Appendix A
Scoping Environmental Assessment Worksheet and Draft Scoping Decision Document

ENVIRONMENTAL ASSESSMENT WORKSHEET

The Environmental Assessment Worksheet provides information about a project that may have the potential for significant environmental effects. The EAW is prepared by the Responsible Governmental Unit or its agents to determine whether an Environmental Impact Statement should be prepared. The project proposer must supply any reasonably accessible data for — but should not complete — the final worksheet. If a complete answer does not fit in the space allotted, attach additional sheets as necessary. The complete question as well as the answer must be included if the EAW is prepared electronically.

Note to reviewers: Comments must be submitted to the RGU during the 30-day comment period following notice of the EAW in the *EQB Monitor*. Comments should address the accuracy and completeness of information, potential impacts that warrant further investigation and the need for an EIS.

1. **Project title**: NorthMet Mine and Ore Processing Facilities

2.	**Proposer:**	PolyMet Mining Inc.	3.	**RGU**	**Minnesota Dept. of Natural Resources**
	Contact person:	Jim Scott		**Contact person**	Randall Doneen
	Title:	Assistant Project Manager		**Title**	Principal Planner
	Address:	P.O. Box 475		**Address**	500 Lafayette Road, Box 25
	City, state, ZIP	Hoyt Lakes, MN 55750		**City, state, ZIP**	St.Paul MN 55155
	Phone:	(218) 225-4417		**Phone:**	(651) 297-3355
	Fax:	(218) 225 4429		**Fax**	(651) 297-1500
	E-mail:	jscott@polymetmining.com		**E-mail**	Randall.Doneen@dnr.state.mn.us

4. **Reason for EAW preparation** (check one)

EIS scoping X Mandatory EAW ___ Citizen petition ___ RGU discretion ___ Proposer volunteered ___

If EAW or EIS is mandatory give EQB rule category subpart number and subpart name.

4410.4400 Subpart 8b. Subpart Name: Construction of a new facility for mining metallic minerals.

5. **Project location**

County: St. Louis

City/Township: Mining Area: Approx. 6 mi. south of Babbitt
Ore Processing Facility and Shops: Approx. 5 mi. north of Hoyt Lakes

Mining Area:

Parts of Sections 1, 2, 3, 4, 9, 10, 11, and 12, Township 59 North, Range 13 West

Railroad:

Parts of Sections 10, 16, 17, and 18, Township 59 North, Range 13 West

Parts of Sections 9, 13, 14, 15, 16, 23, and 24, Township 59 North, Range 14 West

Ore Processing Facility and Shops:

Parts of Sections 3, 4, 5, 8, 9, 10, and 16, Township 59 North, Range 14 West

Tailings Basin:

Parts of Sections 3, 4, 5, 8, 9, 10, and 16, Township 59 North, Range 14 West

Parts of Sections 32, 33, and 34, Township 60 North, Range 14 West

Attach each of the following to the EAW:

- County map showing the general location of the project; - See Figure 5-1
- U.S. Geological Survey 7.5 minute, 1:24,000 scale map indicating project boundaries (photocopy acceptable); - See Figure 5-2
- Site plan showing all significant project and natural features. See Figure 5-3 (Mine and Stockpiles), Figure 5-4 (Plant Site Layout), Figure 5-5 (Tailings Basin Modifications), Figure 5-6 (Area 1 Shops) and Figure 5-7 (Railroad Modifications)

6. **Description**

a. **Provide a project summary of 50 words or less to be published in the *EQB Monitor.***

PolyMet Mining Inc. proposes an open pit mine to extract a low-grade mineral deposit near Babbitt MN. An existing railroad will be used to haul ore to the existing Cliffs Erie processing facility (currently idled) where it will be crushed and concentrated to extract copper, nickel, cobalt and precious metals by dissolution and precipitation.

b. Give a complete description of the proposed project and related new construction. Attach additional sheets as necessary. Emphasize construction, operation methods and features that will cause physical manipulation of the environment or will produce wastes. Include modifications to existing equipment or industrial processes and significant demolition, removal or remodeling of existing structures. Indicate the timing and duration of construction activities.

PROJECT OVERVIEW

This section provides a project overview provided by PolyMet Mining Inc. (PolyMet). It is a plan that will be modified as information from various studies is developed during the EIS. For the EAW, PolyMet used a conservative approach in sizing the operation. As the ore body and mine model are refined, new estimates will be available and incorporated into the EIS. By using maximum values for the evaluation, the maximum impacts can be addressed.

PolyMet plans to excavate and process the low-grade disseminated sulfide mineral deposit (NorthMet deposit) in northeastern Minnesota. The NorthMet deposit is approximately 6 miles south of the town of Babbitt and about 2 miles south of the operating Northshore Mining Company (NMC) taconite open pit. Ore processing and tailings disposal would occur at the currently inactive Cliffs Erie taconite processing facility and the adjoining tailings basin, which are situated about 8 miles west of the NorthMet deposit and about 5 miles north of the town of Hoyt Lakes. This mining and processing effort, designated the NorthMet Project, would utilize a hydrometallurgical process for extracting copper, nickel, palladium, platinum, cobalt and gold from the ore.

Project plans call for the excavation of up to 32,000 tons of ore per day, using open-pit mining methods after overburden and waste rock stripping and stockpiling. Ore would be transported from the mine site to the processing plant on a largely existing railroad. A refurbished and modified Cliffs Erie processing plant is proposed to process the ore. Flotation tailings and reactive residue from ore processing would be disposed of on top of the existing Cliffs Erie taconite tailings basin. The idled processing plant and existing tailings basin where owned and operated by L-T-V Steel Mining Company (LTVSMC) prior to being purchased by Cliffs Erie. Mining operations - including stripping and stockpiling, drilling, blasting, loading, hauling, and processing of the ore – are expected to be conducted 24 hours per day, 365 days per year, over the 20-year life of the project.

Cathode copper (high purity metal) would be produced onsite by solvent extraction and electrowinning. The processing would produce other metals (nickel, cobalt, palladium, platinum, and gold) as precipitates rather than as finished metal. These precipitates would be shipped offsite for further refining. Processing would also result in the production of carbon dioxide and gypsum. A market may be found for both of these processing byproducts.

Total workforce at the project is expected to be between 490 and 600 jobs. Staffing levels are still preliminary and would depend on decisions to be made in the feasibility study and final design.

PolyMet is in the process of completing several studies that will be used to further refine the project and assist in development of the EIS. These studies include:

- A pilot process evaluation of the deposit that will use an approximately 40 ton bulk sample generated from diamond drilling to better define the end product, tailings and reactive residues.
- A waste characterization plan to define better reactive and non-reactive waste rock, tailings, and hydrometallurgical residues as well as the constituents of reactive mine drainage.
- A definitive feasibility study that will be used to further refine the mine process, mine plan and engineering to finalize capital and operating costs.
- A hydrology study that will be used to develop a project water balance and watershed model.

MINE AND STOCKPILES

PROJECT GEOLOGY

The NorthMet deposit is located within the Duluth Complex of northeastern Minnesota (see Figure 6-1). The Complex is a large, composite, grossly layered, mafic intrusion that was emplaced into comagmatic flood basalts along a portion of the Middle Proterozoic Midcontinent Rift System. The NorthMet deposit is situated along the western edge of the Complex within the Partridge River intrusion, which consists of varied troctolitic and gabbroic rock types that have been subdivided into a least seven igneous stratigraphic units by cataloging drill core. All of these igneous units, which are described below, exhibit shallow dips (10º-25º) to the south-southeast.

The regional and local geology are well known. There are over 1,000 exploration drill holes on this part of the Complex, and nearly 800,000 feet of core have been re-logged in the past fifteen years by a small group of company and university research geologists. Following is a composite description of the units in the NorthMet area, from the base to top:

Unit 1: Consists of a heterogeneous mixture of troctolitic to gabbroic rocks, with abundant inclusions of sedimentary hornfels footwall rocks and lesser discontinuous layers of ultramafic rock. Unit 1 is the dominant sulfide-bearing member in the NorthMet deposit. At least three platinum group element ("PGE") enriched "stratabound" layers are present within Unit 1, the uppermost of which has the highest concentrations of PGE. Unit 1 is 200 feet to 1000 feet thick, averaging 450 feet.

Unit 2: Consists of homogenous troctolitic rocks, with minor sulfide mineralization, and a fairly persistent basal ultramafic layer that separates Unit 2 from Unit 1. Unit 2 averages about 200 feet thick.

Unit 3: Consists of a fine-grained, poikolitic, anorthositic troctolite. Unit 3 is the major marker bed within the deposit due to its fine-grained nature and the presence of distinctive olivine oikocrysts that give the rock a mottled appearance. Unit 3 contains little or no persistent mineralization and averages 250 feet thick.

Unit 4: Consists of homogenous ophitic augite troctolite with a local ultramafic layer at, or near, the base of the unit. There is little or no persistent mineralization in this unit and it averages about 300 feet thick.

Units 5, 6, and 7: Consist of homogenous anorthositic troctolite grading to ophitic augite troctolite; units 6 and 7 have persistent ultramafic bases. There is little or no persistent economic sulfide mineralization except for a small horizon in six drill holes in Unit 6. These generally unmineralized units average about 1,200 feet in thickness, but because the top of Unit 7 has not been seen in drill core, this figure is probably a minimum. At the top of unit 6 is a mineralized zone which has the highest Cu and PGE (0.7% Cu, 1.5 ppm Pt + Pd; average thickness 25 ft) values for the deposit.

The footwall rock at NorthMet is the sedimentary Lower Proterozoic (1.8 Ga) Virginia Formation that is underlain by the Biwabik Iron-Formation. The Biwabik is the footwall to the deposit in only a few drill holes and should not be intersected in mining operations. The Virginia Formation may be mined for pit construction and encountered as inclusions in Unit 1, but contains no economic minerals.

There is little surface outcrop over the deposit. Unit 1 (at the base) is the most consistently mineralized unit ("mineralized" means containing minerals which contain metals of interest to the project) and constitutes the main ore horizon. The other units are less consistently mineralized. Mineralization is in the form of zones of disseminated copper-nickel-iron sulfides. These mineralized zones are throughout Unit 1 and irregularly distributed in the upper units. Definition of ore will be driven by assayed metal values, not by geologic definition; many of the discrete zones or "pods" of sulfide mineralization in the upper units will prove to be economic and be mined as ore; if not, they will be mined and stockpiled as lean ore or as reactive waste. Thus, geologic definition is very important in defining deposit genesis and geometry, but not in day to day mining practice, which will be assay driven. Assays show that about 11% of the material that is inside the twenty year pit shell and is in units 2-7 is classified as ore by metals value. Cross-sections, comparisons between closer spaced holes, and modeling indicate small, but distinct, zones of economic mineralization.

MINING METHOD

The deposit would be exploited by conventional open pit methods similar to those currently in use at other locations on the Iron Range. At full, steady state production a daily ore mining rate of between 25,000 and 32,000 tons per day would be achieved. This is equivalent to a maximum annual ore production of 11.5 million tons. An average waste:ore stripping ratio for the mine has been estimated at 1.2:1. Using an average ore production of 30,000 tons per day and taking into consideration overburden and mine construction practices it is estimated that the mine will generate about 12.5 million tons of waste rock annually. The total amount of material moved annually would be approximately 24.8 million tons. The mine would operate 24 hours per day, 365 days per year. Mining would be carried out using conventional diesel powered equipment though there may be an option to use one or possibly two electric rope shovels in place of the more versatile diesel hydraulic back-hoe excavators proposed. Ore-grade material would be truck hauled from the pit to a rail loading pocket (Loading Pocket) where it would be loaded into rail cars and rail hauled to the Processing Plant crusher dump pocket. Waste Rock and Lean Ore would be truck hauled to rock stockpiles located to the northwest and southeast of the deposit. Stockpiled rock would be categorized as reactive or non-reactive and would be placed on stockpiles according to the specifications of the Waste Rock and Lean Ore Management Plan, which will be developed as part of the EIS and the permit to mine.

OVERALL MINE CONFIGURATION

Pit Outline

The pit outline is shown in Figure 5-3 and a cross-section of the site showing the approximate pit cross section is shown in Figure 6-1. The outline and cross-section are preliminary and depict the maximum 20-year size.

MINE OPERATIONS

Drilling & Blasting

Waste rock and ore would require conventional drilling and blasting prior to excavation. Secondary blasting of oversize boulders would require the use of a track mounted, self-propelled diesel powered rig fitted with a hydraulic boom and top hammer drifter. Because of the importance of selective mining to the successful exploitation of this deposit, it is proposed to sample blast holes for grade control, waste characterization and material movement scheduling.

Grade Control & Production Scheduling

A key component of the mining operation would be *grade control*. In this context grade control is the term applied to the process of characterizing the rock mass ahead of mining to determine whether it should be sent to the Processing Plant or to a waste rock stockpile or a lean ore stockpile. Grade control would allow ore of different grades and quality to be blended for optimal processing and would enable differentiation between reactive and non-reactive waste rock. Grade control is discussed in more detail under Question 20. Once material has been characterized, production engineers would plan, schedule and control production to ensure it is hauled to the appropriate destination.

At the Loading Pocket, a minimum amount of ore storage would be available. Any major load-out delay would require a separate ore stockpile near the Loading Pocket. This temporary ore stockpile would be sufficiently large to accommodate about eight hours of production (approximately 12,800 tons). The ore stockpile would be established on an impermeable base that would drain to a collection sump and then to the reactive water collection and treatment system.

MINE DEWATERING

Water would accumulate in the mine pit from precipitation, seepage and surface inflow. The mine dewatering system would collect this water. Depending on the quality of the water, it would be sent to the water treatment system or discharged. The overall system is discussed in more detail below in connection with mine site drainage. The quality, quantity, and impacts of surface and groundwater from the mine and plant are discussed in response to Questions 13, 17 and 18.

STOCKPILES

General Description of Stockpiled Materials

Surface overburden, waste rock, and lean ore must be removed from the mining area to expose the underlying or adjacent ore. These materials would be hauled in large trucks from the mine area and placed in separate stockpiles in a series of lifts.

The stockpiles would be constructed and managed in accordance with the requirements of Minnesota Statute Sections 93.44 to 93.51 and the Minnesota Department of Natural Resources (MDNR) Mineland Reclamation Rules for Nonferrous Metallic Mineral Mining (Minn. Rules Chapter 6132).

Reactive and Non-Reactive Mine Waste Rock

Past experience has shown that sulfide-bearing rock, such as that present at the NorthMet deposit, can release trace metals and produce acid mine drainage when allowed to come in contact with water and oxygen.

The reactive and non-reactive mine waste rocks would be managed separately. Non-reactive rock can be placed on the surface and the drainage from the rock will meet all applicable water quality standards without any chemical treatment. Settling ponds may be needed to remove suspended solids and turbidity. The non-reactive mine waste rocks are those generally have a low sulfide and trace metal content.

Waste rock characterization has been the subject of on-going research by the MDNR. PolyMet has initiated a site-specific waste rock characterization program, one objective of which is to define reactive and non-reactive mine waste rocks. The criterion for classifying mine waste rocks will be analyzed in the EIS and determined in the Permit to Mine. The ultimate purpose of these studies is to estimate the drainage quality from stockpiles so that the waste rock and its drainage can be properly managed.

Non-reactive waste would be used to construct mine infrastructure such as haul roads, stockpile pads, for backfilling and to enclose or "encapsulate" the exterior of waste stockpiles. Reactive waste and lean ore would be stockpiled separately with minimum co-mingling.

When blast holes are drilled, additional sampling would be conducted if required to refine the geological model to insure that ore is located and waste classified at a scale appropriate to mining. It is expected that ongoing in-fill diamond drilling would be carried out as a regular part of the NorthMet operation, in addition to the blasthole drilling and grade control sampling already described.

Non-reactive mine waste rock would be handled in accordance with general requirements for storage piles described previously. Reactive mine waste rocks have the potential to create drainage containing solutes that adversely impact natural resources and would be handled in accordance with state rules for "reactive mine waste" (MDNR Rules 6132.2200). Minnesota rules require that appropriate methods for stockpiles containing reactive mine waste, are either to 1. modify the physical or chemical characteristics of the mine waste, or store it in an environment, such that the waste is no longer reactive, or 2. during construction to the extent practicable, and at closure, permanently prevent substantially all water from moving through or over the mine waste and provide for the collection and disposal of any remaining residual waters that drain from the mine waste in compliance with federal and state standards. PolyMet proposes to prevent water from contacting the reactive waste, to the extent practicable, and providing for collection and disposal of any water that drains from the reactive waste. Details on the designs of lining and capping systems for reactive waste will be included in the EIS.

General Layout of Reactive and Non-Reactive Stockpiles

Three stockpile areas have been proposed to provide the estimated 290 million tons of overall storage capacity. This is considered a conservative estimate that may be reduced as mine planning proceeds. As part of the EIS and the permit to mine, a mine waste management plan will be developed that will meet the requirements of the permit to mine. This plan will be based on the results of the waste characterization and related studies.

Stockpiles will be reclaimed progressively, so that when a section of stockpile is completed, it will be reclaimed based on the approved reclamation plan. Development, use, and reclamation would occur in progressive phases, with each phase providing storage for approximately three to five years of production.

Within the overall stockpile footprint, separate locations for various materials (overburden, lean ore, reactive and non-reactive waste rock) have not yet been specifically identified. A more detailed stockpile plan will be analyzed in the EIS and furnished as part of the Permit to Mine application.

Stockpiles would be designed to provide separate drainage for both surface runoff and seepage to specific collection points and settling ponds where appropriate monitoring and treatment can be provided.

MINE SITE DRAINAGE

Overview

The drainage design for the mine site overall, including mine, stockpiles, and mine infrastructure would segregate the runoff into two categories. Water that has come into contact with ore, lean ore or reactive waste rock could contain dissolved substances that violate water quality standards. This drainage would require treatment before discharge. This is referred to as reactive mine drainage. It includes the pit pumping, the seepage coming from the base of reactive waste rock/lean ore stockpiles, and the runoff from the Loading Pocket and any adjacent ore stockpiles. Quantity, quality and impacts of reactive runoff are discussed in response to Questions 17 and 18.

Runoff from portions of the mine site would not come in contact with reactive materials. This includes seepage from external wetlands through dikes and runoff from non-reactive materials, such as runoff from roofs and roads. The pit would be encircled by a ditch and dike system to intercept and handle non-reactive runoff. This non-reactive drainage system would discharge to three or more detention ponds as shown in Figure 5-3. The runoff from these areas is anticipated to only require treatment by sedimentation prior to discharge. After suspended solids have been settled out, the non-reactive runoff would be discharged to the Partridge River and adjacent wetlands.

Treatment

Treatment plans for mine drainage have not been finalized at this time and are discussed in greater detail in response to Question 18. Space has been reserved south of the Dunka Road for potential wastewater treatment facilities; this location would allow gravity drainage to the facility and discharge to the most downstream portion of the Partridge River.

After closure, if a treatment system were required, a low maintenance treatment system would be desirable. Although an assessment of options has not been finalized, the current preference is to have one low maintenance treatment system that could be located south of the Dunka road. This single system could receive gravity drainage from both the main reactive water stockpile and the southeast reactive water stockpile. Treatment options are discussed in response to Questions 17 and 18.

RAIL HAULAGE

The railroad is owned by Cliffs Erie facility and was used by LTVSMC to haul ore to the plant from the Dunka Mine and pellets from the plant to the dock at Taconite Harbor. The agreement between PolyMet and Cliffs Erie that provides an option to purchase the plant site assets also includes language defining a Rail Service Agreement under which Cliffs Erie would transport ore from the PolyMet mine to the plant site. The railroad is currently a private (non-common carrier) railroad. PolyMet assumes that the Cliffs Erie railroad would be operated by Northshore Mining Company (NMC). The railroad would be a branch of the NMC's current railroad operation to move taconite ore from Babbitt to Silver Bay since both Cliffs Erie and NMC are 100% owned by Cleveland Cliffs Inc.

Because of the extent of existing railroad infrastructure and because the Processing Plant primary crusher dumping pocket is currently configured for acceptance of ore from railcars, rail haulage from the mine to the plant is being proposed.

During operation of the Cliffs Erie taconite facility, ore was brought to the plant from the east via rail. During the later years of operation this line was no longer used. To restore the eastern rail connection for this project, a rail connection would be constructed as shown on Figure 5-7.

At the mine site, a rail spur would be constructed as shown conceptually on Figure 5-3. This spur is included in description and calculation of impacts of the overall mine site development.

PROCESSING PLANT

INTRODUCTION

The process design selected for recovering the base metals and Platinum Group Metals (PGMs) from the NorthMet deposit is based on two major steps:

1. An initial concentration step to recover all of the sulfide minerals by flotation followed by
2. An Autoclave leaching process, which has the advantage of extracting all of the base metals and PGMs. The base metals and PGMs can then be separated and recovered on site.

The Processing Plant design is based around the following key parameters

- A mining rate of 32,000 tons per day;
- Producing only copper metal on site and separate PGM precipitate and nickel/cobalt hydroxide, for off-site shipment and third party processing;
- Acquiring the nearby Cliffs Erie idled crusher/concentrator and all of the land needed for tailings disposal, water supply and storage. This facility also includes a fully established infrastructure of roads, rail, warehouses, offices, workshops, and spare parts.

The Processing Plant would comprise the following unit operations, which are described in Table 6-1 below:

Table 6-1
General Description of Unit Processes of Processing Plant

Unit Process	General Description
Crushing	The ore is crushed in stages to the size of about 0.4 inches or finer
Milling	The crushed ore particles are further reduced to fine sand (0.008 inches particles)
Flotation	The metal sulfide-bearing particles are separated for further processing.
Autoclave Leach	The metal sulfides in the flotation concentrate are oxidized under high pressure and temperature to allow recovery of the metals from solutions.
PGM Precipitation	The Platinum Group Metals (Palladium, Platinum and Rhodium) and gold are recovered from the leach solution
Pre Neutralization	The acidic leach solution is neutralized using limestone
Copper Solvent Extraction (SX)	The neutralized leach solution is mixed with an organic solvent to selectively remove the copper. The copper is then stripped from the solvent using an acidic aqueous solution.
Copper Electrowinning (EW)	The copper is removed from solution by electrochemical means.
Bleed Stream Purification	Iron and aluminum are selectively removed from the leach solution after the Copper SX process to allow recovery of higher-value nickel and cobalt. Residual soluble copper is also removed by precipitation.
Hydroxide Precipitation	Nickel and cobalt are precipitated together to produce a concentrate to be sold for further refining
Magnesium Precipitation	Small amounts of magnesium and other undesired metals are removed from the process stream before it is recycled.

Simplified flowsheets for the proposed Processing Plant are shown in the following figures:

Figure 6-6 Comminution and Flotation Schematic Diagram
Figure 6-7 Hydrometallurgical Process Plant Schematic Diagram and
Figure 6-8 Process Consumables Schematic Diagram

These simplified flow sheets do not show some process equipment that is intended to provide material handling and in-process storage. A more detailed description of the proposed Unit Processes of the Processing Plant is included as Exhibit A of the Scoping EAW.

