIEL C. RETKA
Regional Hydrologist

DCR:bjo

cc: St. Paul
Representative Begich
Paul Pojar

APPENDIX I

INTRODUCTION

This Prospectus describes a magnetic taconite ore body, located near Eveleth, Minnesota, and its proposed exploitation, as well as how it will assure participating companies of a continuing supply of high grade pellets at favorable cost.

The properties, in which Oglebay Norton Company has leasehold interests, contain the ore body and are termed the Troy Lands. The ore reserves, proven by exploratory drilling, are minable by open pit methods and provide sufficient crude ore to sustain an operation producing 2,300,000 tons of pellets annually for fifty years. Annual production is based on the design capacity of the largest single grate-kiln pelletizing system now in operation. The average analyses of the pellets will be 64.10% natural iron, 5.80% natural silica, and 2.00% moisture. Negotiations are progressing to obtain contiguous taconite lands which will extend the life by eighteen years.

Both mine and plant are located near established communities from which labor can be drawn. Ample electric power, water, and rail transportation are available.

The Prospectus contains an analysis of the project including descriptions of lands controlled by Oglebay Norton, proposed location of facilities, estimated capital, and operating costs, and other information pertaining to the production of iron ore pellets from these lands. The information has been prepared by Oglebay Norton Company personnel and is largely based on experience gained from the successful development and operation of the Eveleth Taconite Company. Arthur G. McKee and Company assisted in the preparation of the capital costs. The operating costs are based on wage rates and material costs existing on August 1, 1970; capital costs are based on current costs including escalation until completion of the project.

DESCRIPTION OF ORE BODY AND METALLURGICAL TESTING

The ore body is in the Biwabik Iron Formation of the Mesabi District. More specifically, it is within the south bend of the so-called, "Virginia-Horn", the strike of the formation being NW-SE in the northwest part of the property and nearly E-W in the southeastern part.

The economic taconite is confined to the Upper and Lower Cherty Horizons. These are separated by the Lower Slaty Horizon, which is waste material.

Structurally, the formation is simple and uncomplicated by significant faulting. It dips about 3° SW in the north part of the property gradually increasing to 9° S in the south part. The overburden averages 58-feet in depth.

A systematic exploratory drilling program, comprising seventeen holes totaling 9,185 feet have been completed on the acquired properties. The distribution of these holes is shown on the map, Page 15. The core was logged by magnet and visual inspection. The logging indicated uniformity in the Upper and Lower Cherty Horizons. Some areas of oxidation were delineated, but they are outside the perimeters of the economic ore

body. Davis Tube tests were made on each ten-feet of core from the Upper and Lower Cherty Horizons by the Howard Caddy Laboratory in Virginia, Minnesota. Chemical analyses to determine iron and silica content and recovery were made by Lerch Brothers, Inc., Hibbing, and Ruble-Kaple Company, Duluth.

Ore reserves and grade estimates were calculated by Oglebay Norton and are shown on Page 10. Crude ore containing less than 17% magnetic iron was considered uneconomic and is not, therefore, reflected in the ore reserve figures. The limits of the pit were dictated by the grade of the taconite, the amount of waste materials overlying or contained in the ore, or property ownership.

Examination of core and results of Davis Tube and chemical tests indicate the crude ore to be similar to that in the Thunderbird Mine of the Eveleth Taconite Company. Therefore, the concentrating process proposed for this operation will be similar to that which has operated successfully at Eveleth Taconite Company's Fairlane Plant.

OPERATIONS

The ore body will be stripped of overburden by conventional excavating methods. The overburden material will be dumped initially to build dikes around the fine tailing pond area, shown on the map, Page 14. Ore and waste rock will be drilled by jet, rotary and down-the-hole drills, depending on the character of the material. The most applicable blasting agents will be used to break the ore and rock. Electric shovels will load the broken material into off-highway trucks for transportation to appropriate dumps or the crushing plant. The latter will be located in the Fayal Pit.

The crushing plant will contain four stages of crushers. The mined ore will be reduced in the 60" gyratory primary and two parallel secondary 30" x 70" gyratory crushers to minus 4" and conveyed to a 15,000 ton surge bin located in the Fayal Pit. The partially crushed ore will be conveyed on demand from the surge bin back to the crushing facility for final reduction in the third and fourth stage crushers. The resulting product (98% minus 3/4") will then be conveyed to storage silos in the concentrator facility. All crushing will be done dry; adequate dust collection systems will be provided where required.