Reactive Residues

The Processing Plant would produce reactive residues from five sources:

- Autoclave residue from Leach Residue Filter
- Gypsum from the Gypsum Filter
- Iron/Aluminum precipitate from the Iron/Aluminum (Fe/Al) Removal Filter
- Magnesium hydroxide precipitate from the Mg Removal Thickener
- Crud solids from crud removal

These residues will all be characterized as part of the waste characterization plan being developed as part of the Permit to Mine. Information that is available from the waste characterization will be included in the EIS. It is proposed that these residues be disposed in the Reactive Residue Facility (discussed below) sited in the existing tailings basin. The projection is that these residues will settle to a density of 70% by weight. After considering rainfall and evaporation, the decant return from the Reactive Residue Facility to the process is estimated to be approximately 330 gpm. These residues are discussed in more detail in response to Question 20.

Air Emissions

Air emissions from the processing plant are treated with various air scrubbers prior to discharge to the atmosphere. Airborne dust would be controlled by the installation of dust extraction at specific transfer points in the crushing plant. Water sprays would also be provided in the crusher to minimize dust emissions. Air emissions and the proposed control technologies are discussed in further detail in response to Question 23.

TAILINGS AND TAILINGS BASIN

EXISTING CLIFFS ERIE TAILINGS BASIN

PolyMet proposes to use the existing tailings facility at Cliffs Erie for disposal of the tailings products from the NorthMet project. This assumes that the waste characterization data and subsequent analyses will demonstrate that this is a suitable disposal site. If the characterization tests identify the tailings as reactive mine waste then they would be handled in accordance with state rules for “reactive mine waste” (MDNR Rules 6132.2200). The Cliffs Erie tailings basin was originally constructed by Eire Mining Company (predecessor of LTVSMC), and was used from 1957 to 2000.

There are three discrete cells in the existing basin, Cells 1E, 2E, and 2W, shown on Figure 5-5. Cell 2W is the largest (approximately 1,447 acres), and highest (150 feet on the south side to 230 feet on the north side) of the three cells. It is the driest and has gradually lost the ponded water remaining from taconite processing. Cell 1E is approximately 875 acres and is situated approximately 20 feet below the surrounding natural topographic ridge on its south side, and rises about 40 feet above Cell 2E on its north side; Cell 2E is about 616 acres and has the lowest dam crest elevation of the three cells, situated at the toe of Cell 1E on its north side and rising about 80 feet above natural ground level on its north side. Cells 1E and 2E continue to hold water. The existing basin does not have an overflow or discharge structure. A portion of the seepage from the toe of the dike was captured during operations and pumped back into the tailings basin. The existing water quality of the tailings basin and the seeps is discussed in response to Question 18.

FLOTATION TAILINGS

Initial tests of the flotation process have been conducted and additional pilot testing of the process using samples from the NorthMet deposit will be completed for inclusion in the EIS. The volume and composition of Flotation Tailings are discussed in response to Question 20. If the tailings are determined to be non-reactive, they would be discharged to Cells 1E and 2E using the existing piping and pumping arrangement. PolyMet estimated that the capacity of the existing facility would be more than sufficient for receiving Flotation Tailings for the 20-year life of the mine. A detailed analysis of the design, construction, and operation of the dams and tailings basin including basin storage capacities, closure and reclamation will be conducted as part of the EIS.

If the tailings are determined to be non-reactive, then the tailings disposal methods formerly used for taconite tailings at this facility would be used for Cells 1E and 2E. In this method, starter dams were constructed around the perimeter of the basin before tailing was discharged into the basin. The future dams may be constructed outside, or some distance inside, the present perimeter of Cell 1E or 2E if locally the Cliff Erie deposited tailings prove to be a questionable foundation for these structures. The tailings slurry would be discharged into the basin from multiple spigot points located on the existing dikes. As part of the EIS, the tailings will be evaluated for their suitability as a construction material. If the tailings are suitable, then the subsequent dams could be created by upstream deposition of heavy tailings waste from spigot points, raising each line as disposal moves inward. However, should PolyMet’s Flotation Tailings be unsuitable for dam construction for whatever reason, alternative sources, including coarse taconite tailings from Cell 2W will be evaluated for the construction of the new dams.

The outer slopes of the basin are planned with an average slope of 3.5 to 1. The central reservoir would function as both a settling pond, where coarse and fine tailings settle out of solution, and a clear water reservoir, where water would be returned to the Processing Plant. The maximum ultimate height of the Flotation Tailings waste in the basin will be approximately 240 feet. The basin and dams will continue to be permitted through the MDNR and MPCA.

Water from the tailings basin would be added back to the concentrator Mill Water system to make up for water lost in that process. A detailed water balance will be conducted as part of the EIS. Based on PolyMet’s projections, water from the tailings basin may need to be discharged to control process water quality or water levels in the basin. A proposed location for a decant structure or barge, discharge route, and treatment plant location is shown on Figure 5-5, providing a conceptual discharge path for this water. The water quality of the decant water is discussed in response to Question 18.

Although predictions of the basin water quality will be addressed in the EIS, the process water in the tailings basin would likely have high concentrations of dissolved solids and alkalinity. In addition, it is possible that the flotation process may make the process water unsuitable for direct discharge. Therefore, the conceptual design includes treatment of the decant water as shown in Figure 5-5. The seepage from the basin may also require treatment. Therefore, it is proposed to extend and improve the previous seepage collection system and to direct the collected seepage either back to the tailings basin or to the treatment plant. The possible alternatives for treatment are discussed in response to Question 18.

A 35-acre emergency basin is located adjacent to the tailings basin that was used by Cliffs Erie to receive taconite concentrate in case of an emergency plant shut down. This basin also received overflow sump water from the concentrator. PolyMet proposes to use this basin to receive its in process ground ore, flotation concentrate, and flotation tailings in case of an emergency plant shut down. The existing capacity of the basin would need to be increased by deepening the basin. The basin would be sized to prevent discharge from the basin into the environment. In process material that is discharged to the emergency basin would be pumped to the tailing basin.

REACTIVE RESIDUE CELLS

Reactive residue would be generated as part of ore processing. Characteristics of these wastes are given in response to Question 20.

PolyMet's plans call for the construction of a Reactive Residue Facility made up of smaller containment cells within existing Cell 2W of the tailings basin to hold these wastes. Each cell would contain approximately 2.3 million cubic yards of reactive residue, including gypsum wastes. Water from the Reactive Residue Facility would be added back to the hydrometallurgical water system to make up for water lost in that process. The exact location, number and design of these cells will be addressed in the EIS.

The lined Reactive Residue Facility would be developed in phases within existing Cell 2W, as shown on Figure 5-5. The phases are numbered on Figure 5-5 in the order they are assumed to be developed under the conceptual layout.

Mineralized Virginia formation hornfels is an acid-generating rock that was encountered in the Dunka Pit formerly operated by LTVSMC. In order to remove this material from contact with oxygen it was transported to the tailings basin and buried in taconite tailings in the general area of the Reactive Residue facility. The location of the Hornfels is shown in Figure 5-5. The impact of the proposed storage facility and the hornfels on the water quantity and quality from the site will be addressed in the EIS.

MINE CLOSURE PLANNING

The planned operating dates for the NorthMet project are from 2007 to 2027. A Closure Plan must be submitted as part of the application for the MDNR Permit to Mine (MDNR Nonferrous Metallic Mineral Mineland Reclamation Rules - MR 6132) and will be developed following discussions with the MDNR, the MPCA and the St Louis County Mine Inspector.

The following description is conceptual; the final closure plan and details will be developed in cooperation with the MDNR, MPCA and other local governments and agencies as appropriate. In general, all environmental hazards would be remediated, inactive pit areas closed, all buildings and structures would be demolished, and all associated sites reclaimed and vegetated. The EIS will evaluate the cost for closure of specific project components, as part of the EIS.

The Closure Plan will have the following general timetable, which may require adjustment as conditions and situation dictate:

- 2028 – stop production, stop mine dewatering, initiate tailings basin reclamation, control fugitive dust on the tailings basin, dispose nuclear, PCB and mercury containing devices, initiate collection and disposal of solid waste outside buildings, initiate mineland reclamation, remove equipment
- 2029– continue to control fugitive dust on the tailings basin, continue collection and disposal of solid waste outside buildings, initiate site remediation, continue mineland and tailings basin reclamation, start to demolish buildings, start to remediate fuel handling areas associated with buildings,
- 2030 – complete demolition and fuel handling area remediation
- 2031 – reclaim remaining area
- 2032 – maintain remaining reclamation, construct final pit overflow channels
- 2033 and beyond – monitoring, reclamation and water treatment will continue until released by DNR from reclamation liabilities and PCA determination that water quality monitoring and treatment are no longer required.

This timetable is based on Minnesota Mineland Reclamation Rules.

WATERSHED RESTORATION

Pit Overflow

If required, each of two major portions of the mine pit would have an overflow channel to direct overflow water from the pit to the nearest natural watercourse. The overflow points, nearest watercourse and detailed plans for the channels will be based on results of the hydrology study. The plans will be submitted to the MDNR and the MPCA for approval. Pit overflows would be monitored and inspected as defined in the NPDES Permit for the mine area. Post-closure water quality of the pit is discussed in further detail in response to Question 18.

Tailings Basin Reclamation

Assuming that the tailings are non-reactive and can be discharged into the existing LTVSMC tailings facility, an improved seepage collection system for the tailings basin would be implemented as part of the project. The exact design and efficiency will be developed and evaluated as part of the EIS. During operation and closure, seepage water quality will be monitored to determine if it would need to be collected and treated prior to discharge. At closure, if water quality standards were met, the return of seepage to the basin would cease. If it is determined that water treatment is required, treatment consisting of some or all of an on-site treatment plant, passive treatment systems and/or pumping to municipal treatment systems would be implemented and continued until the seepage meets water quality standards. These issues would be addressed in the EIS.

Fugitive dust would be controlled by mulching and revegetation as defined by MR 6132-2800.

The design of the tailings dam will be prepared by a qualified geotechnical engineer. The design will include a plan for monitoring structural integrity as the tailings basin is being raised and during post-closure as specified by MR 6132-2500. The geotechnical engineer will also recommend safe water levels for each cell. Safe levels will take into account a spring snowmelt/runoff and rainfall storm events and will be based on MDNR-approved design standards. Cells will be monitored and controlled to the recommended levels. All erosion to the dam face will be repaired and revegetated.

If the tailings are non-reactive, the tailings basin will be contoured and vegetated when tailings placement is completed according to MR 6132.2700. Wetlands will be created to the extent that they are compatible with the tailings basin hydrology and the requirements of the MDNR dam safety rules. As required, channels will be constructed to carry stormwater from the basin to the adjacent wetland. Appropriate energy dissipation devices (e.g., rip rap) will be installed where the drainage channel enters the wetland to distribute the stormwater. Detailed plans for the channels and outlet to the wetland will be based on results of a hydrology study. The entire tailings basin construction and reclamation plans will be submitted to the MDNR and the MPCA for approval. If the tailings are reactive, other methods will be developed and evaluated as part of the EIS. The final design will be consistent with mineland reclamation rules.

The Reactive Residue cells would be closed and capped. The details of this closure will be developed as part of the EIS.

Emergency Basin

The 35-acre Emergency Basin is adjacent to the Tailings Basin. This basin would have received ore concentrate during emergency plan shut downs. At closure, three core samples are proposed to be extracted and analyzed. These samples would determine if any further work would be required to identify possible contamination, which would require cleanup. If no contamination requiring cleanup is found, the area would be contoured to create wetlands and vegetated according to MR 6132.2700. In the event that contamination requiring cleanup is found, a Best Management Plan to address the contamination would be developed and submitted to the MPCA for approval. The initial concept for the plan would be to minimize the amount of stormwater reaching the contaminated soil and, therefore, reduce the potential for contamination to be transported out of the basin area. In either event, detailed plans for any required drainage channels and/or outfall structure would be based on relevant hydrologic data and submitted to the MPCA and the MDNR for approval. The basin stormwater outflow would be monitored and inspected as approved by the MPCA or defined in the NPDES/SDS permit for the tailings basin.

Mine Site Sedimentation Ponds

During operation sedimentation basins would be used to manage stormwater runoff from non-reactive stockpiles and other areas at the mine site. At closure, these ponds would be reclaimed and the stormwater diverted to the mine pits. Ponds that receive runoff from reactive stockpiles will be addressed as part of the EIS.

MINE SITE RECLAMATION & VEGETATION

Minewall

Minewall reclamation (according to MR 6132.2300) consists of removing brush, developing a setback from pit edge, sloping and properly vegetating overburden at the mine wall. Design of mine wall reclamation would take into consideration effects of wave action and ice at the expected final pit water elevation. The appropriate method to close the pit will be determined as part of the EIS and will consider various alternatives and their impact on natural resources. In addition to data from waste characterization studies, models will be developed to examine the hydrology and water quality of the reclaimed pit.

Stockpiles

Standard reclamation practice for non-reactive stockpiles (according to MR 6132.2400) consists of covering flat surfaces with overburden, site preparation and properly vegetating stockpiles. Methods for reclamation of reactive stockpiles will be developed as part of the EIS.

Surface Stockpile reclamation (according to MR 6132-2400) consists of site preparation and properly vegetating stockpiles. Areas disturbed as sources for cover material would be sloped and vegetated.

Fencing Pit Perimeter

Fencing, barricades and gates would be installed as per the plan developed and submitted to and approved by the St Louis County Mine Inspector. Safe access to each mine pit would be provided.

PLANT SITE AREA RECLAMATION

The crushing/concentrating facilities, shops and warehouses would be demolished. Structures would be taken down to the foundation and the foundations covered and vegetated according to MR 6132-2700 and 3200.

Demolition waste from structure removal would be properly disposed in on-site demolition landfills constructed and permitted in accordance with MPCA rules. Likely locations have been identified; including the tailings basin, coarse crusher basement, fine crusher basement, concentrator basement, and Plant Reservoir. MPCA landfill permitting cannot occur until the landfill locations are finalized and the landfills designed. Design and permit application would start one year prior to demolition.

After buildings have been demolished, areas of the Plant Site would be reclaimed and vegetated according to MR 6132.2700. All areas would be stabilized as required for stormwater management. Any culverts requiring removal would be replaced with channels.

SOLID WASTE CLEANUP/DISPOSAL

Major areas where scrap and solid waste have accumulated would be identified and the material would be sorted and properly disposed. Any contaminated soil would be remediated or properly disposed.

Any contaminated railroad ballast associated with removed track would be remediated or properly disposed.

MONITORING AND MAINTENANCE

Financial assurance as required by MR 6132.1200 would be provided for extended maintenance. Long term monitoring and maintenance will be conducted as required under permits.

Erosion Maintenance

All reclaimed areas would be inspected in May and September as well as following major rain events for erosion damage and all necessary repairs made. Inspection reports would be submitted within 60 days of the inspection.

Landfill Monitoring and Maintenance

Monitoring and maintenance for the Cliffs Erie Tailings Basin Coal Ash Disposal Area at the Hoyt Lakes site will continue as required by the existing Post-Closure Care Action Plan section of its Closure Plan dated May 2000.

Monitoring and maintenance required by the permits for the new demolition landfill(s) designed and permitted as part of the mine closure would be done.

Water Quality Monitoring

Monitoring and maintenance would be done as required by the NPDES permit for the Hoyt Lakes plant area, the NPDES/SDS permit for the tailings basin, and the NPDES permit the mine area.

Stormwater Inspections

Inspections required by the NPDES permit the Hoyt Lakes plant area, the NPDES/SDS permit for the tailings basin and the NPDES permit for the mine area will be continued.

ONGOING WATER TREATMENT

Ongoing water treatment may be required for reactive mine waste stockpile drainage, mine pit overflow and tailings basin seepage. During operation, each of these would have water quality monitoring and, if necessary, water treatment systems managed via NPDES permit. At closure, systems that achieve water quality objectives and are as maintenance free as possible would be developed.

Proposed Treatment of Topic in EIS:

The EIS will include a complete project description, including the timing of all phases of construction and operation.

The EIS will consider the proposed action of the Mine Site, Railroad Corridor, Maintenance Shops, Processing Plant, and Tailings Basin. The proposal does not contain connected or phased actions that will be considered in the EIS.

c. Explain the project purpose; if the project will be carried out by a governmental unit, explain the need for the project and identify its beneficiaries.

The primary purpose of the NorthMet mining operation is to provide copper, precious metal, and nickel-cobalt concentrates for sale to the world market. Over the project lifetime, it is expected that the operation will produce approximately 3.2 million tons of copper, 860,000 tons of nickel, 9.3 million ounces of palladium, and 2.6 million ounces of platinum.

PolyMet anticipates that optimized mining and processing operations will involve extracting and processing 32,000 tons of NorthMet ore each day. PolyMet will strive to operate the NorthMet project in a manner that is efficient, cost-effective, and that minimizes impacts to the environment. In this way, the production of copper and other metals can remain competitive, not only within the United States, but also in the worldwide metals market.

d. Are future stages of this development including development on any outlots planned or likely to happen? _ _Yes __X__No

If yes, briefly describe future stages, relationship to present project, timeline and plans for environmental review.

e. Is this project a subsequent stage of an earlier project? __Yes _X_No

f. If yes, briefly describe the past development, timeline and any past environmental review.

7. Project magnitude data
Total project acreage:

See Figure 5-2 for delineations of outlines used to calculate the following areas.

Project Component	**Area (acres)**	**Comments**
Plant Site	205	
Area 1 Shops	36	
Tailings Basin	2,166	Includes active tailings basin area only (Cells 1E, 2E and Reactive Residue Facility)
Railroad Construction Area	21	Includes only the proposed new trackage outside of the Mine Area.
Mine Area	3,015	Includes mine pit at ~620 acres and stockpiles at ~1,126 acres
Total	5,443	

Number of residential units: unattached **N/A** attached **N/A** maximum units per building

Commercial, industrial or institutional building area (gross floor space): total square feet:

Project Component	**Area (sq. ft.)**	**Comments**
Plant Site	692,462	PolyMet expects to use only portions of some of the buildings it will occupy at the facility. Approximately 254,000 sq. ft. of the listed plant site building square footage is expected to remain inactive.
Area 1 Shops	48,150	Six existing buildings will be used at the Area 1 Shops area.
Tailings Basin	0	
Railroad Construction Area	0	
Mine Area	41,250	For mine administration, lockers and lunchroom, general storage, etc., a 200' by 100' facility is assumed. A vehicle field service/refueling bay and the loading facility control building are also included. Actual areas will be determined at a later phase of the project.
Total	**781,862**	

Indicate areas of specific uses (in square feet):

Office

Retail

Manufacturing

Other industrial 781,862

Warehouse **Institutional**
Light industrial **Agricultural**
Other commercial (specify)

(Note: A relatively small amount of administrative office space will be required for plant and mine operations; the square footage for this office space is included in that given under "Other industrial.")

Building height If over 2 stories, compare to heights of nearby buildings

The tallest building on the plant site is the concentrator building, with the highest portion of the concentrator building being 174 feet above adjacent grade. The top tier of the concentrator building is higher than any of the stacks. The tallest stacks rise approximately 151 feet above adjacent grade. The Concentrator is set into the side of the hill upon which the overall plant was built. The Coarse and Fine Crusher buildings are on top of that hill. Therefore, the Coarse and Fine Crushers are the highest buildings at the Plant Site in absolute altitude. Beyond these, at the Plant Reservoir (which is at the highest point on the Plant Site hill) there is a water tower, which is the highest structure at the Plant Site. PolyMet stack additions have not been determined, best engineering practices will be used in final design and specific stack heights will be specified in the air quality permit application.

In addition to buildings the mining project would result in an increase in the LTVSMC tailings basin to a maximum height of 240 feet, which is 40 feet taller than the tallest portion of the existing basin. The mine site itself is estimated to result in a mine pit approximately 900 feet deep and waste rock stockpiles up to 320 feet in height.

8. Permits and approvals required. List all known local, state and federal permits, approvals and financial assistance for the project. Include modifications of any existing permits, governmental review of plans and all direct and indirect forms of public financial assistance including bond guarantees, Tax Increment Financing and infrastructure.

Table 8-1 lists permits and approvals that are known at this time.

Table 8-1
Permits and Approvals

Unit of Government	Type of Application	Status
Minnesota Department of Natural Resources	Permit to Mine	To be applied for
Minnesota Department of Natural Resources	Appropriations permit for tailings basins, and mine dewatering	To be applied for. (Process Water for the Plant Site to be provided by Cliffs Erie via an existing permit.)

Unit of Government	Type of Application	Status
Minnesota Department of Natural Resources	Dam Safety Permit Amendment • for tailings basin • for dikes at mine	• Existing Cliffs Erie permit will be transferred • To be applied for if needed
Minnesota Department of Natural Resources	Permit for work in protected waters, possible modifications and diversions of local streams	To be applied for if needed
Minnesota Department of Natural Resources	Approval for wetlands modifications under Wetland Conservation Act (as part of Permit to Mine)	To be applied for
Minnesota Department of Natural Resources	Water appropriations permit for potable water well for mine site administration building	To be applied for if needed
Minnesota Department of Natural Resources	Burning Permit (possibly needed for construction or land clearing)	To be applied for if needed
Minnesota Department of Natural Resources	Permit for taking of threatened or endangered species	To be applied for if needed
Minnesota Pollution Control Agency	Minnesota Air Emissions Permit	To be applied for
Minnesota Pollution Control Agency	SDS/NPDES permit for discharge of mine dewatering water	To be applied for
Minnesota Pollution Control Agency	SDS/NPDES permit for discharge to tailings basins	Existing Cliffs Erie permit will be transferred
Minnesota Pollution Control Agency	SDS/NPDES permit for discharge of sanitary wastewater at processing plant	To be applied for
Minnesota Pollution Control Agency	SDS/NPDES permit for stormwater discharge	To be applied for
Minnesota Pollution Control Agency	Minnesota Waste Tire Storage Permit	To be applied for
Minnesota Pollution Control Agency	General Storage Tank Permit (fuel tanks)	To be applied for
Minnesota Department of Health	Radioactive Material Registration (for low-level radioactive materials in measuring instruments)	To be applied for if needed
U.S. Army Corps of Engineers	Section 404 Permit for Wetland Impacts	To be applied for
U.S. Fish and Wildlife Service	ESA Consultation by U.S. Army Corps of Engineers to determine ESA impacts of federal action on federally endangered species.	Informal consultation
Minnesota Department of Health	Permit for Non-Community Public Water Supply System (serving an average of at least twenty-five individuals daily at least 60 days out of the year) and wellhead protection plan	To be applied for if needed
Minnesota Department of Health	Notification of Water Supply Well Construction	To be provided when constructed
Minnesota Department of Health	Permit for Public On-site Sewage Disposal System	To be applied for if needed
City of Babbitt	Building Permit for buildings at mine site	To be applied for
State of Minnesota	JOBZ designation for tax incentives	Applied for, application pending

9. Land use. Describe current and recent past land use and development on the site and on adjacent lands. Discuss project compatibility with adjacent and nearby land uses. Indicate whether any potential conflicts involve environmental matters. Identify any potential environmental hazards due to past site uses, such as soil contamination or abandoned storage tanks, or proximity to nearby hazardous liquid or gas pipelines.

The regional setting for the project is a landscape that has been historically used for mining and logging. The nearest large communities (Hoyt Lakes, Aurora, and Babbitt) were built to provide housing for workers at the mines and their associated processing plants. The Mine Site lies within the Superior National Forest while the Plant Site lies on the northeast boundary of the Forest. The Superior National Forest is managed for both economic and recreational purposes.

Mine Site

LAND USE OF THE MINE SITE

The Mine Site is currently vacant land in the Superior National Forest. The land is largely wetland, with small upland areas that are periodically logged. The National Forest has a system of unpaved roads constructed in the Forest to allow access and logging. The headwaters of the Partridge River circle the Mine Site on the north, east and south. The Dunka Road, a mining road constructed by Erie Mining Company (now Cliffs Erie) for access to the Dunka Mine about 9 miles to the northeast, crosses the southeastern corner of the Mine Site, as does the Cliffs Erie rail line formerly used to transport pellets to the shipping facility at Taconite Harbor, and ore from the Dunka Mine.

PREVIOUS LAND USE OF THE MINE SITE

The Mine Site has not been used for any purpose other than logging. Historic logging camps dating from before 1937 have been identified near the site; presumably portions of the mine site were logged at that time and have been intermittently logged since then. Portions of the Mine Site are scheduled for logging in 2004-2005.

The only other known use of the site is for exploratory drilling for mineral development. USX Corporation drilled the first exploratory holes on the site in 1969. PolyMet conducted limited drilling in 1990. More extensive drilling by PolyMet occurred in 1998 – 2000, and is continuing in 2004-2005.

LAND USES NEAR THE MINE SITE

To the north of the Mine Site is the Peter Mitchell Pit operated by NorthShore Mining Company, an operating unit of Cleveland Cliffs, Inc. The NorthShore mine maintenance and coarse crushing facilities are located at the eastern end of this pit, about four miles northeast of the Mine Site. NorthShore's Number 2 Crusher is located directly north of the site at a distance of about one mile. These are the nearest buildings to the site. Beyond the Peter Mitchell pit is more forested land and the town site of the City of Babbitt, which lies about six miles north of the Mine Site. The western unit of the Boundary Waters Canoe Area Wilderness lies about 20 miles north of the Mine Site.

To the east of the Mine Site is wetland and forested land; the nearest residences appear to be along State Highway 2, about 12 miles east of the Mine Site. The NorthShore Mining Company Railroad is about three miles east of the site and the Dunka River is about four miles east of the site. The eastern unit of the Boundary Waters Canoe Area Wilderness is located about 21 miles to the northeast of the site.

To the immediate south of the Mine Site is the Partridge River and, beyond that, forested land. A power transmission line passes east-west just south of the western end of the mine on an alignment that includes the south side of Sections 9, 10 and 11. The nearest residence appears to be about five miles south, about three miles north of the unincorporated village of Skibo. The City of Hoyt Lakes lies about nine miles southwest of the Mine Site.

To the west of the Mine Site are forested land and the "One Hundred Mile Swamp." About four miles west of the Mine Site is a Cliffs Erie rock stockpile, Cliffs Erie Area 3 Mine Pit and the Cliffs Erie Hoyt Lakes Plant Site where the PolyMet processing facility will be located.

Railroad Corridor

The railroad corridor between the Mine Site and the Plant Site has been and will continue to be a transportation corridor for hauling ore. Plans call for the construction of an additional length of railway (see Figure 5-7) to make the trip to the Plant Site more direct. Land uses for the railroad construction area are discussed below.

LAND USE OF THE RAILROAD CONSTRUCTION AREA

Construction of the rail line will disturb approximately 21 acres. The land is currently part of the Cliffs Erie mine site and includes the edge of the Area 2 Mine Pit and associated waste rock stockpiles as well as undeveloped deciduous/coniferous forest. Wyman Creek passes through an existing culvert at the east end of the rail construction area. A small portion of the wetland upstream from the culvert is included in the rail construction area.

PREVIOUS LAND USE OF THE RAILROAD CONSTRUCTION AREA

The railroad construction area has been mining property since the opening of the Cliffs Erie taconite facility.

LAND USES NEAR THE RAILROAD CONSTRUCTION AREA

The Railroad construction area lies between the Plant Site and the Mine Site. To the immediate north of the Railroad Construction Area are the Dunka Road and mine stockpiles. Wyman Creek and its associated wetland areas are directly north and east of the construction area. Further to the northeast of the railroad construction area is additional rock stockpile from the Cliffs Erie Area 2 Mine Pit. To the south of the Railroad Construction Area is the Cliffs Erie Mining Company railroad corridor and, beyond that, an area of undeveloped wetlands and wooded land. To the west of the railroad construction area is the Erie Area 2 Mine Pit and associated waste rock stockpiles.

Plant Site and Tailings Basin

Since the plant site and tailings basin are adjacent, they are treated as a single unit for purposes of describing local and adjacent land uses.

LAND USE OF THE PLANT SITE AND TAILINGS BASIN

The Plant Site is located at the former Cliffs Erie/LTVSMC taconite processing plant. It was used for processing taconite from 1957 to 2000. The property is currently inactive industrial land largely covered by the crushing, grinding, concentrating, pelletizing and shipping facilities of the plant.

Portions of the existing Cliffs Erie plant will continue to be owned by Cliffs Erie and will not be used by PolyMet. The plant is currently inactive except for limited use of office space; however several major projects have been proposed at the plant site. These include the Mesabi Nugget Direct Reduced Iron Project, the Excelsior Energy Project, the reactivation of the Cliffs Erie Railroad and pellet yard for shipping of pellets from United Taconite and the Cliffs Natural Stone business. The potential cumulative effects to these projects are discussed in response to Question 29.

The Cliffs Erie tailings basin lies directly north of the Plant Site. The existing tailings facility at Cliffs Erie will be used to contain tailings products from the NorthMet project. The Cliffs Erie tailings basin was originally constructed by Erie Mining Company, and was used from 1957 to 2000. The location and general plan of the tailings basin is shown on Figure 5-1; more detail is given in Figure 5-5. The basin consists of three large cells: 2W, 1E and 2E. Cell 2W is the largest (1,447 acres), and highest (200 feet) of the three cells. It is the driest and has gradually lost the ponded water remaining from taconite processing. Cell 1E is 970 acres and rises about 120 feet above ground level; Cell 2E is about 616 acres and is the lowest cell, rising only about 30 feet above ground level. Both cells continue to hold water. The tailings basin is currently undergoing reclamation under the Cliffs Erie Permit to Mine. The relationship of Cliffs Erie's existing permit to mine and any potential permit to mine for PolyMet will be discussed in the EIS.

LAND USES NEAR THE PLANT SITE AND TAILINGS BASIN

South of the Plant Site are wetlands that form the headwaters of Second Creek, a tributary of the Partridge River. Also located south of the plant are pits formerly mined for natural ore and taconite and mine stockpiles. Four miles south of the plant is Colby Lake and the Syl Laskin Power Plant owned by Minnesota Power. On the south side of the lake, about five miles from the plant, is the City of Hoyt Lakes. The homes in Hoyt Lakes are the closest residences. The City of Aurora lies about six miles southwest of the Plant Site.

To the west of the plant is the rail line of the Canadian National Railway Company, formerly the Duluth, Missabe and Iron Range Railroad. Further west are pits formerly mined for taconite and natural ore, as well as mine stockpiles. Directly west of the plant are the Embarrass Mountains, large hills rising about 500 feet above the nearby terrain.

To the east of the plant is the Number 2 pit and associated mine dumps. Further east is Wyman Creek and additional mine dumps. One Hundred Mile Swamp lies about four miles east of the plant and tailings basin.

The Cliffs Erie tailings basin lies directly north of the Plant Site. The basin is surrounded on the west, north and east by wetlands and low, forested uplands. The nearest homes to the north are rural residences on County Road 358, about one mile north of the tailings basin and three miles north of the Plant Site. Heikkilla Lake is located about two miles northwest of the tailings basin. Additional rural homes are located along County Road 615 about two miles north of the tailings basin. The Embarrass River follows a curving path around the north and west of the tailings basin at a distance of about three miles. The unincorporated town of Embarrass is on this river, about three miles northwest of the tailings basin and about 4.5 miles northwest of the plant. The western end of the Boundary Waters Canoe Area Wilderness lies about 17 miles north of the tailings basin.

PREVIOUS LAND USE OF THE TAILINGS BASIN

The tailings basin portion of the plant and processing area is a large dike constructed of tailings with road access along the top. Tailings were discharged as a slurry with process water. The design of the dikes allows the tailings to settle and the process water to be recycled back to the plant. Several pumping stations were located in the tailings basin and several transformers exist. Cliffs Erie records indicate that these transformers currently contain non-PCB mineral oil. An area within Cell 2W (shown on Figure 5-5) contains buried hornfels. Hornfels is a waste rock type containing sulfide minerals. Limestone was buried with the hornfels to provide neutralization of any acid that might be generated by the hornfels. Monitoring wells are installed surrounding the hornfels burial site and are monitored as part of the NPDES permit. The buried hornfels and their relationship to PolyMet's proposed reactive residue facility is discussed under Question 20. The Tailings Basin Reporting Area is located at the road access point to the tailings basin. This Reporting Area contains a lube station. In addition, two underground storage tanks were removed in 1988. A septic tank and drain field system remain in place.

An area immediately west of the Tailings Basin Reporting Area contains several small equipment and materials storage locations. Most of the salvageable materials are gone.

However several soil stained areas were observed. The Cell 2W salvage area is located along the western edge of the Tailings Basin. Salvage operations are evident with several small soil stained areas as well as the remains of a mobile storage tank containing Choherex, a petroleum-based dust suppressant.

Active treatment of acid mine runoff from the Dunka Mine stockpiles (located about 16 miles east-northeast of the plant near Birch Lake) produced a treatment sludge. The eastern margins of the Tailings Basin contain an area where this sludge was temporarily stored before being shipped offsite; little evidence of its existence remains.

The coal ash landfill was located south of the sludge staging area at the eastern side of tailings basin Cell 1E. The coal ash was generated at the Taconite Harbor power plant and shipped back to Hoyt Lakes on rail cars. The landfill was closed in accordance with a schedule of compliance with the MPCA. The landfill cover appears in good condition.

South of the coal ash landfill and west of the rail line is a petroleum-contaminated soil spread area. This land application site contains approximately 25,000 cubic yards of soil from the Area 1 Shops Tank Farm cleanup, and the cleanup of a remote fueling site not associated with PolyMet facilities. The site has been monitored in accordance with MPCA requirements.

Just south of tailings basin Cell 1E and outside the PolyMet controlled area is the Area 2 Shops area. This was the primary shop for the eastern mining areas and currently contains a locomotive fueling station for the in-mine locomotives. A septic tank and a drain field remain in place.

To the southwest of the tailings basin is the Emergency Basin that functioned as a drain outfall for storm water and overflow of process water for the Plant Site.

PREVIOUS LAND USE OF THE PLANT SITE

The PolyMet Plant Site includes both the Main Plant and the former Area 1 Shops. The Area 1 Shops were used for maintenance equipment. The maintenance activities included fueling, equipment rebuild and repair, steam cleaning and the use of an electrical shop. An underground tank leak (LUST #6421) was reported and corrective action was taken. The soil was removed and land spread near the tailings basin (see above). The MPCA closed the leak site on December 16, 1998.

The previous land use of the Plant Site was, of course, LTV Steel Mining Company's processing of taconite. The plant extends beyond the area controlled by PolyMet.

At the far south end of the PolyMet property is the Bunker C Tank Farm, which is currently being investigated under the MPCA's LUST program (Leak #12254). This area contains three large tanks used for storing #1, #2 and #6 fuel oil.

The Plant Site proper was used for crushing and concentrating of ore, and general maintenance facilities. Past practices may have resulted in releases of fuels and other chemicals. A detailed investigation has not been completed. Five aboveground tanks exist. One was used for fuel oil, one held alcohol and three held mineral oil.

Petroleum-contaminated soils from the Coarse Crusher building were stockpiled adjacent to the building before being shipped off site for treatment in July 2000.

Area 1 Shops

LAND USE OF THE AREA 1 SHOPS

The Area 1 Shops will be used by PolyMet to maintain equipment, the most important being mine haul trucks and other mining equipment. This was the former use of the facility during taconite mining. No new construction or changes in land use are anticipated.

The Area 1 shops facility includes the shop itself, a boiler house, a fire pump house, an oil storage facility and two unheated storage buildings; one for shovel and drill equipment and one for general warehousing.

PREVIOUS LAND USE OF THE AREA 1 SHOPS

The Area 1 Shops facility has been used for mine equipment maintenance since the opening of the Erie Mining Company taconite facility. During operation sanitary wastewater was disposed of through a septic tank and drain field system. Oily drainage from shop floor drains and other industrial wastewater was contained and recycled with residuals from oil/water separates being disposed of through outside services. A closed leak site exists for the fueling portions of the shops.

LAND USES NEAR THE AREA 1 SHOPS

The Area 1 Shops facility is located about 1.5 miles west of the plant site. The facility is located in an area of extensive, long-term mining operations.

To the immediate south of the Area 1 Shops is a small wooded area and, beyond that, haul roads, rail tracks and mine stockpiles. Further south is a large wetland complex associated with Second Creek. West of the Area 1 facility is the former Erie Mine No. 1 pit and associated mine dumps. This complex extends roughly four miles to the west. To the north is wooded land on the slopes of the Embarrass Mountains, a range of high hills. To the east of the facility is mineland, including haul roads, rail lines and mine stockpiles. The Cliffs Erie plant is further east from this mineland.

Proposed Treatment of Topic in EIS:

Land use conflicts are not anticipated due to previous and ongoing mining in the area. The EIS will not include any further discussion on the issue beyond what is included in the Scoping EAW.

10. Cover types. Estimate the acreage of the site with each of the following cover types before and after development:

Note:. Acreages for cover types are approximate and are based on Polymet habitat and wetland mapping , existing and proposed facility CAD mapping and 2003 FSA color aerial photography. Figure 5-2 shows the locations of the project features listed below.

Existing roads and railroads are treated as linear features having no area associated with them. The project will not change the land use and cover types along the extent of these features.

Cliffs Erie Plant Site

	Number of Acres	
Cover Types	Before	After
Brush/Grassland	7.6	7.3
Disturbed Land*	108.5	108.0
Impervious/Building	28.8	29.6
Plant Reservoir	1.9	1.9
Railroad	12.4	12.4
Road	13.1	13.1
Wooded/Forest	32.7	32.7
TOTAL	205.0	205.0

* Includes unimproved roadways, ditches and mining-related areas that can be identified on air photos as disturbed, but cannot be assigned a specific land use.

Tailings Basins

Active Tailings Basin Area (Cells 1E and 2E and 2W including Reactive Residue Facility)

Cover Types	Number of Acres Before	After
Brush/Grassland	11.7	
Grassland Under Reclaimation	2319.5	
Tailings Basin Wetland Under Reclaimation*	638.2	
Types 1 to 8 Wetlands (includes lakes)**	23.2	
Wooded/Forest	148.7	
Mine Infrastructure**		23.2
Reactive Residue Facility		336.0
Reclaimed Grassland		1158.0
Tailings Basin		1624.1
TOTAL	3141.3	3141.3

* Open water within existing Cells 1E and 2E

** Area for treatment plant on north side of Tailings Basin

Post-project conditions will include wetlands, brush/grassland, and forested land; details of tailings basin closure plan and wetland mitigation plan have not yet been established.

Area 1 Shops Area

Cover Types	Number of Acres Before	After
Brush/Grassland	2.4	2.4
Disturbed Land*	29.6	29.6
Impervious/Building	1.8	1.8
Wooded/Forest	1.7	1.7
TOTAL	35.5	35.5

*   Includes unimproved roadways, ditches and mining-related areas that can be identified on air photos as disturbed, but cannot be assigned a specific land use.

Railroad Construction Area

Cover Types	Number of Acres Before	After
Brush/Grassland	0.5	
Disturbed Land*	7.8	13.5
Railroad	1.6	7.2
Types 1 to 8 Wetlands (includes lakes)	1.2	
Wooded/Forest	9.6	
TOTAL	20.6	20.6

*   Includes unimproved roadways, ditches and mining-related areas that can be identified on air photos as disturbed, but cannot be assigned a specific land use.

Mining Area

Cover Types	Number of Acres Before	After
Brush/Grassland	293.5	1108.4
Disturbed Land***	65.9	
Types 1 to 8 Wetlands (includes lakes)	1257.0	
Wooded/Forest	1398.1	
Impervious Surface/Mine Infrastructure**		35.0
Mine Pit		619.6
Railroad		55.5
Road		37.6
Stockpile		1126.0
Treatment Pond		32.5
TOTAL	3014.5	3014.5

*   Post-project conditions will include pit lakes and may include wetlands and small amounts of wooded or revegetated land.
** Includes buildings and miscellaneous mining-related facilities
***   Includes unimproved roadways, ditches and mining-related areas that can be identified on air photos as disturbed, but cannot be assigned a specific land use.

If **Before** and **After** totals are not equal, explain why:

Proposed Treatment of Topic in EIS:
The EIS will discuss potential impacts from changes in cover types as well as provide additional detail on timing of cover type changes and post reclamation cover types.

11. Fish, wildlife and ecologically sensitive resources

a. Identify fish and wildlife resources and habitats on or near the site and describe how they would be affected by the project. Describe any measures to be taken to minimize or avoid impacts.

This section is organized into two major parts: 1) Wildlife Resources & Habitat, and 2) Aquatic Resources & Habitat.

Wildlife Resources & Habitat

With respect to wildlife resources and habitat, four general areas may be considered:

1. Mine site
2. Road and railroad corridors.
3. Plant site (including the Area 1 shop truck maintenance facility)
4. Tailings basin, and

These are addressed separately below.

MINE SITE

Wildlife Resources – Mine Site

Amphibians, reptiles, birds, and mammals were surveyed during field studies. Green and chorus frogs were observed in several wetlands on the study area. Tadpoles were also seen in several wet areas, but could not be identified as to species. Garter snakes were observed in clearcuts. Thirty-two species of birds were identified. Great blue heron, common snipe, belted kingfisher and swamp sparrow were observed near wetlands and ponds. Mourning dove, eastern kingbird, water pipit, chipping sparrow, song sparrow, and white-throated sparrow were associated with disturbed areas and grassland/shrublands. The remainder of species was primarily associated with forests, including five species of woodpeckers (black-backed woodpecker, hairy woodpecker, northern flicker, northern three-toed woodpecker, and pileated woodpecker). Woodpecker cavities and foraging sign were common on larger snags (>6 in diameter at breast height - dbh) and on stumps. Other cavity-nesting species seen in forests included black-capped chickadee and red-breasted nuthatch. Broad-winged hawk, least flycatcher, eastern phoebe, eastern wood peewee, gray jay, blue jay, common raven, common redpoll, American crow, winter wren, hermit thrush, American robin, gray catbird, red-eyed vireo, Nashville warbler, pine warbler, black-and-white warbler, common yellowthroat, dark-eyed junco, and snow bunting were found in forests. Ruffed grouse were heard drumming, especially on the central portion of the property.

Common mammals seen or identified based on sign included beaver, pine marten, red squirrel, white-tailed deer, moose, coyote, gray wolf, bobcat, river otter, and showshoe hare. Marten dens and sign were common in jack pine and spruce forests associated with wetlands. Red squirrel sign were abundant in jack pine forests. Deer and moose were associated with clearings associated with nearby forest, although moose droppings were common in sedge and alder wetlands near upland forests. Moose were most common on the western portion of the property. Black bear scat was seen in the north central portion of the property, and a bear and cub were seen near the western boundary of the property. Red fox scat was found in the study area. Coyote tracks were seen along roadways, and wolves were heard during night call surveys. Bats were seen flying over wetlands in the evening.

Wildlife Habitat – Mine Site

Habitat observed on the study area was typical of habitats associated with much of the Iron Range. The study area has little relief. The area consists of a mosaic of slightly elevated upland areas surrounded by wetlands, and slopes toward the east-northeast, in the direction of the Partridge River. Elevations range from 1,620 feet msl along the western boundary to 1,550 feet msl near the southeastern boundary of the study area. More upland habitat was associated with the central portion of the study area, in the vicinity of the proposed mine. The One Hundred Mile Swamp is the dominant feature on the landscape, located in the northern portion of the study area. The Partridge River drains this swamp and flows along the northeastern and eastern boundary of the study area, before entering and leaving the southeastern portion of the study area.

Forest vegetation dominates the study area. Most forest stands contained trees that were 12 inches diameter at breast height (dbh) or less. In general, the site can be divided into quadrants. The northwest quadrant is dominated by lowland black spruce, with scattered stands of quaking aspen and balsam fir/aspen; tamarack is also scattered throughout these stands. Most trees are estimated to be 60 years or older. Interspersed within forest stands are brush/sapling tree stands that were recently logged and provide habitat for deer and moose. Several wetlands are found in this quadrant, with One Hundred Mile Swamp comprising most of the western and northern portions of the quadrant.

The northeast quadrant is dominated by nearly equal amounts of jack pine and spruce, with scattered aspen stands and speckled alder swamps. Although there are scattered black spruce stands containing trees greater than 60 years in age, most trees, especially jack pine, are 20 to 60 years in age. There are few recently logged areas within this quadrant. The Partridge River and several large associated wetlands are found in this area. Most shrub/sapling tree habitat is associated with these wetlands and drainages.

Grouse tend to favor areas with younger aspen and birch trees associated with mature conifer forest habitat, and it appeared that grouse were more common in the northeast quadrant than in any other quadrant, especially during 2000 winter surveys.

The southeast quadrant contains a nearly equal mix of lowland and upland spruce, jack pine, and aspen, with some balsam fir and paper birch. Most tree stands are from 40 to 80+ years of age, although jack pine tree stands along Dunka Road are from 20 to 40 years of age. The Partridge River and a tributary to the river, Stubble Creek, are found in this quadrant and are dominated by sedge and cattail meadows and shrubs, including speckled alder and willow. Minnesota Power's Taconite Harbor to Hoyt Lakes powerline and Cliffs Erie's railroad are also important features in this quadrant.

Aspen, black spruce, and speckled alder wetlands dominate the southeast quadrant. There is more balsam fir in this quadrant than in the other quadrants, while jack pine is rare and found only in scattered stands. Most tree stands are 60 years of age or older, with the oldest stands found near the southern boundary of the quadrant; most jack pine stands have been harvested within the past 40 years. Clearings comprised of grasses, forbs, and shrubs were associated with the powerline right-of-way, and several recently logged areas. The Partridge River is the dominant aquatic feature in this quadrant, but several wetlands were also found along the powerline route.