The crushing equipment in the Fayal Pit and related storage bins in the concentrator are sized according to ten shifts of mining and coarse crushing, and fifteen shifts of fine crushing operations per week (see Page 16); whereas, the concentrating and pelletizing operations will require twenty-one shifts per week.

The concentrator is designed to process 890-tons of crushed material per hour, or 6,963,000 tons annually. The process, shown on Page 17, consists of two parallel circuits, each of which includes a rod mill, two ball mills, magnetic separators (cobbers, roughers, and finishers), fine screening, hydro-separators for desliming, and vacuum filters for dewatering the concentrate. The filter cake will be conveyed to the pellet plant storage bins for balling or to a surge pile if the pellet plant is undergoing repairs. Coarse tailings will be trucked either to the fine tailings pond for dike material or to a waste dump. The fine tailing will be dewatered in two 250-foot diameter thickeners and then pumped to the fine tailings pond; the thickener and tailing pond overflows will be reused in the process.

Pelletizing of concentrate may be done by any one of the methods in use, such as shaft furnace, grate-kiln, straight grate; the Arthur G. McKee circular grate concept should be investigated. Costs herein have been developed based on the grate-kiln system.

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APPENDIX I (CONTINUED)

EXPANSION OF FACILITIES

This Prospectus has described a mine and plant capable of producing 2,300,000 tons of pellets annually. This is predicated on full capacity operation of the pelletizing system and concentrating facilities, whereas the primary 60" gyratory crusher will be operated at approximately one-half full capacity. This imbalance is caused by the necessity to have a large primary crusher capable of receiving and crushing large pieces of taconite without incurring excessive delays because of bridging and plugging. Hence, should the developers of the Troy Lands decide in the future to expand this operation, up to 4,600,000 tons of production are possible without addition of a second primary crusher. Other facilities will be required, their extent dependent on the increase in production desired.

TROY PROJECT
GENERAL INFORMATION

RESERVES AND EXPECTED PELLET ANALYSES

	Upper Cherty	Lower Cherty	Total
Tons - Crude	240,342,000	109,158,000	349,500,000
% Magnetic Iron	22.66	22.90	22.73
Tons - Pellets (Natural)	79,355,000	36,153,000	115,508,000
% Iron (Natural)	63.90	64.41	64.10
% Silica (Natural)	6.20	4.95	5.80

WASTE MATERIAL VOLUMES

Cubic Yards - Overburden	37,178,000
Cubic Yards - Waste Rock (in Upper Cherty Horizon only)	32,677,000
Cubic Yards - Lower Slaty	46,767,000

RATIOS - WASTE MATERIALS TO CRUDE ORE AND PELLETS

	Overburden	Waste Rock	Lower Slaty
Cubic Yards Waste/Ton Crude	0.106	0.093	0.134
Cubic Yards Waste/Ton Dry Pellets	0.328	0.289	0.413

OPERATING SCHEDULES

Mine	49 Weeks @ 15 Shifts
Crushing	49 Weeks @ 15 Shifts
Concentrator	49 Weeks @ 20 Shifts
Pelletizing Plant	47 Weeks @ 21 Shifts

ESTIMATED ANNUAL MINE CAPACITY — 6,936,000 Tons Crude

ESTIMATED AVERAGE DAILY MINE PRODUCTION — 28,400 Tons Crude

ESTIMATED ANNUAL PLANT CAPACITY — 2,300,000 Tons Pellets

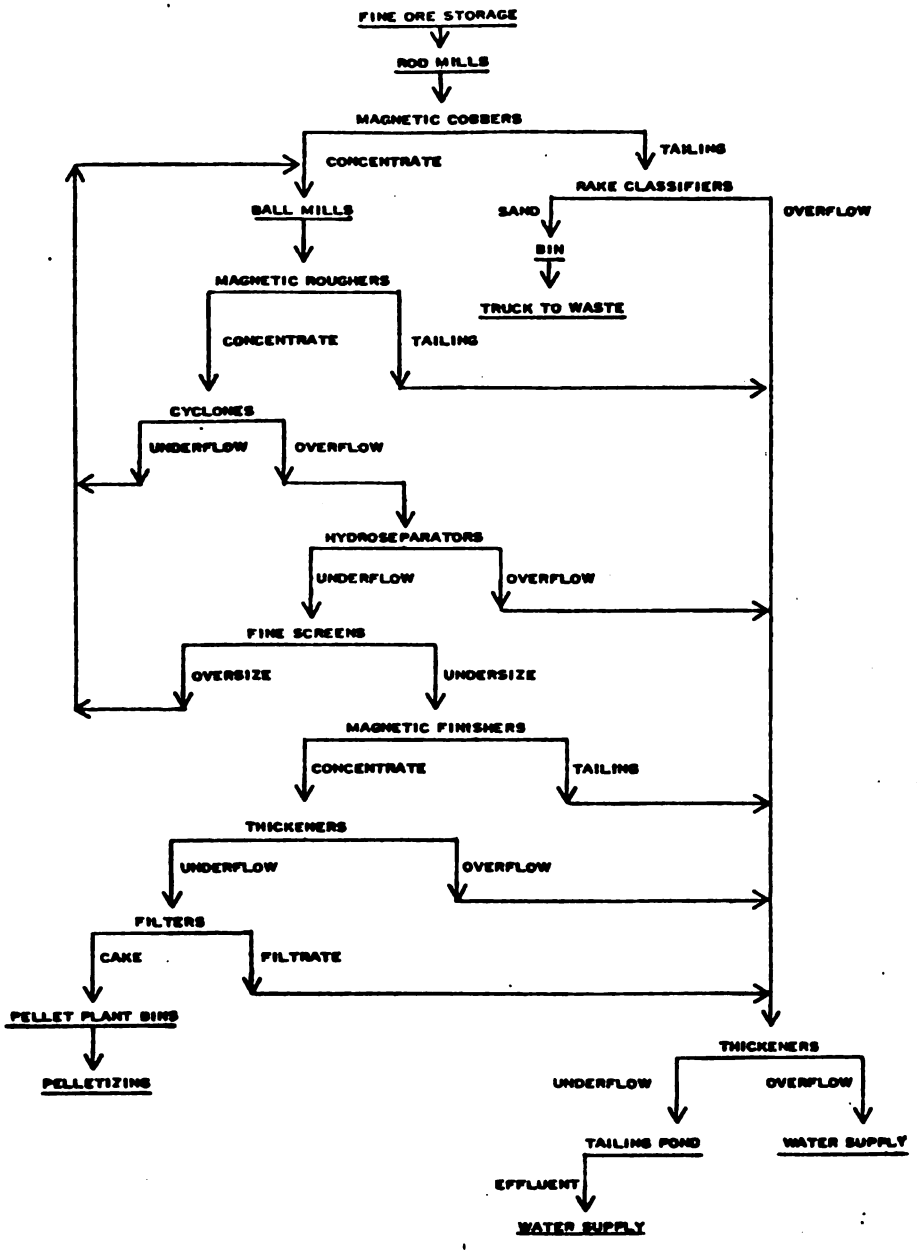
ESTIMATED AVERAGE DAILY PLANT PRODUCTION — 7,000 Tons Pellets

EMPLOYEES	Exempt and Non-Exempt Salaried	Bargaining Unit	Total
Mine	25	143	168
Plant	23	267	290
Works General	39	—	39
	87	410	497