The recently logged areas consist of grasses and ferns with aspen saplings and speckled alder. The areas of more mature upland forests consist of jack pine, balsam fir, and aspen, with lesser amounts of paper birch, red pine and white pine. The mature lowland areas consist mainly of black spruce and tamarack growing on a bed of sphagnum moss and clubmoss with speckled alder, Labrador-tea, and leatherleaf. The open wetland areas consist of grasses, sedges, cattails, speckled alder, and pussy willow.

Upland areas appeared to be used more by wildlife than wetlands, especially by large mammals such as deer and moose, probably because uplands provided greater cover and more browse and other food items during winter than did wetlands. Deer favor aspen and birch forests in northern Minnesota for foraging, while conifer-dominated stands are important in late winter.

Likely Impacts to Wildlife Resources and Habitat – Mine Site

Potential impacts to wildlife from activities associated with the Mine Site include the following:

- Habitat loss and modification
- Land use and disturbance
- Acid mine drainage

Habitat Loss and Wildlife Species Impacted

Habitat analysis is a standard approach used to assess the impacts of land management activities on wildlife. Habitat relates the presence of an organism to the physical (e.g., topography, microclimate) and biological (e.g., plant composition and cover) attributes of the environment.

Most habitat assessment studies focus on the biological attributes, which are often delineated as cover types, or areas of land or water with similar habitat characteristics. Once the landscape is delineated into a group of cover types, the relationship between occurrence of cover types and presence of various wildlife species can be determined. This relationship can be used to assess whether a certain species is likely to occur in an area, and how loss of or a change in cover types could influence wildlife species occurrence.

Development of the Mine Site would directly impact approximately 3,015 acres of wildlife habitat. Of this 3,015 acres, approximately 1,305 acres (43%) are wetland, and 1,710 acres (57%) are upland (Figure 11-3). Although undeveloped portions of the lease area, primarily on the perimeter of the Mine Site, will be retained as wildlife habitat and to buffer the Mine Site from adjacent, undisturbed habitats, noise disturbance and human presence would render these habitats unsuitable for some wildlife during mine operations.

Species that are fossorial, nest or roost in cavities, or are relatively immobile and could not avoid construction equipment would be killed during mine development. These include amphibians and reptiles, burrowing small mammals, rodents and other slow-moving mammals, and cavity nesting/roosting birds and bats. More mobile species, such as deer, moose, coyote, and birds would leave the area during construction, but would have to compete with other wildlife for food and shelter in newly-occupied sites. As a result, health and survivorship of these individuals could be lessened. If construction occurred during winter when most birds and bats are on wintering grounds or migrating, the number of wildlife killed during construction would be reduced. Displacement of resident species due to winter construction, however, would force these animals to seek new food and shelter sources during the time of year when these sources are most limiting and wildlife tend to be under greatest physical stress.

Habitat Fragmentation and Travel Routes

The proposed mine project would increase the amount of habitat fragmentation in the area, changing shrubland, and pole and young mature forest to disturbed areas, and later to mostly open-water habitat and grassland/shrubland/young forest. Construction and development of iron mines to the north and west of the property has made much of this area of limited value to wildlife, especially in areas with pits and waste rock stockpiles. Waste rock stockpiles have begun to revegetate and provide some browse and cover for wildlife, but their value is greatly reduced compared to habitat that existed in the area prior to mining.

In addition, timber harvesting in the area has already removed some of the mature timber in the area, and construction of the Mine Site would remove an additional 308 acres of mature forest. Mature forest provides habitat for species that favor older forests, and provides important cover for deer and moose during winter.

The travel routes of most non-flying wildlife in the study area typically followed existing or historic logging or drilling roads, powerline, road, and railroad rights-of-way, streams, and forest edges. Trails were also common between two adjacent forest types, especially between forage and shelter areas. There was no evidence that the Mine Site is used by large concentrations of wildlife or that the site serves as a critical wildlife corridor. However, the site does serve as a movement corridor, as demonstrated by tracks and trails that suggested movement primarily in an east-west direction, and also to the south. Studies of radio-collared lynx, and observations of gray wolf, bobcat, and coyote show that these animals are found on or near the Mine Site, and that the Mine Site is part of the movement corridor of these species After construction, these species would likely avoid the site.

Land Use Related Impacts

Light and glare, roads, and noise associated with the mine project would impact wildlife. The mine would operate 24 hours a day, 365 days per year, for approximately 20 years. Light and glare would primarily be associated with mine buildings, active stockpiles and the mine pit. Light and glare can benefit wildlife by attracting insects that are important to some species, such as bats. Light and glare, however, can affect the behaviors of wildlife and make some species more susceptible to predation at night. Most wildlife would avoid areas of the mine that are active and well-lit.

Wildlife injury and death are expected to occur from increased traffic volume on the roads. Information on the current number of wildlife killed annually on roads in the area is not known, but is likely small since only a few cars travel on the portion of the Dunka Road through the Mine Site each day. During mine construction and operation, vehicle traffic would increase on the Dunka Road. Thus, wildlife fatalities would be expected to increase during mine construction and operation. Amphibians, reptiles, and small and large mammals would probably be most affected. Habitat suitability for some wildlife would also be reduced near the Mine Site and more heavily used mine access roads due to vehicular traffic and noise.

The impacts of noise on wildlife are largely unknown and the assessment of impacts remains subjective. Wildlife are receptive to different sound frequency spectrums, many of which may be inaudible to humans. Wildlife also are known to habituate to noise, especially noises that are steady or continuous, such as noises that would occur at the mill. Wildlife are less likely to habituate to sudden, infrequent impulse noises.

Noise has the potential to impact all life functions of wildlife, but may have greatest impacts during breeding, roosting, and hibernation. Loud, sudden noises would be expected to displace a variety of wildlife found on the Mine Site, including deer, game birds, and small mammals.

Acid Mine Drainage Impacts

Water flowing from reactive waste rock stockpiles would be collected in ponds and treated prior to discharge to the Partridge River. Studies have shown that the waste rock has the potential to generate acid and leach metals. Drainage water would be collected in ponds and could be used by amphibians, birds, and small and large mammals as a potential foraging, loafing, and drinking site. The risk to wildlife health and potential for wildlife mortality would depend upon the acidity and concentration of metals in the water, and the types and duration of use by wildlife. Potential water quality impacts are described in the responses to Questions 17 and 18.

The risks to wildlife of a spill during the transport of materials used for maintenance and operation of the Mine Site, and during storage and use of the materials at the mine, would depend on the location of the spill and type and amounts of materials spilled. Potentially toxic compounds used in mine processes include water treatment chemicals, ammonium nitrate, gasoline, and diesel fuel. The management and use of these materials is described in the response to Question 20.

Mitigation of Impacts

A number of best management practices (BMPs) and reclamation measures would be taken to reduce or avoid impacts to wildlife. Specific BMP's and reclamation measures will be identified in the EIS.

The size of the footprint would be kept as small as possible to reduce the amount of habitat disturbance. Where feasible, trees and other large vegetation would be left as a buffer around the perimeter of the Mine Site to reduce glare, noise, and other disturbances to wildlife.

The mine would be constructed in phases to minimize the amount of area disturbed at any one time, and to allow sequential reclamation as mining activities permanently cease in each disturbance area. Small trees, scrub vegetation, and forest detritus would be mulched and removed with the topsoil and stockpiled for future use in reclamation. As sections of waste rock stockpiles or other mine facilities are closed, the sites would be graded for precipitation runoff and/or to better match the local topography, covered with soil, and revegetated. A stormwater management plan would be developed that identifies practices to ensure that stormwater runoff does not adversely impact off-site water quality.

Reactive waste rock would be stockpiled on top of a seepage barrier and drainage collected in lined storage ponds. The water in ponds would be treated prior to discharge to the Partridge River. Pit water would also be collected, sediments would be allowed to settle out, and then treated, if necessary, before discharge. Fuel and other hazardous materials would be stored within a roofed structure. Bulk oil storage tanks would be enclosed with a berm sized to contain all oil within the storage tanks.

Speed limits would be enforced along the Dunka Road and this would reduce the risk of wildlife-vehicle collisions. Mine workers would be given training to make them aware of the importance of the area to wildlife, to request that employees report sick or dying wildlife along roads or at facilities, to ensure that employees do not dump wastes or other harmful materials off the site, and to make employees aware of other actions that could be harmful to wildlife or their habitats. After mine closure, most access roads would be reclaimed.

RAILROAD CORRIDOR

Wildlife Resources– Railroad Corridor

The railroad route contains habitats for amphibians, reptiles, birds, and mammals. Several species of waterfowl were observed to be using the large marsh wetland. The marsh is also expected to support frogs, great blue heron, common snipe, belted kingfisher, swamp sparrows, beaver, and possibly river otter. The forested habitats are expected to provide habitat for woodpeckers, cavity-nesting birds (see Mine Site section for specific species), ruffed grouse, pine marten, red squirrel, white-tailed deer and possibly moose. The habitats are very fragmented in this area by stockpiles, mine pits, railroads, roads, and trails. The fragmented nature of the area may limit its use by some wildlife.

Wildlife Habitat – Railroad Corridor

Habitats within the proposed railroad corridor include a mix of upland and wetland habitats commonly found in the area. The railroad route closely follows or crosses several existing roads and trails north of its connection with the existing railroad (Figure 5-7). Ground elevations within the route range from 1620 feet msl on the north side where the route would extend from an existing mine road grade down to 1570 feet msl at the southeast where the route ties into an existing railroad grade. Habitats within the route include a mix of forest cover, roads and trails, and wetlands. The forests were predominantly mixed deciduous/coniferous cover with varying amounts of aspen, black ash, balsam fir, jack pine, and spruce. There is a wet meadow wetland in the northern portion, a black ash swamp adjacent to the central part, and a large shallow and deep marsh at the southeast end of the route. The wetlands are dominated by Canada bluejoint grass in the wet meadow and open water with a perimeter of cattails in the shallow water area with shrubs along the saturated perimeter. The marsh wetland is a floodplain extension of a perennial stream that drains approximately 2,000 acres. The primary north-south road along which the route runs is a gravel road in good condition. Three unimproved trails cross the route in the southern end.

Likely Impacts to Wildlife Resources & Habitat – Railroad Corridor

The proposed railroad would result primarily in the loss of a small amount of mixed upland forest land. A small amount of wetland filling may be necessary to connect the proposed railroad into the existing railroad embankment. The railroad would not significantly fragment habitats as it is planned to closely follow existing roads and trails. The railroad is not expected to significantly impact wildlife resources. Currently, much of the area through which the railroad passes is fenced with an approximately 6-foot tall fence which hampers wildlife movement. The construction of a railroad through this area is not expected to alter wildlife movements, but may allow more free dispersal if the fence is removed. The proposed railroad construction will not cross Wyman, Longnose, or Wetegs Creek.

Based on conceptual railroad design, it is anticipated that the following areas of habitat types will be impacted:

1. Shrub lands - 0.5 acre
2. Wetland – 1.2 acres
3. Railroad Right-of-way – 1.6 acres
4. Disturbed Roads and Trails – 7.8 acres
5. Forests/Wooded – 9.6 acres

PLANT SITE

The Plant Site has been extensively disturbed and/or filled as a result of previous construction and almost 50 years of mining-related activity. An aerial photo of the Plant Site is shown in Figure 11-1. With exception of the northeast quadrant of this site, the majority of the area is covered by buildings and tanks with deep and substantial foundations, mechanical equipment, related foundations product storage areas, and ballast or finished surfaces related to the construction of paved road, parking lots and railroad facilities. Proposed project construction located at the Plant Site will occur on previously paved areas or within existing buildings. No direct impact to wildlife resources or habitat is expected as a result of the construction and operation at the Plant Site.

TAILINGS BASIN

Wildlife Resources & Habitat – Tailings Basin

On October 30, 2001, all of LTV Steel Mining Company's (LTVSMC) mining related property was transferred to Cliffs Erie L.L.C. (CE).

CE has continued to aggressively carry out reclamation activities on the former LTVSMC tailings basin on a timetable that allows development and reuse of the site to be fully explored as stated in the CE Closure Plan dated May 23, 2002. The planned end use under the CE Closure Plan is wildlife habitat.

The tailings basin consists of three large cells: 2W, 1E and 2E (see Figure 11-2). Cell 2W is the largest (1,447 acres), and highest (200 feet) of the three cells. It is the driest cell and has gradually lost the ponded water remaining from taconite processing. Thus, the entire cell is upland and has undergone reclamation to establish an upland grass/forb plant community since 2000. This program relies heavily on an initial introduction of plentiful plant seed adapted to harsh conditions of the tailings basin. This circumstance limits the potential of early volunteer (native) plants to successfully colonize the basin.

Plant operations personnel have observed wildlife in the tailings basin for many years. Common wildlife visitors large enough to be clearly observed or to leave tracks include: white tailed deer, moose, badger, coyote, fox, muskrat, mink, otter, Canada geese, mallard, scaup, canvasback, redhead, blue-winged teal, American widgeon, swans, red tailed hawk, sparrow hawk, snow buntings, kingfisher, and numerous songbirds. The lowland pond areas in Cells 1E and 2E also attract other migrating waterfowl and shore birds for short periods of time.

Likely Impacts to Wildlife Resources & Habitat – Tailings Basin

Based on the conceptual basin operating plan and hydrometallurgical residue disposal facility plans, it is anticipated that the following areas of habitat types would be impacted (see Figure 11-2):

1. Shrub Lands/Grasslands - 12 acres
2. Tailing Basin Lowlands – 226 acres
3. Tailings Basin Open Water – 638 acres
4. Tailings Basin Upland – 2093 acres
5. Wetland – 23 acres
6. Wooded/Forest – 149 acres

The actual acreage of the existing tailings basin that would be impacted is likely less than what is described above. The above acreage identifies the entire tailings basin due current uncertainty about the amount and location of coarse tailings that will need to be borrowed from Cell 2W. The shrub lands and forested/wooded areas of the tailings basin represent the only areas on the interior of the area enclosed by tailings basin that have not been significantly disturbed by past tailings discharge related activities. The tailings basin lowlands represent lowlands and deepwater habitats that developed within the former LTVSMC tailings basin during operation and ongoing reclamation activities. The reclaimed grasslands represent the reclaimed portions of the west cell of the LTVSMC tailings basin, which was closed during operation of the basin by LTVSMC. The remaining areas classified as disturbed represent areas around the east cells of the LTVSMC tailings basin that were in operation when the plant shut down. These areas are under various stages of reclamation and include roadways.

Attraction of wildlife to open water in the tailings basin and reactive residue facility could be a potential impact depending on the level of attraction and the toxicity of the water.

Aquatic Resources & Habitat

Biological sampling of aquatic invertebrates and fish was completed in September 2004 for the Partridge River, two palustrine wetlands adjacent to the toe of the tailings basin, and Trimble Creek downstream of the tailings basin. A survey of freshwater mussels was also completed for the Partridge River, Trimble, Creek, and the Embarrass River in October 2004 (see Figure 11-4 for all the biological sampling locations). Aquatic invertebrate data will be available for EIS preparation, preliminary fish and freshwater mussel results are described below. Reports of all completed aquatic biological monitoring will be available for EIS preparation.

Stream fish assemblages were sampled by pulse DC electofishing using either a tote-barge or a portable backpack unit. The type of gear used depended on stream depth, width, and substrate type. The distance of stream reach included in the survey was generally based on 10x the stream width, but a minimum of 100 m was sampled. A single-pass method was determined adequate to establish an estimate of taxa richness within each sample reach.

Freshwater mussels were collected in October by visually searching and tactilely by hand using SCUBA and by snorkeling. Both living and empty (dead) freshwater mussels were collected, placed in a 0.125 mm mesh-sized bag, brought to the surface, identified, enumerated, total length measured and age of the mussels recorded.

With respect to aquatic resources and habitat, four general areas may be considered, mine site, tailings basin, road and railroad corridors, and effected downstream water bodies including the Partridge River. However, until greater detail is provided in the final fisheries and invertebrate reports, these areas are considered together to provide a general description of the aquatic resources and habitats of the entire project area. Potential impacts to aquatic resources from changes in quantity and quality of water are also identified in response to EAW Questions 12, 17 and 18.

FISH RESOURCES

The fisheries data that is currently available from the survey includes the range and average fish lengths, abundance, and trophic structure. Species abundance values will be included in the EIS, but because the effectiveness in sampling effort was not equal among all sites (resulting from low conductivity experienced at some sites, differences in stream width, bottom characteristics, etc.), the abundance values should be used cautiously. Similarly, the depth and surface area associated with the wetland sites eliminated the opportunity to use electofishing gear. Thus, the effort and gear-type should both be considered prior to making any inferences between fish assemblages or community structure between sites. Some general observations can be made for all habitats sampled.

No taxa collected in this survey were endangered or considered rare to the region. Table 11-1 identifies the fish species that were indentified.

Table 11-1: Fish Species Identified

Partridge River
Blacknose Dace
Brassy Minnow
Brook Stickleback
Central Mudminnow
Common Shiner
Johnny Darter
Longnose Dace
Northern Redbelly Dace
Pearl Dace
Tadpole Madtom
White Sucker
Trimble Creek
Brook Stickleback
Burbot
Central Mudminnow
Creek Chub
Northern Redbelly Dace
White Sucker
Wetlands Adjacent to the Tailings Basin
Brook Stickleback
Central Mudminnow
Common Shiner
Creek Chub
Fathead Minnow
Finescale Dace
Northern Redbelly Dace
While Sucker

FRESHWATER MUSSELS

A total of 82 mussels were collected at sampling locations on the Partridge River, Trimble Creek, and Embarrass River. Two species were found: *Pyganodan grandis* and *Lampsilis siliquoidea*, comprising 59 percent and 41 percent of the mussel species, respectively. Neither of these species are listed as state or federal threatened or endangered species. The greatest abundance of mussels was found at M-1 on the Partridge River (41 living mussels), followed by M2 on the Partridge River (4 living mussels), M-4 on the Embarrass River (3 living) and no mussels at M-3 on Trimble Creek (Figure 11-4). In general, population densities at these sampling locations can be considered low. Overall the mussel fauna in Partridge and Embarrass River is typical for small stream in the western Lake Superior Basin. The two species that were found are very widespread and common throughout the upper Midwest and are area generalists that occur in nearly all types and sizes of waterbodies.

LIKELY IMPACTS TO AQUATIC RESOURCES & HABITAT

With the exception of open water wetlands within the proposed mining area, development of the mine, plant site, road and rail corridors, and the tailings basin are not expected to cause direct physical displacement of fish, mussels, and invertebrates.

Potential impacts would be associated with:

- the discharge of treated drainage from various operating locations in the mine (i.e. treated reactive water discharged from treatment facility; non-reactive water discharged from detention basins)
- temporary disturbances to upland areas adjacent to streams intersecting upgraded road or new railroad corridors, and
- the discharge of water directly from the plant/tailings basin treatment facility
- Accidental spills that discharge toxic material into water

Potential impacts from discharges at the mining site are primarily associated with hydrologic/hydraulic effects on the integrity/stability of the receiving stream (Potentially effecting aquatic habitats in the Partridge River) and the water quality of potential receiving waters (may include Partridge River, Trimble Creek, Embarrass River and potentially others).

The predicted impacts to magnitude and duration of flow in the Partridge River, Trimble Creek and other waters are discussed in response to Question 13. Potential water quality impacts on receiving water are discussed in response to Questions 17 and 18.

Proposed Treatment of Topic in EIS:
The EIS will discuss potential impacts to fish and wildlife habitats. This discussion will make use of existing studies that are appropriate for identification of the potential impact. Examples of studies that may be used include The Copper-Nickel Study Plots and previous work in the area. A Rosgen Level 1 geomorphology assessment and hydrologic assessment (described below in Question 12) will also be used to assess any impact to aquatic resources. The EIS will also discuss potential mitigation for impacts to fish and wildlife habitat.

b. Are any state (endangered or threatened) species, rare plant communities or other sensitive ecological resources such as native prairie habitat, colonial waterbird nesting colonies or regionally rare plant communities on or near the site? _X_ Yes No

If yes, describe the resource and how it would be affected by the project. Indicate if a site survey of the resources has been conducted and describe the results. If the DNR Natural Heritage and Nongame Research program has been contacted give the correspondence reference number. Describe measures to minimize or avoid adverse impacts.

Wildlife Species of Concern

The MDNR conducted a Minnesota Natural Heritage Program database query during January 2000 for State and Federal Threatened and Endangered plant and animal species as well as State Special Concern Species and Native Plant Communities likely to be found on or near the site. The Minnesota Natural Heritage Program conducted a second database search on June 8, 2004. The results of that search showed that three state-listed plant species (least moonwort, neat spike-rush, and Torrey's manna-grass) are found in the area. In addition, one plant species (matricary grapefern) and one wildlife species (northern goshawk) were identified that are found in the area and are tracked by the Program, but are not given special status by the State of Minnesota.

During the time between the June 8, 2004 database search and the preparation of this Scoping EAW a wood turtle record was added to the database. This wood turtle was sighted about one mile south of the mine site on the Partridge River. The wood turtle is a state-listed threatened species.

U.S. Fish and Wildlife Service (USFWS) and U.S. Forest Service (USFS) were contacted for to identify potential species that may be of a concern in the project area. The Minnesota List of Endangered, Threatened, and Special Concern Species on the MDNR Website (http://files.dnr.state.mn.us/natural_resources/ets/endlist.pdf) and the Birds of Fisherman's Point and Hoyt Lakes Area were reviewed.

Based on the above discussions, database search, document reviews, and field studies on and adjacent to the Mine Site, it was determined several wildlife species of concern may be found in the Mine Site, although most species are rare visitors to the area or migrate through the area during spring or fall. The following discussion provides an assessment of the current status of state and federally listed species at the project site with emphasis on the Mine Site.

FEDERALLY-LISTED THREATENED AND ENDANGERED SPECIES

The U.S. Army Corps of Engineers will consult with USFWS as required in Section 7 of the Endangered Species Act (ESA) prior to any federal decision on the project. The results of this consultation will be available for inclusion in the EIS.

Bald eagle (Threatened). No bald eagles were observed during surveys conducted in June of 2004. Although 100-Mile Swamp could provide foraging habitat for eagles, no large perch or nesting trees were seen near the swamp, thus it is unlikely that bald eagles would use the Mine Site. The nearest bald eagle nest is located 7.5 miles to the north on Birch Lake.

Canada lynx (Threatened). Canada lynx are rare in northern Minnesota. Surveys for lynx were conducted using bait traps and track surveys on the NorthMet site during winter 2000; no lynx were found.

Approximately 50 lynx have been seen in St. Louis County since 2000 and 4 of these lynx had young. The nearest sightings were approximately 6 miles from the project site. A lynx was captured and radio-collared approximately 12 miles north of the site in

August 2003; the animal subsequently moved west to near Pelican Lake in the northwestern portion of St. Louis County. The nearest sightings of a lynx with young were approximately 16 miles north of the project site in 2002 and 16 miles south of the project site in 2004. No lynx were recorded on the NorthMet Mine Site during these surveys. Recent studies of snowshoe hare and red squirrel pellet density suggest that hare and squirrel numbers are greatest in jack pine, red pine, black spruce, and mixed pole and mature forests; presumably, lynx would be more common in these habitats. Longer-term studies have shown that lynx favor mixed forests in Minnesota. Since lynx have been seen near the NorthMet Mine Site, and habitats used by prey species are common on the site, the potential exists for lynx to use or travel through the proposed Mine Site area.