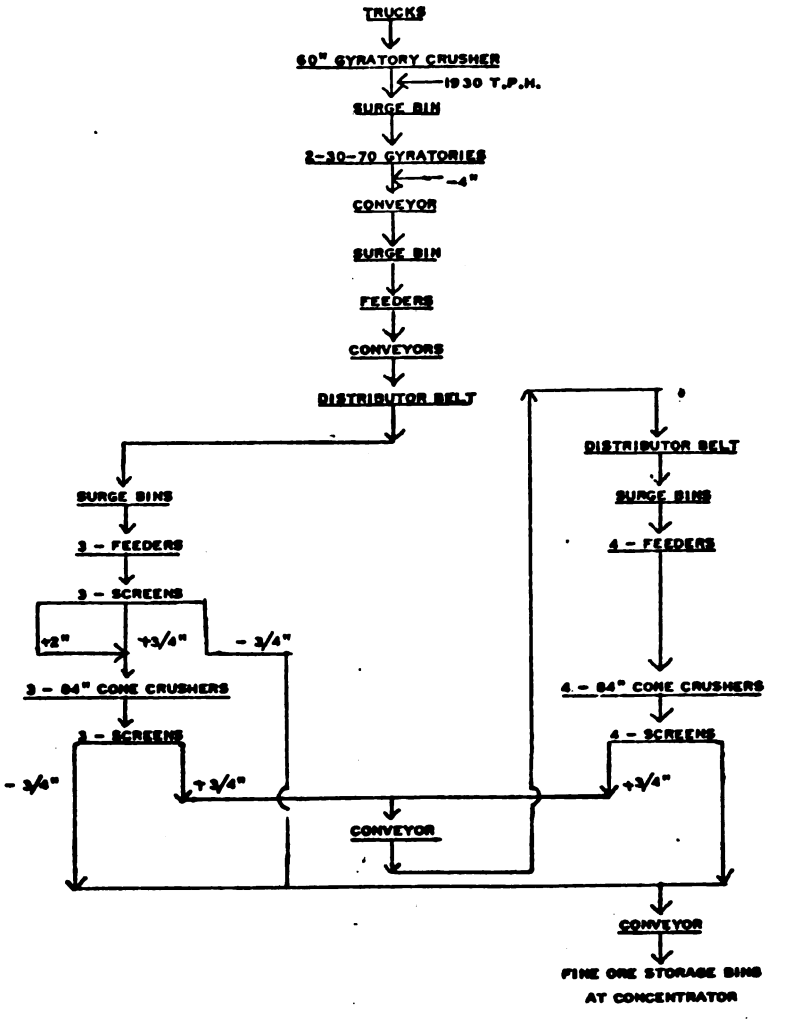
STOCKPILE - WINTER STORAGE	Railroad Docks
SHIPPING POINT	Fayal, Minnesota
VESSEL LOADING	Duluth, Superior or Two Harbors.

APPENDIX I (CONTINUED)

TROY PROJECT
CONCENTRATOR FLOWSHEET



TROY PROJECT
CRUSHING PLANT
FLOW SHEET



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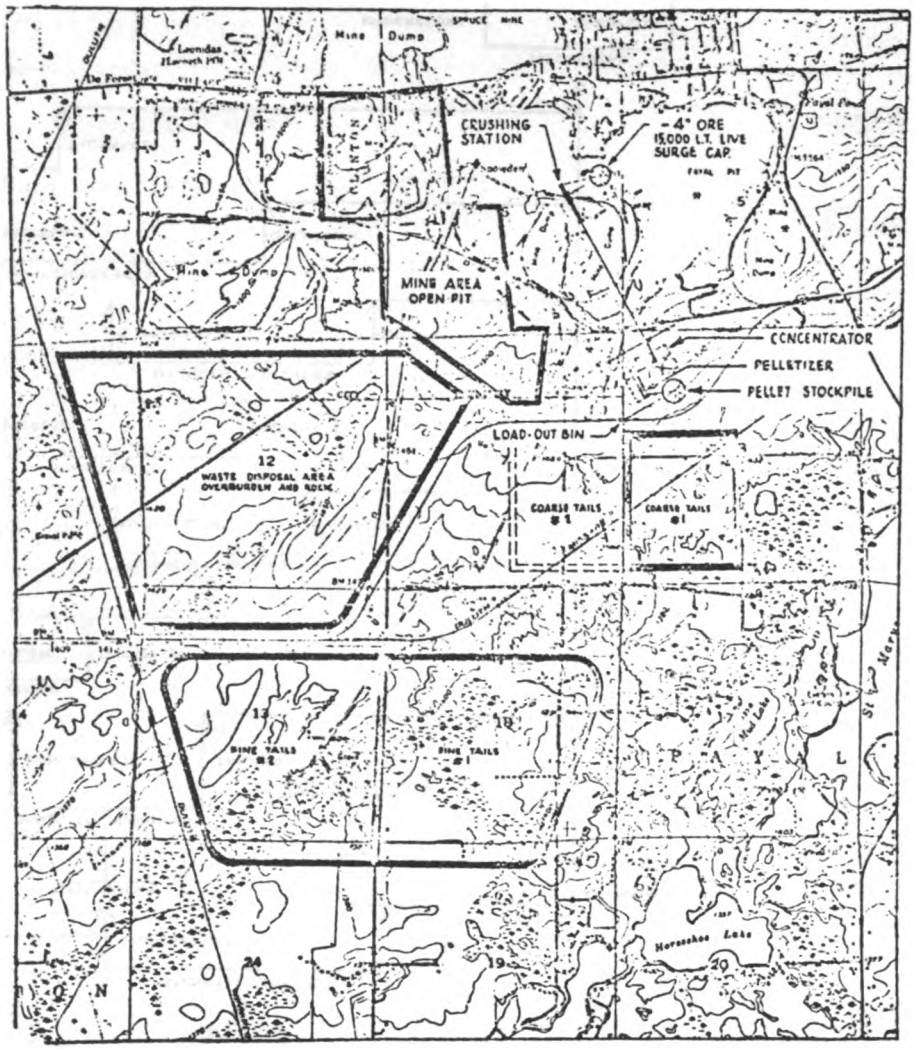
APPENDIX I (CONTINUED)



TROY PROJECT
LOCATION OF FACILITIES
AND
WASTE DISPOSAL AREAS

SCALE 1" = 2500'

APPENDIX J

MINNESOTA HISTORICAL SOCIETY

Fort Snelling Branch (Building 25), Fort Snelling, St. Paul, Minnesota 55111 • 612-726-1171

11 September 1975

Mr. Paul Pojar, Geological Engineer
Department of Natural Resources
Centennial Office Building
St. Paul, Minnesota 55155

Dear Mr. Pojar:

RE: Oglebay Norton Mine Expansion
Eveleth, Minnesota

The project listed above to which you have drawn the attention of Mr. Alan Woolworth by letter of August 28, 1975 has been reviewed by the Survey and Planning and Archaeology sections of the Minnesota Historical Society. It is the finding of this review that there will be no effect upon recorded structures or properties of archaeological or historical significance as a result of the implementation of the Oglebay Norton project.

Respectfully,

Charles W. Skrief
Environmental Assessment Officer

CWS/fr

cc: Alan Woolworth, Chief Archaeologist
Minnesota Historical Society
Building 27, Fort Snelling
St. Paul, Minnesota 55111

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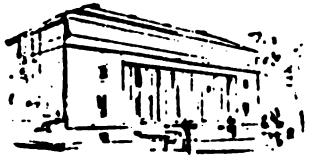
SEP 16 1975
DIVISION OF MINERALS



MINNESOTA HISTORICAL SOCIETY

Fort Snelling Branch (Building 25), Fort Snelling, St. Paul, Minnesota 55111 • 612-726-1171

3 October 1975

Mr. Paul Pojar, Geological Engineer
Department of Natural Resources
Centennial Office Building
St. Paul, Minnesota 55155

Dear Mr. Pojar:

RE: Oglebay Norton Mine Expansion
Eveleth, Minnesota

By letter of August 28, 1975, you drew the attention of Mr. Alan Woolworth to the above described project. I replied to that letter on September 11, 1975, as Environmental Assessment Officer for the Minnesota Historical Society by stating that there would be no effect on archaeological or historical sites as a result of the project in question. Since that letter of September 11 it has come to my attention that two archaeological sites might be affected if the water levels on Long Lake and Murphy Lake respectively were altered. Therefore I would like to amend my earlier letter and statement of "no effect" to include a caveat, to wit: should the levels of either Long Lake or Murphy Lake be radically altered through the operation of the expanded Oglebay Norton Mine in Eveleth, the Minnesota Historical requests that notification of that alteration be given the Society prior to the occurrence of that alteration.

Thank you for your attention to this matter.

Sincerely,

Charles W. Skrief
Environmental Assessment Officer

CWS/fr

cc: Alan Woolworth, Chief Archaeologist
Minnesota Historical Society
Building 27, Fort Snelling
St. Paul, Minnesota 55111

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OCT 7 1975
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