Gray wolf (Threatened).

Approximately 2,600 wolves reside in northern Minnesota. Wolf packs are generally comprised of four to eight wolves. Several wolf packs have been identified, and individuals within the pack radio-collared, near the study area by the U.S. Geological Survey/International Wolf Center. Territory size for wolves in northern Minnesota ranges from 20 to 150 square miles and wolf packs tend to avoid areas used by other wolf packs.

Gray wolves were recorded on the site during surveys in 2000 and 2004. Wolves appeared to be traveling through the area and radio-collared wolves have been observed traveling within a few miles of the Mine Site. During 2000 and 2004, wolf tracks were seen along Dunka Road. Interestingly, wolf tracks were not observed on the study area during January 2000, when an exploration drill rig was operating, but only during March 2000, and June 2004, when the rig was not in operation. Thus, noise and activity associated with drilling activities may have discouraged wolves from using the area in the immediate vicinity of the exploration area. No active dens are known to occur in the Lease Area. Mine activities would displace wolves from the site and disturbances associated with mining could cause wolves to avoid the area; however, wolf tracks were seen on a service road along the boundary between the Northshore Mine and Mesaba and NorthMet Mine sites.

STATE-LISTED THREATENED AND ENDANGERED SPECIES

PLANT SPECIES OF CONCERN (THREATENED, ENDANGERED, AND SPECIAL CONCERN)

The MDNR was consulted to provide records from their Natural Heritage database for the Mine Site and within one mile of the site. The database showed the presence of, one state-listed threatened species, three state-listed special concern species, and one tracked, but not state-listed species.

A botanical field survey was conducted between July and August 2004 at the Mine Site. The area of the survey was greater than the project area, due to early uncertainty regarding the extent of the project. This survey was intended to provide field data concerning the presence or absence of certain MDNR state-listed or federal-listed plant species. Several species of rare plants were given priority in the search, but all state- and federal-listed species were included in the search along with other species listed as sensitive by the USFS Superior National Forest Region 9.

The survey was conducted by three teams of botanists during July and August of 2004:

Methods
Disturbed soils of roads, railroads, and trails through brushy or wooded areas; shallow water bodies; and forested, shrub, and grassy wetlands were considered potential habitat for listed species.

Searches were intensely focused on likely habitats identified from aerial photographs, topographic maps, and wetland maps. The site was first searched using widely spaced transects. Smaller habitat types located within major vegetation cover types were intensely searched to locate any rare plant species that may occur in them at times appropriate for their known phenologies.

Results
A total of thirteen species of rare or sensitive plants were located and identified during the rare plant surveys within and near the Mine Site including eight state-listed species (Figure 11-5). The survey located and identified two state-listed endangered species (Figure 11-6), one state-listed threatened species, and five state-listed special concern species. A total of six species are *Botrychium* ferns or moonworts and the rest are flowering plants. The species and populations are identified on Table 11-2.

Proposed Treatment of Topic in EIS:
The EIS will evaluate potential impacts to threatened and endangered species. Existing information will be evaluated and additional information collected if necessary to support state and federal regulatory requirements for threatened and endangered species. Potential mitigation strategies and alternatives will be evaluated to prevent and minimize any identified impacts.

Table 11-2: Rare species survey results – mine site

Common Name	Scientific Name	State Status[1]	Polymet Mine Site Observations	Approximate number of Individuals	Habitat
Moonwort fern	*Botrychium dissectum var dissectum*	NON	2 populations identified	5	Full exposure, moss cover.
Daisy leaf moonwort	*Botrychium matricariifolium*	NON	12 populations identified	471	Full to shady exposure, edge of alder thicket, forest roads, along Dunka Road, and railroad and power line rights-of-way.
Michigan moonwort	*Botrychium michiganense (=hesperium)*	NON	6 populations identified	242	Full to shady exposure, edge of alder thicket, forest roads, along Dunka Road, and railroad and power line rights-of-way.
Moonwort fern	*Botrychium multifidum*	NON	11 populations identified	402	Full to shady exposure, edge of alder thicket, forest roads, along Dunka Road, and railroad and power line rights-of-way.
Pale moonwort	*Botrychium pallidum*	E	4 populations identified	58	Full to shady exposure, edge of alder thicket, along Dunka Road, and railroad and powerline right-of-way.
Ternate grape-fern	*Botrychium rugulosum (=ternatum)*	T	None identified		Disturbed habitats, fields, open woods, forests
Least grape-fern	*Botrychium simplex*	SC	20 populations identified	1,337	Full to shady exposure, edge of alder thicket, forest roads, along Dunka Road, and railroad and power line rights-of-way.
Floating marsh marigold	*Caltha natans*	E	13 populations identified	~150	Shallow water in ditches and streams, alder swamps, shallow marsh, beaver ponds, and Partridge River mudflat.
Neat spike-rush	*Eleocharis nitida*	T	11 populations identified	~1,450 sf	Full exposure, moist ditches along Dunka Road, wet area between railroad grades, and railroad ditch.
Northern commandra	*Geocaulon lividum*	SC	11 populations identified		On *Pleurozium* and *Sphagnum*moss mats under black spruce, open to partly shaded.
Vasey's rush	*Juncus vaseyi*	NON	3 populations identified	9 clumps	Low wet areas along Dunka Road.
Buttercup	*Ranunculus gmelinii*	NON	7 populations identified	~475 sf	On muddy soil of drying ponds, floating in 1.5 feet of water in channel, along Partridge River.
Lapland buttercup	*Ranunculus lapponicus*	SC	7 populations identified	~825 sf	On and adjcent to *Sphagnum* hummocks in black spruce stands, up to 60 percent shaded with alder also dominant.
Stalked bulrush	*Scirpus pedicellatus*	NON	11 populations identified		Conifer swamps and wet meandows.
Clustered bur-reed (floating marsh marigold)	*Sparganium glomeratum*	SC	13 populations identified	>100	Shallow pools and channels up to 1.5 feet deep in *Sphagnum*at edge of black spruce swamp, beaver pond, wet ditches, shallow marsh
Torrey's manna- grass	*Torreyochloa pallida*	SC	8 populations identified	~800 sf	In muddy soil along shore and in water within shallow channels, beaver ponds, shallow marshes, along Partridge River.

[1] E - Endangered, T - Threatened, SC - Special Concern Species, NON - not listed

12. Physical impacts on water resources. Will the project involve the physical or hydrologic alteration — dredging, filling, stream diversion, outfall structure, diking, and impoundment — of any surface waters such as a lake, pond, wetland, stream or drainage ditch? _X_Yes __No
If yes, identify water resource affected and give the DNR Protected Waters Inventory number(s) if the water resources affected are on the PWI: .

Describe alternatives considered and proposed mitigation measures to minimize impacts.

GENERAL DESCRIPTION OF PROJECT'S PHYSICAL IMPACTS ON WATER RESOURCES

Mine Site

Physical impacts on water resources from the mine site can be characterized into two categories:

1. Direct and indirect wetland impacts from mine pit (construction and dewatering), stockpiles and miscellaneous construction activity.

2. Potential fluvial geomorphology impacts to Partridge River from mine dewatering and stockpile discharges.

Railroad Corridor

Although the majority of the railroad corridor for this project would remain unchanged, there is a small section that needs to be constructed and construction would impact approximately 1.2 acres of wetland. The use of existing culverts and stream crossing will prevent any addition physical impacts to water resources from the railroad corridor.

Plant site

A new building will be constructed on upland at the plant site to house the autoclaves for the pressure oxidation process. There are no physical impacts to water resources anticipated from this construction.

Tailings basin

There could be physical impacts to water resources from the tailings basin. The extent and location of these impacts is not well known at this time. Water seepage from the tailings basin as well as potential wastewater discharges after treatment of process water from the reactive residue facility may have some hydrological impact on Trimble Creek.

Information about the amount of water and any potential impacts to Trimble Creek will be identified in the EIS.

MINE SITE WETLAND IMPACTS

Hydrology and Hydrogeology

The Mine Site is situated in the headwaters of the St. Louis River Watershed #3. The Mine Site north of the Dunka Road is partially encircled by the Partridge River. The headwaters of the Partridge River receive mine dewatering discharge from the Peter Mitchell Pit, operated by Northshore Mining Company and located less than one mile north of the Mine Site. Additional discharge to the Partridge River comes from the local tributary area including the One Hundred Mile Swamp and the far northern portion of the mine site. On the north side of the Mine Site, the Partridge River flows north and then east and turns south along the east boundary of the lease boundary before reentering the project site south of the Dunka Road where it flows southwest to where it leaves the south-central portion of the lease boundary.

Surface elevations of the Mine Site north of the Dunka Road range from 1630 feet MSL in the northern part to 1580 feet MSL along the Dunka Road. Surface elevations in the One Hundred Mile Swamp range from 1610 feet MSL northwest of the Mine Site to 1600 feet MSL near the north-central portion of the Mine Site. Ground elevations south of the Dunka Road range from 1580 feet MSL in the north to 1540 feet MSL along the Partridge River in the south. A surface water divide oriented generally from the southwest to the northeast is situated in the northern portion of the site. South of the drainage divide, surface water generally drains from north to south to culverts in five general locations under the Dunka Road. South of the Dunka Road, surface water generally flows south through large wetland complexes to the Partridge River.

Wetland Descriptions

Due to the large number and large acreage of potentially impacted wetlands and the early stage of planning, the individual wetlands have not been described. The identified wetland locations are shown on Figure 12-1. A tabulation of the identified wetlands including the type, classification, and total size is provided in Table 12-1. A total of 114 wetlands covering 2,544 acres have been identified within an area slightly larger than the proposed mine site (Figure 12-1). A summary of the wetlands by Circular 39 wetland type is provided in Table 12-3. Over one-half of the wetlands identified are predominantly black spruce and open bog communities. Approximately one-fourth of the wetland area is predominantly alder swamp communities. Wet/sedge meadow and shallow marsh communities cover nearly equal areas of the site, and lowland hardwood swamps make up a minor percentage of the wetlands (Table 12-3). The majority of the wetlands are present in complexes that either lie in the floodplain of the Partridge River or are tributary to the Partridge River. There are a few isolated wetlands and isolated raised bogs within the mine site that represent a small percentage of the total wetland resources (Figure 12-1). More detailed characterization, delineation, and descriptions of wetlands will be provided during specific permitting phases.

Wetland Impact Areas

The wetlands identified and mapped at the Mine Site are shown on Figure 12-1. Potential impacts to the Mine Site wetlands were determined based on the projected limits of mining activities, including stripping, stockpiling, water treatment, and support facility construction as described previously in response to Question 6b.

A detailed Mine Site plan and mine phasing plan have not yet been completed, so the timing of wetland impacts cannot yet be defined. All impacts are expected over the initial 1-year construction phase and subsequent 20-year mining plan. A mine plan, including detailed facilities layout and phasing of mining and stockpiling is under development. The resulting estimate of wetland impacts for construction and the first 5 years of operation will be submitted as part of the MDNR Permit To Mine and will be available for use in the EIS. The EIS will evaluate the entire estimated 1,257 acres of direct impacts to wetlands as well as indirect impacts from changes in hydrology or chemistry that could impact the species diversity or ecological functions of the wetlands.

A summary of all potentially impacted wetlands within the Mine Site is provided in Table 12-2. This table includes the wetland type, the Circular 39 classification, the Cowardin Classification, and the direct wetland impact area. The stockpile impact areas shown assume that all stockpiling will occur on the surface.

Summary of Wetland Impacts

It is anticipated that a total of 1,257 acres of wetland would be impacted by the proposed mining, construction of mine support facilities, rock and overburden stockpiling, and miscellaneous transportation and utility requirements during the life of the project (Figure 12-2). Preliminary evaluations indicate that approximately one-half of these wetlands are predominantly bog communities. Approximately one-fourth of the potential wetland impacts are predominantly shrub swamp communities. The remaining one-fourth of the potential wetland impacts includes a mix of wet/sedge meadows, shallow marshes, and lowland hardwood swamps. These impacts are summarized in Table 12-4. More detailed evaluation of wetland impacts will be determined during future planning.

Permitting for each phase of the project typically will be conducted on approximately 5-year increments as has been done at other Iron Range mines. The permitting for activities planned within each 5-year period will begin with a more detailed field delineation, characterization, and mapping of wetlands within areas of planned activities. Future mine planning will include attempts to avoid wetland impacts where practicable, but due to the operational requirements of the mining operations, opportunities to avoid wetlands may be limited. This analysis will be used to determine the level of mitigation that will be needed. Specific wetland mitigation plans will be developed and submitted for approval to compensate for the expected impacts.

Wetland Mitigation Strategy

Due to the proposed 20 year mine operation and associated gradual wetland impacts, PolyMet has proposed a five year cycle of wetland fill permitting and mitigation. This would allow a more detailed delineation and mitigation of wetlands that will be impacted on schedule that is tied to the actual impact. The U.S. Army Corps of Engineers has not yet determined the suitability of this wetland strategy.

PolyMet has not yet identified a conceptual wetland mitigation plan. The EIS will evaluate potential wetland mitigation strategies including, on-site in-kind wetland creation, off-site out-of-kind wetland creation, high value wetland preservation, wetland enhancement, stream habitat enhancement, and use of wetland banks. This evaluation will focus on the feasibility of successfully mitigating the potential wetland impact.

Impacts to other Water Bodies
The Partridge River will not be physically changed by the project due to channelization or dredging. The Partridge River is identified as a Protected Watercourse on the Protected Waters Inventory, but there is no official PWI number for watercourses. Due to watershed modifications and mine dewatering discharges to the Partridge River some changes in streamflow will occur.

The Embarrass River and Trimble Creek are likewise subject to seepage from the existing Cliffs Erie Tailings basin and wastewater discharges from treated tailings basin water.

Proposed Treatment of Topic in EIS

Avoidance, minimization and mitigation of the 1,257 acres of potential wetland impacts will be evaluated as part of the EIS. Indirect impacts to wetland function on ecological diversity from changes in hydrology and water chemistry will also be evaluated. The EIS will also discuss the suitability and feasibility of various wetland mitigation strategies. Additional detailed wetland delineations will be included for the first five years of proposed mining activity.

The EIS will include a watershed assessment of the upper Partridge River due to net hydrologic effects of Polymet's proposal. This watershed assessment will evaluate the changes in watershed discharge due to land surface changes (loss of wetlands, vegetation, and mine pit construction), as well as the direct hydrologic changes from mine pit dewatering and other mine site discharges. The response to Question 13 describes a hydrogeologic study that will be used to quantify the mine site discharges. A Level 1 Rosgen geomorphic survey will be conducted for the Partridge River, down to Colby Lake to identify any potentially geomorphilogical sensitive stream reaches. If the watershed assessment combined with the Level 1 Rosgen geomorphic survey indicates a potential for fluvial geomorphic impacts resulting from Polymet's proposal, there will be additional evaluation of the impact. If this additional evaluation determines that the changes in magnitude, timing, duration or rate of stream flow will cause significant adverse impacts, additional mitigation and monitoring will be developed.

13. Water use. Will the project involve installation or abandonment of any water wells, connection to or changes in any public water supply or appropriation of any ground or surface water (including dewatering)? _x_Yes __No

If yes, as applicable, give location and purpose of any new wells; public supply

affected, changes to be made, and water quantities to be used; the source, duration, quantity and purpose of any appropriations; and unique well numbers and DNR appropriation permit numbers, if known. Identify any existing and new wells on the site map. If there are no wells known on site, explain methodology used to determine.

This project would require a new water appropriation for mine pit dewatering and would use a pre-existing water appropriation permit at the Process Plant, as discussed below. No water wells will be abandoned. The pre-existing appropriation permit proposed for use at the processing plant withdraws from Colby Lake, which is also the public water supply for Hoyt Lakes.

Mine Site

OVERVIEW OF MINE SITE HYDROLOGY

The proposed mine will require the appropriation of water from the pit in order to keep the pit dewatered.

The pit has the potential to receive water from the following sources:

- Direct accumulation of precipitation on the pit
- Groundwater inflow and direct runoff from the unconsolidated sediments overlying the bedrock
- Groundwater inflow from the Duluth Complex (gabbro)
- Groundwater inflow from the Virginia Formation and
- Groundwater inflow from the Biwabik Iron Formation (BIF)

The hydrologic impacts and expected quantities of water from each of these sources will be discussed below. The quantity and quality of surface runoff from stockpiles and surrounding mine facilities as well as the handling and treatment of stockpile seepage are discussed in response to Questions 17.

The proposed PolyMet mine will be located within the Partridge River Watershed, between Hoyt Lakes and Babbitt. The Partridge River flows through Colby Lake near the city of Hoyt Lakes before joining the St. Louis River on its way to Lake Superior. The Partridge River watershed is bounded by the Laurentian Divide just east of the Site. The Laurentian Divide separates the Hudson Bay drainage from the Lake Superior drainage.

At the Mine Site, the bedrock surface appears to be hummocky, with a general southeasterly slope. Approximately 40% percent of the Mine Site is covered by peat/wetland deposits, with the remaining area covered by rolling to undulating

Wisconsin aged Rainey Lobe till. Rainey Lobe till is generally a bouldery till with high clay content. To the south is the Toimi Drumlin Field. There are not significant quantities of outwash (sand and gravel) in the area of the mine site. Unconsolidated sediments in the mine site form a thin cover over the bedrock.

DIRECT RUNOFF AND PRECIPITATION – MINE SITE

Surface runoff to the pit from the surrounding land surface would be reduced by construction of dikes and trenches. Surface drainage would generally be controlled by exterior dikes or by natural drainage area divides around the perimeter of the site. A separate dike would be constructed north of the mine pit to connect the high ground to the northeast and northwest of the pit (see Figure 5-3). This is proposed to prevent water from the Partridge River and adjacent wetlands from draining into the mine area.

On the east lobe of the West Stockpile there are wetlands north of the pile and the natural drainage is to the north. The exterior of the stockpile in this area would be constructed to act as a dike. Seepage through this dike section could then be collected and drained to the non-reactive drainage system. Any residual seepage infiltrating from the seepage collection ditch would pass through the non-reactive base of the stockpile and be captured in the downstream section of the same collection ditch.

The general expectation is that these dikes can be constructed from select material removed during the initial stripping process. Soil characterization and testing during design would locate suitable materials for these dikes. Construction of dams and dikes through wet muskeg has been accomplished at a number of sites on the Mesabi Range. It typically includes rolling a progressive series of lifts into the peat soils to displace and compress the peat. Slurry wall cutoff trenches or other barrier construction may be added, if needed, to minimize seepage. Dikes will be subject to MDNR dam safety rules as appropriate. These dikes are proposed to prevent water from external wetlands from flowing onto the Mine Site.

Trenches are proposed to prevent surface run-off from entering the mine pit. The pit would be encircled by a ditch and dike system to intercept and handle non-reactive runoff. The trenches will intercept runoff from the interior of the Mine Site (including stockpile runoff that has not contacted reactive materials) and direct it to stormwater treatment ponds for discharge.

All stockpiles are proposed to be located near the rim of the pit (as shown in Figure 5-3). Water from non-reactive stockpiles would be collected in a Stormwater Collection System and conveyed to sedimentation basins and thereby prevented from entering the pit. The Stormwater Collection System would handle water that has not come into contact with reactive waste rock or ore and would not likely require treatment beyond sedimentation. A separate Reactive Water Collection and Treatment System would collect water that has come into contact with reactive materials for treatment as appropriate. The stormwater and reactive water systems are described in greater detail in response to Questions 17 and 18.

The intent of the dike and ditch system would be to minimize inflow into the mine pit from surface run-off and seepage from area wetlands. Additional details concerning this system and its effectiveness will be included as a topic in the EIS.

The volume of water produced from direct precipitation on the pit surfaces is important because it may come in contact with sulfide-bearing materials and, if so, would likely require treatment. This is especially true for that portion of the runoff that comes in contact with the inventory of freshly broken ore in the pit.

When considering the direct accumulation of precipitation, two separate volumes need to be considered: single storm event precipitation and yearly average/total precipitation.

Storm events will be analyzed during design and submitted as part of the permit applications for use in the EIS. Hydrologic design is required in order to correctly size the sumps that will be located on the footwall of the pit. Pit pumping would be done in stages, from sump to sump and the upper sumps designed to intercept as much runoff as possible to minimize pumping from the deepest parts of the pits. The sizes of the sumps are related to the rate at which water would be discharged to the Partridge River, and must be sized to prevent the discharge of any untreated water. This will be evaluated as part of the EIS.

The average yearly volume of water from the direct runoff of precipitation into the pits would depend on both precipitation rates and evaporation rates. The sumps can be designed to continually have water in them, allowing for some evaporation of water from the sumps. In addition, a certain volume of water that falls into the pit as precipitation would not reach the sumps, as it would be lost to evaporation from intercepted water and from depression storage. As part of the application for the appropriations permit and NPDES permit, a watershed yield model, such as the MDNR's WATBUD, Barr's Meyer Model or other similar model, will be used to quantify the long-term amount of water that will need to be discharge as a result of the direct accumulation of precipitation in the pit. The model will also be used to estimate the amount of runoff water from the pit and stockpile after reclamation. This information will be included in the EIS.

GROUNDWATER INFLOW AND DIRECT RUNOFF FROM THE UNCONSOLIDATED SEDIMENTS

Saturated conditions exist within the unconsolidated sediments at the site. Groundwater divides in this area generally coincide with surface water divides. However, groundwater flow can be interrupted or diverted by bedrock outcrops, which force deviations in the groundwater flow field (Siegel and Ericson, 1980). Figure 13-1 shows water table contours delineated by Siegel and Ericson (1980) for the area surrounding the Mine Site with arrows showing groundwater flow directions. At the Mine Site, groundwater flow is towards the Partridge River, a major discharge point for the area. Because of the shallow nature of the unconsolidated sediments, flow paths are generally thought to be short, with the recharge areas being very near the discharge areas.

The bouldery till of the Rainy Lobe which covers the site has an estimated hydraulic conductivity range of 0.1 to 30 ft/day (Siegel and Ericson, 1980). Regional studies have found that the ability of this unit to transmit water is highly dependent on the thickness of the sediments (Adams et al., 2004; Siegel and Ericson, 1980). At the Mine Site, the sediments may be more than 40 ft thick in spots, but are on average 10-15 ft thick.

The variability in sediment thickness and hydraulic conductivity allows for the possibility of significant quantities of water entering the pit via groundwater inflow. However, both mining and ecological concerns require that lateral inflow to the pit from the wetlands and other saturated sediments must be minimized by the use of dikes and trenches.

Much of the lowland area at the Mine Site is covered by wetlands (see Question 12). Flow generally occurs across the surface or within the top foot of the wetland surface and hydraulic conductivity tends to decrease with depth. Field observations have found numerous wetlands located near existing mine pits in the area that have not been dewatered. The exceptions to this is when granular sediments with high permeability underlay the wetland deposits and are connected to a water source such as a local stream of lake. The potential for this to happen is being evaluated through hydrogeologic and wetland studies that will be incorporated in the EIS.

As part of the ongoing feasibility study, a soil boring campaign will be conducted in the winter or spring of 2005 to obtain soils information and install piezometers. In areas where bedrock hills do not separate the area wetlands from the pit, unconsolidated sediments will be sampled and evaluated to determine whether sand seams exist that could transmit significant quantities of water into the pit. If such sand seams exist, cutoffs would be designed and installed to prohibit the inflow of groundwater/wetland water from entering the pit. Information about the unconsolidated sediments ability to transmit water and designs to prevent seepage into the mine pit will be included in the EIS.

GROUNDWATER INFLOW FROM THE DULUTH COMPLEX (GABBRO)

Existing information has indicated that the Duluth Complex (gabbro) produces small amounts of water. It is anticipated that the gabbro at the PolyMet site will have similar low water yield. However, because the amount of water can vary spatially, site specific data is needed to predict the yield of this unit into the PolyMet pits. Saline water was encountered at the Amax site, and the possibility of saline water at the Polymet operation will be evaluated in the EIS.

As part of the PolyMet feasibility study (being conducted concurrently with Environmental Review) the company will drill an additional 100 to 120 exploration holes at the site during the winter of 2005.

As part of this program, basic data was collected to assist in characterizing the quantity and quality of water that might be expected form the Duluth Complex. The emphasis of the effort was to capitalize on the winter drilling program, which had other intended purposes, to collect data that could be used to better understand the hydrogeology of the formation. This investigation was termed a phase I investigation with the understanding that an additional investigation (phase II) would be needed to better understand the hydrogeology. The basic approach to the phase 1 investigation included the following steps:

1. Check the drill cores and consulting with site geologists as drilling is proceeding to characterize drillholes that would be expected to have looser or tighter rock. This would include attempting to place one or more drillholes through a major fault zone.

2. Install water level monitoring equipment in a completed drillhole before it has been capped or abandoned and pump the drillhole to produce a significant drawdown. As pumping is occurring, monitor the conductivity of the pumped water and the level in the hole. As pumping is completed, take grab samples of the pumped water for further analysis.

3. Monitor the recovery of the water (if any) in the drillhole.

4. For one or two of the wells with the greatest number of fractures and/or lowest recovery rates, monitor adjacent holes while pumping is occurring to help evaluate the degree of interconnectivity between the holes and provide information for further evaluation of probable pumping quantities.

Phase I of a hydrogeologic investigation has been completed and results will be available for inclusion in the EIS. The results from the phase I investigation will be used to help design the phase II investigation. Results from the phase II investigation will also be available for use in the EIS.

GROUNDWATER INFLOW FROM THE VIRGINIA FORMATION AND THE BIWABIK IRON FORMATION

Within the region, both the BIF and the Virginia Formation are used for water supply. Based on specific capacity test data reported in the Minnesota Geological Survey's County Well Index, the BIF has an average hydraulic conductivity of 6 ft/day and the Virginia Formation at a depth greater than 250 ft has an average hydraulic conductivity of 0.06 ft/day. Although the proposed pit is not anticipated to contact the BIF, which will be separated from the pit walls by over 100 ft of Virginia Formation, there is potential for faulting in the Virginia Formation, which could transmit water from the underlying BIF. The amount of water that could contribute to the mine pit from the Virginia Formation will be investigated and discussed in the EIS. Since there is no reliable method to predict faulting in the Virginia Formation, it will not be evaluated in the EIS.

OVERALL MINE PIT APPROPRIATIONS

Direct precipitation is expected to be a major source of water to the pit. Based on runoff modeling the DNR has conducted for taconite pits, pit yield from precipitation alone at full development is expected to average between 300 gpm to 400 gpm. Short-term appropriations due to wet weather conditions are likely to be larger and would be controlled by the capacity of the pump. Cut-offs, dikes, or other seepage control measures would be used to minimize the seepage of surficial and near surface groundwater from entering the pit. Minimal amounts of water are expected from the Duluth Complex, however, specific capacity tests conducted in the winter or spring of 2005 will provide additional information on this potential source. The proposed mine pit should not intersect the BIF. Although the Virginia Formation can produce water, it has a lower conductivity thatn the BIF, and it not anticipated that large volumes of water would be generated from this unit. According to the County Well Index database, there are no water supply wells located within two miles of the Mine Site so well interference is not likely to be a significant problem.

Preliminary models were run by Polymet to get an "order-of-magnitude" estimate of the quantity of water entering the pit from both the Duluth Complex and the Virginia Formation. These models predicted that at 20 years, the entire pit would receive between 3 and 19 cfs of water from the bedrock units (1350-8500 gpm). Due to the assumptions that were used in this model, the results should only be considered as approximate. Following the analysis of field data collected as part of the phase I and phase II hydrogeology study the model will be revisited and further analysis performed for the EIS.

As part of the EIS a water balance will be prepared for the mine. This will provide a range of estimated flows from the mine as a function of time.

Process Plant

The Process Plant would primarily use recirculated water for operations. This water would need to be supplemented by fresh water to make up for water losses during operations. Water budget analysis indicates that the amount of make-up water needed may be as high as 4,200 gpm, but will likely be closer to 2,800 gpm. Cliffs Erie and Minnesota Power jointly hold an existing MDNR Appropriation permit (#490135) authorizing the taking of up to 6,307 million gallons per year (12,000 gpm average pumping rate) from Colby Lake. Polymet may be able to satisfy some or all of their make-up water need from Colby Lake, by amending and/or transferring part of the authority under this permit. A condition under this permit requires that Cliffs Erie pumps water from The White Water Reservoir into Colby Lake to offset their appropriation when the water level of Colby Lake is below a determined threshold. The control structure between the White Water Reservoir and Colby Lake was owned by Cliffs Erie, but is now owned by Minnesota Power. There is an agreement between Cliff's Erie and Minnesota Power whereby the conditions of the permit would be met. Any assignment of an appropriation permit from one party to another would require the consensus of all parties and the DNR's review and approval. The review would take into consideration effects on Colby Lake and Whitewater Reservoir water levels and outflow from Colby Lake. The volume and source of make up water will be addressed in the EIS.

Tailings Basin

Modifications will be made to the current seepage collection system at the Tailings Basin. This system will be designed to recapture process water seeping from the toe of the Tailings Basin to avoid untreated discharge of seepage from the basin. Captured water will either be pumped back to Cell 2E or will be pumped to a treatment plant for discharge. Seepage water has been collected from these sites in the past by Cliffs Erie. This collection will not need an appropriation permit because the system recaptures water previously authorized for appropriation as described above. The EIS will address details on the tailings basin seepage collection system, including the design, efficiency and volume recovered as a function of time, both during and after operation.

Proposed Treatment of Topic in EIS:
Mine Site - The amount of water that must be discharged to dewater the mine pit is a significant issue that will be included in the EIS. In order to better estimate this amount of water the following information will be included in the EIS.

- Design and effectiveness of diking and trenching to prevent surface run-off into the pit.
- Estimates of direct precipitation into the mine pit
- Results of unconsolidated sediment hydrology study
- Results of phase I and phase II hydrogeology study of the NorthMet Deposit including potential water to enter the pit from the Virginia Formation.
- Development of a water balance model to estimate the quantity of water entering the pit from various sources with consideration of seasonal changes and pit size.

This information will be used to help design water treatment facilities and estimate changes in Partridge River streamflow as part of the watershed assessment described in response to Question 12. Hydrologic modeling will also be done to estimate the quantity and timing of outflow from the pit and runoff from stockpiles after mining. This information will be necessary to determine potential water treatment needs for reclamation. Because this water is likely to have come into contact with exposed ore or could be saline, it could be reactive and need appropriate treatment. The amount of water potentially needing treatment will be an important consideration in the EIS.

Processing Plant and Tailings Basin – The EIS will use the results of the pilot plant process and existing information on the LTV tailings basin to develop a water balance model for the processing plant and tailings basin. The EIS will provide additional information on water quantity from the processing plant and tailings basin, including the redesigned seepage collection system. The following information will be used in the water balance model:

- Water generated from the flotation tailings and from the hydrometallurgical processing
- Water collected at the base of the existing tailings basin

- Makeup water needed for the processing plant

Similar to the mine site this information will be used to discuss water quantity effects as well as to develop a better understanding of water treatment needs. Additional information will be presented on the proposed appropriation from Colby Lake.

14. Water-related land use management district. Does any part of the project involve a shoreland zoning district, a delineated 100-year flood plain, or a state or federally designated wild or scenic river land use district? __Yes _X_No

If yes, identify the district and discuss project compatibility with district land use restrictions.

15. Water surface use. Will the project change the number or type of watercraft on any water body?
__ Yes _X_No

If yes, indicate the current and projected watercraft usage and discuss any potential overcrowding or conflicts with other uses.

16. Erosion and sedimentation. Give the acreage to be graded or excavated and the cubic yards of soil to be moved:

Table 16-1
Area and Volume of Grading and Excavation

Location	Acres	Cubic yards
Mine pit	620	380,000,000
Stockpiles	1,126	286,000,000
Railroad Construction Site	21	100,000
Plant site	20*	
Tailings basin	2,166	218,000,000 cy tailings 14,000,000 cy hydromet

*Minor grading for building construction

Describe any steep slopes or highly erodible soils and identify them on the site map. Describe any erosion and sedimentation control measures to be used during and after project construction.

MINE

The mine site itself is flat to gently sloped terrain. The areas within the mine project boundary proposed to be graded or excavated at the mine site (other than pits and stockpiles) would be for drainage features, treatment ponds, roads and railroad spur, and mine infrastructure; including loading pocket, maintenance shops and mine office/break rooms. Work would be conducted under the MPCA's NPDES requirements for construction stormwater management. This would include preparation of a construction Stormwater Pollution Prevention Plan that will specify construction sequencing and installation, maintenance and inspection of construction best management practices for erosion and sediment control. The construction practices would be specified during final design but those most likely to be applied include:

- prompt revegetation of distributed surfaces
- interim erosion protection of disturbed areas that would be re-graded at a later date, including interim seeding and/or mulching
- use of silt fences on short slopes during grading
- provision of berms and channels to intercept sheet flow and convey sediment to sediment basins
- energy dissipation devices installed at same time as installation of culverts and steep ditch sections
- staging or construction areas to minimize exposed soil

The pit would cover approximately 620 acres at the maximum extent and stockpiles would cover another 1,126 acres. Steep slopes would be created on stockpiles and on the edges of the pits. MDNR rules define practices for pits and stockpile construction.

Pit development regulations require that:

- The toe of the surface overburden portion will be set back at least 20 feet from the crest of the rock portion of the pitwall.
- Lift heights will be no higher than 60 feet and will be selected based on the need to protect public safety, the location of the pitwall in relation to the surrounding land uses, the soil types and their erosion characteristics, the variability of overburden thickness, and the potential uses of the pit following mining.
- The sloped area between benches will be no steeper than 2.5:1.
- Runoff water will either be temporarily stored on benches or removed by drainage control structures

Runoff from the overburden portion of the pit wall would be co-mingled with the pit runoff. Direct runoff onto the rock walls and floor of the pit would be directed to sumps located at intervals along the footwall of the pit. These sump and associated pumps would be sized to detain water and trap sediment before the accumulated water is pumped to the reactive water basin prior to treatment and discharge.

Details of the pit design and methods of reclamation will be described in the application for the Permit to Mine and included in the EIS.

STOCKPILES

The stockpiles would be constructed and managed in accordance with the requirements of Minnesota Statute Sections 93.44 to 93.51 and the MDNR Mineland Reclamation Rules for Nonferrous Metallic Mineral Mining (Minn. Rules Chapter 6132). Details of the stockpile design, location, construction and reclamation will be described in the application for the Permit to Mine and included in the EIS.

RAILROAD CONSTRUCTION AREA

Construction of the rail line would disturb approximately 21 acres. As described above, the construction for the project, including the railroad construction would be covered by MPCA's construction stormwater program and would include preparation of a construction Stormwater Pollution Prevention Plan that will specify construction sequencing and installation, maintenance and inspection of construction best management practices for erosion and sediment control. The construction practices would be specified during final design but those most likely to be applied include:

- prompt revegetation of distributed surfaces
- use of silt fences on short slopes during grading
- provision of berms and channels to intercept sheet flow and convey sediment to sediment basins
- energy dissipation devices installed at same time as installation of culverts and steep ditch sections

PLANT SITE AND TAILINGS BASIN

Soil disturbance at the plant site would be much smaller than at the mine site or railroad construction site. The major grading would be done for the foundations for a pre-engineered metal building adjacent to the existing warehouse. The area of disturbance would be approximately 20 acres. Typical construction erosion control practices would be employed as described above for the mine, stockpile and railroad construction areas.

The major tailings basin modifications would be ongoing construction and closure of lined containment cells for hydrometallurgical wastes on Cell 2W. Any sediment produced during construction would flow to the low point in the basin and infiltrate. There is a potential need for taconite tailings to be used for dam construction of flotation tailings basins proposed for Cells 1E and 2E. It is possible the Cell 2W would be used as a source for these tailings. Depending on the amount of tailings excavated, there could be significant disturbance of Cell 2W.

AREA 1 SHOPS

No grading or construction are anticipated at the Area 1 Shops other than maintenance of existing roads and re-activation of the existing shops.

Proposed Treatment of Topic in EIS:
This topic is minor, but it will be discussed with limited information beyond that in the EAW. Details of excavation activities and prevention of erosion on Cell 2W will be developed during EIS preparation.

17. Water quality: surface water runoff

a. Compare the quantity and quality of site runoff before and after the project. Describe permanent controls to manage or treat runoff. Describe any stormwater pollution prevention plans.

Like most major mining operations, the PolyMet project is expected to be covered by a combined permit for both stormwater and industrial wastewater discharges. Because some stormwater would likely require significant treatment, the distinction between runoff (Question 17) and industrial wastewater (Question 18) is a matter of definition. For purposes of this EAW site runoff will fall into one of three categories:

1. Non-contact runoff that consist of surface water runoff that has not come into contact with mining operations, but may be captured in stormwater collection systems and would need to be managed accordingly. Examples of non-contact runoff include water from adjacent wetlands or runoff from undisturbed portions of the site.
2. Non-reactive runoff that has come into contact with mining operations, but has not come into contact with reactive materials and the runoff would meet all applicable water quality standards without any chemical treatment, although settling ponds may be needed to remove suspended solids and turbidity. Examples of non-reactive runoff include runoff from roofs and drainage from stockpiles containing non-reactive mine waste.
3. Reactive runoff that has come into contact with ore, lean ore or reactive waste rock. This water could be acidic and could contain metals in concentrations that would require treatment before discharge. It includes the pit pumping, the seepage coming from the base of reactive waste rock/lean ore stockpiles and the runoff from the Loading Pocket and any adjacent ore stockpiles.

Non-contact and non-reactive runoff will be addressed as site runoff in Question 17, while reactive runoff will be addressed as an industrial wastewater discharge in Question 18. The distinction between reactive and non-reactive runoff is important and it will be a significant issue to be addressed in the EIS.
PolyMet proposes to co-mingle and manage non-contact and non-reactive runoff as a single source of runoff. Sources of this type of runoff and proposed management of these sources is described below:

- Mine site runoff. The pit would be encircled by a ditch and dike system to intercept and handle non-contact and non-reactive runoff. This drainage system would discharge to three or more detention ponds as shown in Figure 5-3. The runoff from these areas is anticipated to only require treatment by sedimentation prior to discharge. The proposed collection system would use typical mine drainage procedures and would not be leak proof.

- Area 1 Shops runoff. The Area 1 shops would continue to be used as a mine truck maintenance facility; runoff would continue to be regulated under the NPDES Stormwater regulations.
- Runoff from the rail corridor construction area would be regulated under the NPDES Construction Stormwater Permit. There are no additional plans for managing runoff from the rail corridor during regular operation.
- Plant site runoff. The Process Plant is proposed to be located within the existing Cliffs Erie taconite processing facility. Runoff from this facility would be regulated under the NPDES Stormwater regulations.
- Tailings basin runoff. All collected water from the tailings basin is proposed to be managed as industrial wastewater and is addressed in response to Question 18.

Runoff generation and management would also be dependent upon the project phase which would include construction, active operation, and post operation.

BACKGROUND WATER QUALITY DATA COLLECTION

Sampling was conducted at a variety of locations in the vicinity of the project from May 2004 through November 2004. The sampling locations are shown in Figure 17-2. These sampling locations were chosen to characterize the existing water quality of streams that may potentially receive discharges from the Mine Site or Plant Site, including the Tailings Basin.
Additional information for the remaining months of sampling will be compiled and submitted as part of the application for an NPDES discharge permit and for use in the EIS. Existing sources of water quality data will be evaluated and included as appropriate in the EIS. Potential sources of existing data include the Regional Copper-Nickel Study and sampling conducted by other mining projects in the area such as AMAX, Cominco, and Northshore.

MINE SITE

RUNOFF QUANTITY

Regional Setting

The proposed PolyMet Mine Site is located within the Partridge River Watershed, between Hoyt Lakes and Babbitt. The Partridge River flows through Colby Lake near the city of Hoyt Lakes before joining the St. Louis River on its way to Lake Superior. The Partridge River watershed is bounded by the Laurentian Divide just east of the Mine Site. The Laurentian Divide separates the Hudson Bay drainage from the Lake Superior drainage. To the north of the Mine Site is the Giants Ridge formation which also forms a watershed divide between the Partridge River and the Embarrass River watersheds. The Partridge and Embarrass Rivers are both tributary to the St. Louis River. Figure 17-1 shows the locations of the primary watersheds discussed here.

NorthShore Mining's Peter Mitchell Pits (Northshore) are located just north of the Mine Site, with some of the pits lying within the Partridge River watershed (Figure 17-1). Currently, Pit A has filled with water and discharges to the west and Pit B is still filling with water. Because Pit B does not currently contribute water to the Partridge River, its watershed is not part of the Partridge River watershed. However, as this pit continues to fill with water, it would eventually discharge (either naturally or via an engineered outlet) to the Partridge River. At that point, the pit's watershed would become part of the Partridge River watershed.

Existing/Historic Conditions

Streamflow

Low streamflow quantities are commonly used in water-quality and water-supply management applications, including determining waste-load allocations, discharge limits, and allowable water transfers and withdrawals. Frequency analysis is a common procedure for analyzing low-flow. In the United States, the 10-year 7-day-average low flow (denoted 7Q10) is most frequently used. Low flows were calculated for three ungauged locations on the Partridge River, shown in Table 17-1 (see Figure 17-1 for locations).

Average flow conditions were analyzed for several area streams. Average flows were calculated for three ungauged locations on the Partridge River, shown in Table 17-1.

Bankfull flow is generally considered to be the 1-day average high flow that has a recurrence interval of 1.5 to 2 years and is commonly used as a measure of high flow. High flows were calculated for three ungauged locations on the Partridge River, shown in Table 17-1. In general, the watershed exhibits a wide range of flow, with the potential for near no-flow conditions as well as very large flows. This is likely due to the high water table and shallow bedrock in much of the region, resulting in a "flashy" stream with a wide range of flows.

Table 17-1
Calculated Low, High, and Average Flow Statistics
For Ungauged Portions of the Partridge River

		Low Flow - 7Q10 (cfs)		**High Flow - Q2 (cfs)**		**Average Flow (cfs)**
Location	**Drainage Area (mi^2)**	**Brooks And White**	**Siegel and Ericson**	**Siegel and Ericson**	**This Study**	**Siegel and Ericson**
PU-1 without Pit B Area	10.8	0.23	0.05	90	57	6
PU-1 with Pit B Area	14.4	0.33	0.08	114	78	9

PU-2 without Pit B Area	20	0.49	0.13	149	111	13
PU-2 with Pit B Area	23.6	0.61	0.17	171	132	15
PU-3 without Pit B Area	54.4	1.71	0.65	340	325	37
PU-3 with Pit B Area	58	1.86	0.72	358	348	39

NORTHSHORE DISCHARGE

For a portion of 2003 and 2004, NorthShore's Peter Mitchell Pit B was dewatered to facilitate mining with the discharge going to the Partridge River upstream of the PolyMet site. During 2003, this discharge was approximately 34 cfs, much higher than the average flow for the upstream reaches and low flow for the river. NorthShore still has this discharge permit, and the company plans to keep the permit up to date allowing for the possibility of similar discharges in the future. The EIS will evaluate impacts from NorthShore discharges under cumulative effects.

Future Conditions

The proposed project would affect low, average and high streamflows in the Partridge River. The anticipated flows and the impacts will be addressed in the EIS. The two factors that would most affect site runoff are changes in land use and discharge of mine dewatering to the Partridge River. Although discussions of water quality due to reactive runoff are deferred until EAW Question 18, discussions of the quantity of water discharged in EAW Question 17 will include reactive runoff.

Land Use Changes

The proposed mine activities would result in land use changes for much of the Mine Site. Land use changes are described in detail in the response to Question 9. In general, existing areas of wetland and upland with high water table would be replaced by mine pit, stockpiles and mine infrastructure. Although the mine pit would allow rapid runoff, the sumps in the pit would be designed to allow efficient pumping over a longer period of time. With the addition of numerous collection and storage areas, the runoff from the Mine Site would be expected to become more steady and less "flashy". As part of the application for an NPDES permit and Minnesota Department of Natural Resources (MDNR) water appropriations permit, these land use changes will be used to predict future Partridge River flow statistics in terms of low, average, and high flows and from these prediction evaluations can be made to determine the significance of these changes. This can be done in part using the flow-drainage area relationships derived as part of this EAW and/or more detailed hydrologic modeling. This analysis will include calculations of runoff from storage piles and surrounding mine facilities. These submittals will be available for use in preparing the EIS.

Discharge of Mine Dewatering

The mine pits would accumulate water from four potential sources: precipitation, seepage from wetlands and glacial material, seepage from the Duluth Complex, and seepage from the Virginia Formation. The largest contributor of water to the pit would most likely be from precipitation and inflow from the bedrock (Duluth and Virginia formations). Trenches, dikes and/or other seepage control structures are proposed to prohibit the lateral inflow of water from area wetlands and surficial material. The overall pumping from the pit is expected to be low because, typically, the Duluth Complex and the Virginia Formation do not yield a substantial volume of water. As explained in response to Question 13, although the amount of water is not anticipated to be large, site specific data is needed to develop a better understanding of how much water would be produced by the Duluth and Virginia formations in the area of the NorthMet Deposit.

Mine dewatering water would be collected in sumps, pumped to the surface, treated if necessary, and discharged to the Partridge River. The mine pit sump areas and pump capacities would be designed to minimize any impact to the Partridge River's bankfull flow at the point of discharge. The effect of flow changes on the Partridge River needs to be evaluated in the context of percent increases in flow. The timing and duration of these flow changes are important as well. A better estimate of the quantity of mine dewatering discharge is needed prior to evaluating any impacts. The phase I and phase II hydrogeolocial studies (described in EAW Question 13) will be used to develop a better estimate of discharge. This information will be included in the EIS.

RUNOFF QUALITY

The quality of runoff from the mining area after development, during normal operations, and after closure will be a major topic of the EIS and NPDES permit application. This will require a detailed evaluation of available data, hydrologic modeling, and the development of chemical models to estimate water quality. Each of these stages of mine operation is discussed below. The impact of the proposed operation on the quality of the Partridge River will also be addressed in the EIS.

Existing Conditions

The quality of Mine Site runoff before mining development is likely similar to the overall water quality of the Partridge River which is currently under evaluation. The Regional Copper-Nickel Study identified the Partridge River as being influenced by mining activities. The water quality sampling program included two stations on the Partridge River, located upstream and downstream from the proposed Mine Site. These are listed as stations PM-3 and PM-16 in Table 17-2. Further characterization of the receiving waters and potential impacts will be included in the EIS.

Future Conditions

Normal Operations

As described above surface water runoff management is proposed with a non-contact/non-reactive runoff system and a separate system for managing reactive runoff. Both of these systems are proposed to allow sampling and appropriate treatment prior to being discharged to the environment. Design, operation and monitoring of these systems will be developed during preparation of the EIS. The proposed reactive runoff system as well as potential impacts to water quality from this type of runoff is addressed in more detail in response to Question 18.

The non-contact/non-reactive runoff system is described in response to Questions 6b and 13. Generally it is proposed to consist of a series of trenches and dikes that direct the runoff to settling ponds. The ponds would be designed to have a retention time that allows suitable sediment removal prior to discharge to area wetlands and the Partridge River.

The reactive runoff collection system is described in more detail in response to Question 18. The system will be designed such that potentially reactive runoff can be directed to treatment if necessary. Sumps from within the mine pit and runoff from the loading pocket would be directed to this same system. Runoff water within this system is proposed for discharge to the Partridge River. As described in response to Question 18, the design of the reactive mine waste storage area, wastewater treatment, and water quality considerations from reactive runoff are significant issues that will be evaluated in the EIS.

In addition to the water quality of the mine site discharge itself is the potential for the quantity of the discharge to cause bank erosion and sedimentation. The potential for geomorphological impacts and sedimentation to the Partridge River from pit dewatering will be developed during EIS preparation.

Closure

The mine site would be reclaimed after the estimated 20-year mine life. For this discussion potential effects to surface water after closure can be divided into four areas: 1) mine pit, 2) reactive waste rock piles, 3) non-reactive waste rock piles, and 4) disturbed areas.

The mine pit would be allowed to fill with water. The rate of filling is largely a function of precipitation, groundwater inputs, runoff from adjacent upland areas, and evaporation. However, water could be diverted from other sources to expedite pit filling. Potential sources will be evaluated as part of the EIS. Additional information on mine pit hydrology including modeling of water quantity and quality will be prepared for inclusion in the EIS.

As discussed above runoff from reactive waste rock is a significant issue for this project and it will be a central discussion in the EIS. Reclamation and closure of reactive waste rock stockpiles is discussed in more detail in response to Question 18. Progressive reclamation of stockpiles, prevention of infiltration into the stockpiles, and minimization of long-term maintenance and operation costs are important considerations that will be discussed and evaluated in the EIS.

Runoff from non-reactive waste rock stockpiles is not anticipated to create significant chemical water quality impacts. The waste characterization study, modeling estimates and operational monitoring are proposed to verify that this assumption is correct. If this assumption is correct, non-reactive runoff and non-contact runoff can be treated similarly. The EIS will describe and evaluate reclamation to prevent sediment load increases from this runoff after mine closure.

Plant Site
As discussed previously, industrial wastewater discharge from the Process Plant and Tailings Basin are discussed in response to Question 18, below. This section deals with stormwater runoff from the Plant Site.

RUNOFF QUANTITY

Existing Conditions

Processing of the ore would take place at the Cliffs Erie ore processing plant. PolyMet operations would be located in the northern most area of the plant in the area of the crushing plant and the concentrator plant. Historically runoff from these areas has been routed through ditches and culverts to the Emergency Basin.

Future Conditions

The crusher/concentrator portion of the Process Plant would be refurbished and brought up to date and a hydrometallurgical processing facility would be constructed. Runoff rates after development are not expected to change as the existing crusher/concentrator plant would be used and the hydrometallurgical processing facility would be constructed on existing impervious areas. Expected runoff quantity from the Process Plant project area will be estimated as part of the stormwater pollution plan submittal to the State.

RUNOFF QUALITY

Existing Conditions

The Cliffs Erie Hoyt Lakes Plant is currently inactive. It is expected that storm water runoff quality would be similar to the quality of runoff experienced during the operation of the plant under the LTV Steel Mining Company, unless it contacted process consumables or reactive materials.

Future Conditions

A storm water pollution plan was prepared for the Cliffs Erie facility. A storm water pollution prevention plan for the PolyMet facility will be developed as part of the NPDES/SDS industrial permit application. In general, stormwater runoff from the new facility should be similar to the conditions that have existed over the last 50 years. The major new concerns would be the possibility of stormwater contact with Process Consumables being unloaded or stored at the Plant Site.

Each of the Process Consumables includes a delivery and storage step prior to use. While detailed plans have not been completed, in general Process Consumables would be unloaded and stored in covered conditions and protected from contact with precipitation. Where unloading or storage must occur outside of the buildings the loading area would be surrounded by a collection berm and stormwater would be collected and routed to the process water system.

Precipitates are high-value products that would be stored and packaged for shipping and loaded indoors and shipped in protective containers.

Runoff controls and management of chemicals associated with operations will be described in the pollution prevention plan and will be dependent upon plans and specifications regarding the Process Plant as available at the time of the application submission.

For the remainder of the facility, existing stormwater pollution prevention controls would be followed. Depending on the status of the plant water balance, the treated runoff would be pumped to the Tailings Basin or discharged to Trimble Creek. The stormwater pollution prevention plan will specify new treatment or water reuse plans, if necessary.

Tailings Basin

QUANTITY and QUALITY

Existing Conditions

The Tailings Basin currently consists of three cells, 2W, 1E, and 2E. Cell 2W contains coarse and fine tailings from LTV Steel Mining Company operations, is currently being closed and would not receive additional tailings as part of the PolyMet operations. The other two basins were constructed by the LTV Steel Mining Company and would receive flotation tailings as part of the PolyMet operations. Some of the site runoff that is generated from areas directly adjacent to the Tailings Basin currently drains to the basin. Direct precipitation either infiltrates into the basin or is captured by the clear water pool. Some portion of the water in the Tailings Basin leaves as seep water at the toe of the basin or infiltrates into groundwater beneath the basin. As part of the EIS, baseline water quality will be collected in and around the tailings basin and plant site. Some historic data already exists and Polymet has collected some additional samples. Some current concentrations exceed water quality standards. These will be discussed as part of the EIS.

Future Conditions

Cell 2W would not receive tailings as part of the PolyMet operations but a new Reactive Residue Facility is proposed to be sited there. PolyMet has also proposed using material from this cell for dam construction if PolyMet tailings are not suitable. Direct precipitation that falls on the existing Cell 2W would infiltrate, evaporate, or would be captured by the Reactive Residue Facility. Water accumulated in the Reactive Residue Facility would be recycled back into the Hydrometallurgical portion of the Process Plant. The current proposal for the project assumes that the tailings will be non-reactive and that Cells 1E and 2E can be used without modification. Precipitation that falls on Cells 1E and 2E would infiltrate, evaporate, or be contained in the Tailings Basin structure and be recycled to the Flotation Process at the Process Plant. The expected water quantity and water quality of water that leaves the Tailings Basin as seep water at the toe of Cell 2W, 1E and 2E or infiltrates into the groundwater is discussed in the response to Question 18.

Road and Railroad Corridors

RUNOFF QUANTITY

The transport of ore from the Mine Site to the Plant Site would be on an existing railroad with the exception of the construction of a short section of track that would extend from existing track that is adjacent to Wyman Creek and existing stockpiles (see Figure 5-2). There is very little impervious area associated with the railroad corridor, most the track is underlain with crushed rock that would facilitate infiltration. No new roads would be constructed as part of the project and the expected usage would be similar to historical usage during LTV Steel Mining Company operation.

RUNOFF QUALITY

Because the railroad track is primarily underlain with a pervious gravel base, during normal operation there would be little runoff generated in the railroad corridor. At the Mine Site and Plant Site stormwater collection and treatment plans will avoid direct impervious area discharges to receiving waters.

Side dump rail cars would be used to transport the coarse ore from the Mine Site to the Plant Site. These cars would be loaded within the confines of the Mine Site, and at the Plant Site ore would be deposited directly into the feed hopper of the coarse ore crusher as the side of the car is opened and the car is tilted into the hopper. It is not expected that there would be significant loss of ore along the railroad corridor, however spillage may occur in the section of railroad track closest to the loading pocket. This spillage could occur as the train initially shakes the load and dislodges pieces of rock not located well within the car hopper. Large pieces of rock that spill from railcars would be recovered to the loading pocket surge pile as a matter of routine work practice to maintain safe working conditions for the rail and mine equipment.

During construction of the railroad extension, temporary erosion control measures would be implemented where the corridor intersects wetlands or streams (i.e. Wyman Creek) to prevent sediment inputs.

Treatment of Topic in EIS:
The EIS will include surface water quantity and quality impacts as well as alternatives and mitigation to prevent or minimize impacts. Additional detail will be developed for surface water runoff systems that handle non-contact and non-reactive runoff as well as the quality and quantity of this water. Characterization of non-reactive runoff will also be estimated to ensure the suitability of treating this runoff source as non-contact runoff.

b. Identify routes and receiving water bodies for runoff from the site; include major downstream water bodies as well as the immediate receiving waters. Estimate impact runoff on the quality of receiving waters.

The impact of runoff from the mining area after development, during normal operations, and after closure on receiving waters will be a topic of the EIS and NPDES permit application. This will require a detailed evaluation of available data, hydrologic modeling, and the development of chemical models to estimate water quality.

Mining Area

The Partridge River is adjacent to the mining area from the north, east, and south. The Partridge River flows in a southwest direction to Colby Lake. The Partridge Rive has its headwaters in the Hundred Mile Swamp, including Mud Lake (69-148P). Little or no information is available on Mud Lake; there is no public access to the lake and no known recreational use. The Partridge River flows east along the base of the Giants Ridge formation to the Mine Site. Near the proposed Mine Site, the Partridge River turns south and then east, circling the Mine Site. In this location the watershed is almost entirely undeveloped. Stubble Creek joins the Partridge River about one mile below the Mine Site and the South Fork of the Partridge River enters about three miles below the Mine Site.

The river continues to flow through a largely undeveloped area, before emptying into Colby Lake. Colby Lake is a 540-acre mesotrophic lake which discharges to the lower reaches of the Partridge River. The lake is controlled by a concrete and rock weir. The City of Hoyt Lakes is located on the South Side of Hoyt Lakes and takes its drinking water from the lake.

Water from the Partridge River can also enter Whitewater Lake, located south of Colby Lake. Formerly known as Partridge Lake, Whitewater Lake was impounded in 1955 for use as a water storage reservoir for the Erie Mining taconite operation. It is separated from Colby Lake by three 8-foot gates that can be opened to release a large flow of water from Colby Lake to Whitewater Reservoir during high water levels. The diversion works also contains three high-volume pumps to move water back to Colby Lake during low water levels. Minnesota Power now operates the diversion works and has stabilized lake levels to facilitate recreational use on the lake. An overflow outlet to the St. Louis River on the southern dike is not used. Water losses due to groundwater seepage are substantial. Whitewater Lake receives sewage treatment effluent from Hoyt Lakes. Waters downstream of Colby Lake and Whitewater reservoir include the lower Partridge River, the St. Louis River, and Lake Superior.

As described previously, all forms of drainage from the Mine Site would be collected and treated, if necessary, prior to discharge. Before treatment, reactive runoff is expected to contain increased levels of dissolved solids and trace metals, such as copper, nickel, cobalt, and zinc. Each water source would be managed to control peak discharge rates to minimize erosion and effects on stream bank stability and to control sediments, metals, and other water quality parameters to levels below applicable criteria. There is a potential impact of increased sulfate concentration leading to mercury methylation in downstream water bodies and wetlands. It should also be noted that some background mercury levels in the Partridge River are above water quality standards.

STREAM CLASSIFICATION AND PHYSICAL EFFECTS

Erosion and stream instability are potential physical effects of a Mine Site discharge on the Partridge River. At the request of the MDNR, a physical classification of the Partridge River was performed using the Rosgen classification system to determine the capacity of the stream to receive a controlled discharge of water from the Mine Site.

Stream channel characteristics were measured at two locations in the Partridge that had been identified as potential locations of the Mine Site discharge (Figure 17-3). Field measurements taken during the site visit included: bankfull width, bankfull area, bankfull mean depth, bankfull maximum depth, floodprone width, dominant bed material, riffle slope, and channel cross sections. These measurements were used to classify the Partridge River stream reaches according to the Rosgen classification methodology.

Partridge River Reach 1, which lies at the eastern boundary of the Mine Site was classified as a Type C stream. This type of stream reach has an adequate floodplain to dissipate energy during higher-than-bankfull flows. No erosion problems were evident in the stream (despite high discharge flows from Northshore at the Partridge River headwaters). Because this reach is dominated by boulder riffles and beaver-pond pools, it is not very sensitive to disturbance and the potential for channel recovery is good.

Partridge River Reach 2, which lies at the southern boundary of the Mine Site was classified as a Type C5 stream. This reach has a milder slop than Reach 1 and is affected by frequent beaver dams. Although boulders are common at the riffle section, silt/clay was the dominant material at the surveyed cross-section. The silt/clay was due to the milder slope and the presence of beaver dams. No erosion problems were evident at this site. This type of channel is more sensitive to disturbance than the Type C channel. It appears, however, that boulders underlay a thin layer of topsoil in the stream corridor and they would serve to keep significant erosion in check.

Ponds and sumps would be used extensively in the Mine Site to reduce the peak discharge rate of runoff from impervious areas in the Mine Site and to minimize any potential erosion effects on the Partridge River. Standard practices such as the use of riprap would be employed to minimize erosion at the point of discharge.

Plant Site

The primary operations of PolyMet would be in the crusher and concentrator portions of the existing Cliffs Erie Processing Plant. Runoff from this area of the plant was historically routed to the Tailings Basin or to the Emergency Basin which was located on the Southwest corner of Tailings Basin Cell 2W. Water that seeps from the Emergency Basin and Cell 2W enters adjacent wetlands that eventually drain to the Embarrass River.

It is expected that changes in runoff quantity would be minimal as the new ore processing equipment would be housed within existing facilities or new facilities would be constructed on existing impervious areas. Water quality is not expected to be significantly different from previous operations. Piles of ore would not be stored on the Plant Site.

Tailings Basin

Runoff from the edges of the tailings basin would flow into the nearest cell of the tailings basin. Direct precipitation would fall on Cells 1E and 2E and on the new Reactive Residue Facility that would be sited on Cell 2W. The Reactive Residue Facility would have a decant structure within the cells to return water to the Hydrometallurgical Processing Plant. Precipitation that falls on the inactive Cell 2W outside the footprint of the Reactive Residue Facility and Cells 1E and 2E would infiltrate or drain to the collection system.

Water that infiltrates into Cell 2W has the potential to seep through the toe of the perimeter dams to surrounding wetlands that drain to the Embarrass River. Water that infiltrates into Cell 1E and 2E has the potential to seep through the toe of the perimeter dams to surrounding wetlands that drain to the north into Trimble Creek and Kaunonen Creek. New seepage collection systems would be constructed and would consist of ditches along the south, west and north side of Cell 2W and the north side of Cell 2E and pumps to return the water to Cell 1E and 2E. These systems will be designed to capture as much seep water as is feasible to reduce the volume of seep water that enters the surrounding environment. The efficiency of these systems will be addressed in the EIS. These wetlands and the creeks are tributary to the Embarrass River. The expected water quality of the seeps is covered in Question 18.

The Embarrass River flows east to west along the north side of the Giants Ridge formation before turning south near Biwabik to join the St. Louis River. The headwaters of the river are near Babbitt. The City of Babbitt discharges municipal wastewater to wetlands and pits in the headwaters of the watershed. In 2004 water quality data were collected upstream from the proposed PolyMet facility at the crossing of County Road

620. This location is designated PM-12 on Figure 17-2; available data are summarized in Table 17-2.

Road and Railroad Corridors

The transport of ore from the Mine Site to the Plant Site would be on an existing railroad with the exception of the construction of a short section of track that would extend from existing track adjacent to Wyman Creek and existing stockpiles. No new roads would be constructed as part of the project and the expected usage would be similar to historical usage during LTV Steel Mining Company operation. The existing railroad corridor crosses Longnose Creek, Wyman Creek, Wetlegs Creek, and the Partridge River.

Proposed Treatment of Topic in EIS

The EIS will include information on the quality and quantity of existing water bodies and any potential for changes to these parameters from all aspects of the mining project. Estimation of hydrologic and chemical balances in the Mine Site during normal operations and after closure and the potential effect of discharges on receiving water biota will need to be evaluated in the EIS (the hydrologic and chemical balances for the Tailings Basin and reactive runoff from reactive waste rock stockpiles are addressed in the Response to Question 18).

As part of the EIS, conservative estimates for the flow will be used to insure that any environmental impacts are minimized. (For example, the lowest reasonable estimate of 7Q10 will be used to insure that in stream water quality standards are met.)

18. Water quality: wastewaters

a. Describe sources, composition and quantities of all sanitary, municipal and industrial wastewater produced or treated at the site.

Overview

Water that would be generated from reactive waste rock stockpiles, mine pit dewatering, and the ore loading pocket has the potential to not meet water quality standards such that treatment of the water would be necessary prior to discharge. As discussed earlier in response to Question 17, for purposes of this discussion water from these sources are being considered an industrial wastewater discharge. The term reactive runoff is being used to describe this water that has come into contact with reactive material.

As part of the EIS, baseline data will be collected in areas being considered for mine waste disposal. This will include reviewing historical data and if necessary establishing new surface and/or groundwater monitoring location. Some or all of these monitoring locations may be used for permit monitoring during the project.

A major part of the EIS will be to address the quality, quantity and treatment of various types of wastewater both during and after operation. The EIS will also include a detailed discussion of wastewater treatment options.

Sanitary wastewater at the Mine Site will be managed and treated through the installation of an approved septic tank and related drain field. A second option would be to collect sanitary wastewater in a tank and provide for off-site treatment.

The Process Plant would produce both industrial wastewater and sanitary wastewater. In discussing industrial wastewater generation, the Process Plant and Tailings Basin need to be considered as a single system. Water in the Tailings Basin would be the primary source of water for grinding and flotation separation processes. Water would leave the flotation process as a slurry of tailings, which would be deposited, in the Tailings Basin where the liquid and solid phases separate. This water use process is then repeated in this circular fashion. The only discharge of industrial wastewater from the Process Plant will be via the Tailings Basin and the tailing discharge water will be treated, if necessary, to meet water quality standards. A new sanitary wastewater treatment facility employing primary and secondary treatment will need to be constructed to treat sanitary waste at the Process Plant.

Mine Site

The design of the reactive mine waste storage area and the reactive runoff collection system will be developed as part of the EIS and permits. In general the system will be designed such that potentially reactive runoff can be directed to treatment if necessary. The water quality of this runoff will be estimated from the waste characterization study (see EAW Question 20), available data, and modeling methods. Management and treatment of this runoff will also likely change as the project progresses from development, to active operation, and to post operation.

Initial mineral processing tests were conducted by SGS Lakefield Research Limited in 2000 as part of an evaluation of the property by the former owner. Although some water quality data exists, the EIS will primarily rely on data generated during the next processing tests that are scheduled to occur during the summer of 2005. The additional pilot process evaluation is proposed to provide data that can be used in conjunction with the waste characterization study and other existing data to perform calculations that estimate the mass loading of constituents from the different exposed and fractured rock surfaces at the Mine Site. This information can then be used in conjunction with expected volumes of precipitation or other water sources that come in contact with the rock; modeling will be required to estimate the concentration and loading of constituents from the various runoff sources.

Additional waste characterization studies will be conducted on waste rock and lean ore and information will be available as part of the EIS (see the response to Question 20 for details). The characterization studies are designed to define better the trace metal release and the acid generating and acid neutralizing capacity of waste rock and lean ore as a function of the sulfur content (acid generating) and as a function of unit and rock type. These studies are also designed to better define the interplay of acid generation and acid neutralization over time. The time scale of acid generation and neutralization for waste rock and the mine pit itself will have an effect on how the rock and pit will be managed during operation and after closure. Thus the outcome of the waste characterization study will dictate the appropriate application of mine waste storage, methods to prevent and control generation of problematic drainage and treatment techniques.

The conceptual design of the Mine Site (see Figure 5-3) has designated routes for runoff from each waste rock pile, lean ore pile, temporary ore storage pile, and other runoff sources to ponds designed to settle solids and to act as temporary storage to reduce the peak discharge rate of large storm events. In addition, the final design of the rock stockpiles would provide for the separation and collection of reactive runoff water from distinct areas of the stockpiles as defined by varying levels of sulfur and metal content in the stockpile rock. This approach would allow for separate monitoring and/or management of reactive runoff water during operations and after mine closure. This monitoring data could also be used to specifically tailor stockpile closure procedures from maximum efficiency and ecological benefit.

Depending on the source and expected quality of the runoff, runoff collected in each pond may either be discharged after solids have been removed or routed to a central treatment facility located at the Mine Site. Once the composition of the seepage water quality has been projected for the expected operating life of the mine (e.g. 20 years) and water quality standards and points of compliance identified, the options for wastewater treatment will be evaluated. Treatability studies will need to be completed as part of the EIS with synthetic wastewater or water from existing stockpiles of Duluth Complex.

SANITARY WASTEWATER

Operations at the Mine Site will result in the production of limited quantities of sanitary wastewater. Using normal parameters for industrial facilities, sanitary wastewater generation is expected to be less than 5000 gpd. PolyMet currently plans to manage and treat this wastewater with the installation of an approved septic tank and related drain field. A second option would to be to install a holding tank and contract for collection and off-site treatment of sanitary wastewater at a local municipal wastewater treatment facility.

Plant Site and Tailings Basin

Hydrometallurgical Processes

From a water use and wastewater perspective the Process Plant can be separated into two major parts: the ore beneficiation and hydrometallurgical processes. The hydrometallurgical water circuits would be self-contained. There are several waste streams that would report to the lined cells of the Reactive Residue Facility, proposed to be constructed on Cell 2W of the Tailings Basin. Decanted water from the Reactive Residue Facility would report back to the filter wash tank in the hydrometallurgical section of the Process Plant. Another potential waste stream, the spent electrolytic solution, would be recycled back into the solvent extraction-electrowinning process.

Potential leakage from the Reactive Residue Facility will be evaluated in the EIS.

Additions of water to the hydrometallurgical process would occur by adding water from the raw water supply as part of the overall plant appropriation from Colby Lake. Precipitation on the Reactive Residue Facility and discharge water from the scrubbers would add water to the hydrometallurgical water system. Water would be lost through entrapment in the voids of deposited residue, cooling tower evaporation, and evaporation from tanks and the residue facility itself. Reducing makeup water as needed can control the water quantity balance of the plant. Buildup of dissolved solids in the hydrometallurgical process water can be controlled to acceptable processing limits by the individual process steps in the hydrometallurgical process circuit. Additional detail about the use of processing steps to control buildup of dissolved solids will be included in the EIS.

As part of the EIS, complete water and chemical mass balances for the processing and hydrometallurgical circuits will be calculated. Water quality for each waste stream will be estimated.

Ore Beneficiation Processes

The other major part of the Process Plant is the ore beneficiation process, including crushing, grinding and flotation. This process would have an intermittent discharge of industrial wastewater. The flotation tailings from the ore beneficiation process report to Tailings Basin Cells 1E and 2E.

Some hydrologic data for the Tailings Basin currently exist. A hydrologic balance was performed by Barr Engineering (Barr 2001) for the Tailings Basin after operations had ceased at the LTV Steel Mining Company plant and after closure of Cell 2W. This study estimated that approximately 3,600 gpm seeps from Cell 2W to the surrounding area (not including seepage to Cell 1E from 2E). The study indicated that seepage from 2W into Cell 1E, 2E, and the surrounding area are decreasing. Cell 2W no longer receives discharge water and is not proposed to receive ore beneficiation process water, water levels beneath this cell are anticipated to continue to drop until a new equilibrium is achieved. This would result in less seepage flowing into Cells 1E and 2E and the surrounding area then were estimated during the 2001 study.

Additional hydrologic data can be obtained from the East Range Hydrology Project completed by the Minnesota Department of Natural Resources (MDNR) in March 2004 (MDNR, 2004). This study evaluated the long-term water levels in the three cells of the Tailings Basin after the LTV Steel Mining Company closure and the long-term need for dam safety permits. The study predicted that water would remain in Cell 1E and 2E but that water levels would remain stable after closure and not exceed dam safety thresholds. It was found that Cell 2W will normally be dry and that any water that accumulates on the cell would infiltrate rapidly. The study also concluded that infiltration would increase with time as the cell becomes more vegetated. The data and models created for this study can be modified to assist in developing a water balance for PolyMet's operations, which will be required as part of the EIS.

Under the proposed operating plan, PolyMet has predicted that discharges from the Tailings Basin will generally not be required in order to maintain the water balance. A MetSim process simulation model developed for the Process Plant estimates that there would be a net make-up water use of 2199 gpm. This model considered several losses such as loss to void space of tailings discharged to the Tailings Basin, evaporation from the Tailings Basin, evaporation from the thickeners, water loss from stacks, water loss from concentrate, as well as several other water losses in the Process Plant. The model included precipitation on the Tailings Basin as a source of water. Groundwater inflows to the Tailings Basin from Cell 2W were not considered. Although there is net water demand based on average annual conditions, in prolonged wet weather the Tailings Basin may accumulate water and a discharge may be required in order to maintain the water balance in the Process Plant and Tailings Basin. A discharge may also be required to manage the accumulation of dissolved substances in the process water.

As part of the NPDES permit application and the permit to mine, additional work will be necessary to better estimate net water use or accumulation that will occur in the Tailings Basin. This will allow an estimate of the probable frequency of climatic wet cycles that might make discharge of treated water necessary. An overall water balance of the plant and Tailings Basin area will need to consider the following components: water consumption by the plant, water lost in the void space of tailings discharged to the Tailings Basin, return of seepage water to the Tailings Basin by the recovery/pumping system; loss of water that seeps through the Tailings Basin that is not returned to the Tailings Basin by the recovery/pumping system, evaporation from the water pools of the Tailings Basin, direct precipitation on the Tailings Basin, and groundwater inputs to Tailings Basin Cell 1E and 2E from Cell 2W and from upland areas adjacent to the basin (for Cells 1E and 2E only). A detailed water balance will be available for use in the EIS.

A chemical mass balance model (MetSim) of the ore beneficiation plant indicates that the flotation tailings slurry will contain a mixture of tailings, dissolved constituents such as metals and other salts, and residual levels of the chemical additives. Several chemicals are used in the beneficiation/flotation process. These flocculants have a high affinity for solids and it is expected that the residual levels in the liquid will be in very low concentration. A complete chemical balance of the processing plant will be developed as part of the EIS to fully understand the water quality that will be generated from the process plant.

Another factor that would affect the overall quality of the wastewater is the capture and reuse of seepage through the dams of the Tailings Basin. There are several locations on the perimeter of the Tailings Basin where water seeps out to the exterior (Figure 18-1). To minimize water loss from the Tailings Basin, seep water would be managed by constructing a new seep water collection and return system (see question 6, Figure 5-5). Additional collection pipes or trenches would be constructed along the south, west and north side of Cell 2W and along the north side of Cell 2E (no seeps have been observed along the east side of the basin). Seep water that is collected by this system would be pumped back into Cell 1E or Cell 2E. The water quality of these seeps was monitored during the operation of the former LTV Steel Mining Company plant, after plant closure, and as part of the baseline surface water monitoring program (see Figure 17-2) in preparation for the use of Cell 1E, Cell 2E, and Cell 2W by PolyMet. Several water quality parameters were elevated in the seeps. These parameters included bicarbonates, boron, hardness, specific conductivity, and turbidity.

Water quality monitoring data that has been collected at the same Tailings Basin seep locations as part of the baseline surface water monitoring program for PolyMet, and as part of the current NPDES permit requirements suggests that the water quality of the seeps since the plant has ceased operations has stabilized or there has been a slight trend of improvement. In addition to this data, a flow and water quality data survey was completed at several additional seeps along the perimeter of the Tailings Basin in October 2003 and October 2004. The effect of the recaptured seep water on the PolyMet Process Water will need to be estimated in order to define the wastewater treatment requirements. The expected future water quality of seep water from Cell 1E and Cell 2E would be a function of many variables, including but not limited to the dissolved concentration of constituents in the liquid phase of flotation tailings, the mineralogical composition of the solids tailings, the mineralogical composition of the existing tails in Cell 1E and Cell 2E, weathering of existing taconite tailings and tailings that would be contributed from the PolyMet plant operation, and ultimately how weathering of the tailings contribute to the concentration of dissolved solids in the seeps. It should be noted that conceptual design of the Tailings Basin also includes the possible use of existing Cell 2W taconite tailings in future dam construction.

The existing tailings basin is not lined, and PolyMet does not propose to install a liner beneath the flotation tailings. There is a potential that process water will seep into the groundwater underneath the tailings basin and not be captured by the seepage collection system. The emergency basin may receive material and water from crushed ore, ore concentrate, and flotation tailings during and emergency plant shut down. The potential and impact of this groundwater seepage will be evaluated in the EIS.

SANITARY WASTEWATER

Sanitary wastewater will not be generated at the Tailings Basin.

A new sanitary wastewater treatment facility employing primary and secondary treatment will need to be constructed to treat sanitary waste at the Process Plant. The average number of Process Plant workers will be about 200. Using normal parameters for industrial facilities, sanitary wastewater generation is expected to be up to 4000 gpd (3 gpm). It is expected that this wastewater will require treatment for removal of BOD, bacteria and suspended solids.

Area 1 Shops

The Area 1 Shops will continue to be used as a vehicle maintenance facility for Mine Trucks. Sanitary wastewater will continue to be discharged to the existing septic tank and drain field system. Floor drains and other industrial wastewater will continue to be contained and reused with residuals from oil water separators disposed of through outside services.

Road and Railroad Corridors

No sanitary or industrial wastewaters will be generated from roads and railroad corridors.

b. Describe waste treatment methods or pollution prevention efforts and give estimates of composition after treatment. Identify receiving waters, including major downstream water bodies, and estimate the discharge impact on the quality of receiving waters. If the project involves on-site sewage systems, discuss the suitability of site conditions for such systems.

Mine Site

During the initial wastewater treatment studies, numerous wastewater technologies will be evaluated for use at the PolyMet site. Estimates of reactive runoff water quality and applicable water quality standards will be used to design the wastewater treatment studies and potential treatment technologies to address the water quality parameters of concern. As part of the EIS, models will be developed to estimate a comprehensive water quality. Parameters that have already been identified as potential issues include hardness, pH, trace metals (specifically mercury, copper, nickel, cobalt, and zinc), and sulfate. Other parameters that could cause concerns include residual blasting agents and chloride.

The PolyMet project is located in the Lake Superior basin that has stringent limits for mercury from new wastewater sources because of its bio-accumulative properties. The discharge standard for mercury is 1.3 ng/L at the PolyMet location. Precipitation in the area already exceeds this standard. The projects ability to meet this standard will be an important consideration in the EIS. Treatment methods considered as removal technologies for mercury and metals include sulfide precipitation, ion exchange, carbon adsorption, and reverse osmosis. The ability of taconite tailings and possibly flotation tailings from PolyMet will also be evaluated to remove mercury from solution. If it is determined that the project cannot meet the mercury standard as a new source, there is the possibility of providing pretreatment of the wastewater and discharging to an existing permitted wastewater discharge that is capable of requesting a variance. Mercury and the effect of any discharge on the mercury cycle will be addressed as part of the EIS.

Additional options for the management and treatment of Mine Site discharges exist. These include: 1) pumping the discharge to the Process Plant for direct use in hydrometallurgical processing, 2), pumping the discharge to the Tailings Basin for treatment prior to discharge from the basin or surface water and/or pumping to the Hoyt Lakes POTW for additional treatment, 3) pretreatment of the discharge prior to pumping to the Babbitt POTW for additional treatment, or 4) pretreatment of the discharge prior to pumping to the other industrial facilities for beneficial reuse and consumption. These will be evaluated as part of the EIS.

Wastewater treatability studies will need to be completed to demonstrate adequate removal efficiencies for mercury and possibly other pollutants.

Closure

The quantity and water quality of runoff from the waste rock stockpiles, lean ore piles, and the pit are expected to change after mine closure. Hydrologic models will need to be employed to estimate changes in runoff from stockpiles, runoff, precipitation and ground water inflows to the pit, and pit water elevation over various phases of pit closure. Results of the waste characterization studies will need to be used in concert with geochemical and hydrologic models to predict the effect of time on expected water quality of the waste rock stockpile runoff and pit water. Details on lining and capping systems of reactive waste rock stockpiles will be included in EIS.

After closure, pit dewatering would cease and the mine pit will begin to fill with water. The rate of filling is largely a function of precipitation, groundwater inputs, runoff from adjacent upland areas, and evaporation. The amount of time it will take the pit to naturally fill will be estimated. If this time is deemed to be excessive, options for more rapid filling will be evaluated. Water could be diverted from a number of local sources to expedite pit filling. Some of those sources include the waste rock pile runoff, Northshore mine pit overflows, other local mining pits overflows, a portion of high flows in the Partridge River, municipal or industrial runoff sources, or other municipal or local discharges. Expedited pit filling may have the benefit of reducing the pit wall rock oxidation, acid generation, and metal leaching. Alternative methods of filling the pit and water quality predictions for these alternatives will be evaluated as part of the EIS.

Treatment employed during the various phases of mine closure would need to be commensurate with expected runoff volume and water quality. Treatment options include continued operation of an active treatment system that was employed during mine operation, connection of the runoff and pit water discharges to a local municipal treatment plant, and/or implementation of a low maintenance treatment system.

Plant Site and Tailings Basin

Final selection of the treatment technology will require more data on wastewater composition and quantity, discharge location, applicable water quality standards, and point of compliance. Water balance and chemical modeling will estimate the water quantity and quality during Process Plant operations. At a minimum, chemical modeling will need to consider a wide variety of factors, including but not limited to: expected water management practices, make-up water use, precipitation, evaporation, seep recovery, seep losses, Process Plant operations and tailings slurry water chemistry, and the effect of tailings weathering on seep water chemistry. The level of dissolved solids in the Tailings Basin will also depend on the proposed plan of management of water in the Tailings Basin and the expected hydrologic conditions. Treatment could be used to control accumulation of some of the solids in the process water. Under dry climatic conditions, infrequent discharges may induce greater accumulation of less-treatable substances in the process water; this could require greater treatment efforts to manage the buildup.

Once the composition of the Tailings Basin water quality has been projected for the expected operating life of the Process Plant (e.g. 20 years), the options for wastewater treatment will be evaluated. Treatability studies will need to be completed with synthetic wastewater to determine the efficiency of treatment methods being considered.

Water treatment alternatives will be addressed in the EIS.

Receiving Waters

Treated wastewater from the Tailings Basin would be discharged to the Embarrass River or its tributaries. Data on flow and water quality for these receiving waters will be required as part of the EIS. The Wastewater Treatment Plant is proposed to be constructed on the north side of the Tailings Basin but the precise location of the discharge has not been decided. At this time, seeps flow into the headwaters of Trimble Creek and into nearby wetlands that discharge to the Embarrass River. Currently these seeps are included as part of the NPDES permit for the existing tailings facility, which is managed by Cliffs Erie.

The Embarrass River flows east to west along the north side of the Giants Ridge formation before turning south near Biwabik to join the St. Louis River. The headwaters of the river are near Babbitt. The City of Babbitt discharges municipal wastewater to wetlands and pits in the headwaters of the watershed. In 2004 water quality data were collected upstream from the proposed PolyMet facility at the crossing of County Road 620. This location is designated PM-12 on Figure 17-2; available data are summarized in Table 17-2.

A majority of the seeps from the Cliffs Erie Tailings Basin currently flow to the headwaters of Trimble Creek and then to the Embarrass River. The seeps have been monitored as described previously at locations PM 7, PM-8, PM-9 and PM-10 on Figure 17-2. Table 17-2 includes data collected at these sites as well as data from the Trimble Creek monitoring location, designated PM-11. Additional water quality monitoring data for these locations will be available for preparation of the NPDES permit application and for use in the EIS.

Downstream the Embarrass River flows to Sabin Lake and then to Wynne Lake. These two lakes, located north of Biwabik and Aurora, are connected by a navigable narrows and form a four-mile long water body. The lakes have MDNR public water access and are adjacent to the Giants Ridge recreational facility. Fish populations in Sabin and Wynne Lakes in 1996 were dominated by white sucker, walleye, bluegill sunfish, and northern pike. In 1998, the MPCA listed Wynne and Sabin Lakes on the 303(d) list of impaired waters on the basis of a fish consumption advisory for mercury issued by the Minnesota Department of Health.

The Embarrass River flows out of Wynne Lake through a diversion channel to Embarrass Lake in the City of Biwabik. The City has constructed a City campground, picnic area, beach, fishing pier, and boat landing with concrete boat ramp off Hwy. 135 along the west shore. Standard limnological quality measurements were taken in Embarrass Lake in 1983 and 1993. These measurements indicate that the lake is mesotrophic and has generally good water quality. Fish populations in 2002 were dominated by white sucker and northern pike, followed by rock bass, bluegill sunfish, and walleye. In 2002 the MPCA listed Embarrass Lake on the 303(d) list of impaired waters for mercury on the basis of a fish consumption advisory issued by the Minnesota Department of Health. The City of Biwabik discharges wastewater from its municipal treatment plant to a wetland that is tributary to Embarrass Lake.

Below Embarrass Lake, the river flows through Cedar Island Lake, Fourth Lake, and Esquagama Lake and then flows an additional four miles in a highly sinuous channel to join the St. Louis River. The City of McKinley discharges its wastewater treatment lagoons to a creek that is tributary to the Embarrass River below Esquagama Lake. In 1998, the MPCA listed Esquagama Lake on the 303(d) list of impaired waters on the basis of a fish consumption advisory for mercury issued by the Minnesota Department of Health. The immediately downstream reach of the St. Louis River has also been listed by the MPCA as an impaired water on the basis of a fish consumption advisory for mercury. Ultimately, the St. Louis River discharges to Lake Superior.

The impact of increased sulfate concentrations in receiving waters due to wastewater discharges will need to be addressed in the EIS. In some systems, increased sulfate concentrations can lead to an increase in methyl mercury production, which could increase the amount of methyl mercury in the food chain.

SANITARY WASTEWATER

The existing Cliffs Erie Sanitary Waste Water Treatment Plant is not included in the area to be purchased by PolyMet. A new dedicated wastewater treatment plant which would likely employ primary and secondary treatment would be provided at the Plant Site to treat sanitary wastewater prior to discharge. A plant designed to accommodate 200 workers would be capable of treating approximately 4000 gpd (3 gpm).

Sanitary waste would also be generated at the Area 1 shops. Historically, sanitary waste at this location was managed via an existing septic tank and related drain field. PolyMet proposes to continue this practice under its operating plans.

c. If wastes will be discharged into a publicly owned treatment facility, identify the facility, describe any pretreatment provisions and discuss the facility's ability to handle the volume and composition of wastes, identifying any improvements

necessary.

A sanitary wastewater system is proposed at the Mine Site. Two optional systems are available to manage this waste. The first option would include the installation of an approved septic tank and related drain field. The location for such a system has not been determined at this time but will be addressed in a NPDES permit application if the option is exercised. The second option would include installation of a holding tank for sanitary waste. A commercial sanitary waste management contractor would be responsible for maintenance and operation of this system. The commercial contractor would remove sanitary waste from the holding tank on a regular schedule. The final destination of the collected wastewater has not been determined; the Babbitt POTW is the most likely location. The design flow for the Babbitt wastewater treatment plant is 500,000 gallons per day; the plant now treats about 200,000 gallons per day so the plant could easily handle the estimated 5,000 gpd generated at the Mine Site.

As noted previously, an option for the management and treatment of tailings basin discharge would be to pre-treat and pump the discharge to the Hoyt Lakes POTW for final treatment. The currently permitted flow of the Hoyt Lakes POTW is 685,000 gallons per day; the plant now treats about 250,000 gallons per day so the plant could accommodate an additional 435,000 gpd flow from the tailings basin, if necessary. Pretreatment provisions have not been defined to evaluate this option. Improvements to the plant may be necessary to accommodate increased flows and/or final treatment.

Potential options for the treatment of discharges from the Mine Site also include conveyance to POTWs. Two such options were listed: 1) pump the discharge to the Tailings Basin for treatment prior to pumping to the Hoyt Lakes POTW for final treatment, and 2) pretreatment of the discharge prior to pumping to the Babbitt POTW for final treatment. Pretreatment provisions have not been defined to evaluate these options. Improvements to the plants would likely be necessary to accommodate increased flows and/or final treatment.

The use of POTW for wastewater discharge and the required pretreatment options will be evaluated in the EIS.

d. If the project requires disposal of liquid animal manure, describe disposal technique and location and discuss capacity to handle the volume and composition of manure. Identify any improvements necessary. Describe any required setbacks for land disposal systems.

The Project will not require disposal of liquid animal manure.

Proposed Treatment of Topic in EIS:

Estimates of the quantity and quality of industrial wastewater generation from the mine site, processing plant and tailings basin will be included in the EIS. Predictions will be made as a function of time, during both the operating life of the project and after operations cease.

The following studies and information will be developed as part of the EIS to better understand potential wastewater impacts, and methods of prevention and mitigation as appropriate.

MINE SITE

- Waste characterization study results
- Pilot Plant Process Testing
- Phase I and II Hydrogeological Evaluation
- Wetland Hydrology Study
- Effectiveness of mine site water management systems (including lining and capping systems for reactive waste rock stockpiles)
- Existing water quality data from other sources such as AMAX test shaft, Copper-Nickel Study, and other mining operations.
- Treatability studies for reactive runoff
    - Conceptual treatment design and tests capacity of design to meet expected water quality goals. Synthetic laboratory water, which has the expected chemical composition of seep and pond water, will be created for the test or water from existing stockpiles of Duluth Complex may be used.
    - A variety of treatment options will be evaluated. This may include both active and low maintenance treatment.

MINE SITE OPEN PIT

- Description of composition of the pit walls as a function of time
- Surface area of pit walls
- Models to predict water quality under various closure scenarios

PLANT-TAILINGS BASIN

- Tailings Basin/Plant Water and Water Quality Management Approach, including effectiveness of the tailings basin seepage collection system.
- Existing water quality data from tailings basin seepage
- Water quality impacts from emergency basin seepage and material discharged to the basin.
- Processing Plant and Tailings Basin Water Balance and Chemical Budget
    - Chemical budget, modeling of the Tailings Basin seep and pond chemistry requires the following inputs:
        - Model(s) will be run in conjunction with water balance and projected pond water chemistry.
        - Tailings characterization. From ongoing waste characterization studies for new Process Plant tailings.
        - Modeling and tailing leaching kinetics results delivered as part of the NPDES and permit to mine applications

        - Prediction of water quality in cells designed for hydrometallurgical residue
        - Interaction of water from Polymet operation with underlying taconite tailings

- Treatability Study for Seep Water and Water from the Ponds
    - Conceptual treatment design and tests of design to meet expected water quality goals. Synthetic laboratory water, which has the expected chemical composition of seep and pond water, will be created for the test or water from existing stockpiles of Duluth Complex may be used.
    - A variety of treatment options will be evaluated. This may include both active and low maintenance treatment.

OTHER ISSUES

- Existing Environment of receiving waters
    - Biological monitoring (fish, mussels, and invertebrates)
    - Existing water quality parameters that do not meet standards
- Mercury
    - Ability to meet 1.3 ng/L water quality standard for discharge
    - Methylation of mercury due to increased sulfate concentrations

Sanitary wastewater treatment, which will be needed at the Plant and Mine Site, is a conventional technology and will not require study for the EIS

REFERENCES

Barr. 2001. LTV Tailings Basin Interim Water Balance Study. Barr Engineering. September 2001.

MDNR 2004. East Range Hydrology Study. Minnesota Department of Natural Resources (MnDNR). March 2004.

19. Geologic hazards and soil conditions

a. Approximate depth (in feet) to ground water: 0 (in wetlands) **minimum** 3-4 feet (interflow zone in soils)
average to bedrock: 0 (bedrock outcrops) **minimum** / unknown but < 30 feet **average.**

Describe any of the following geologic site hazards to ground water and also identify them on the site map: sinkholes, shallow limestone formations or karst conditions. Describe measures to avoid or minimize environmental problems due to any of these hazards.

None

b. Describe the soils on the site, giving NRCS (SCS) classifications, if known. Discuss

soil granularity and potential for groundwater contamination from wastes or chemicals spread or spilled onto the soils. Discuss any mitigation measures to prevent such contamination.

Information on soils, including hydraulic conductivity, will be developed as part of the hydrogeological study to be conducted during the EIS. This data, along with the predicted water quality from the various waste units will be used to evaluate the potential for groundwater contamination and chemical transport.

With respect to soils and the potential for groundwater contamination, four general areas may be considered: the Mine Site, the Plant Site (including the Area 1 Shop truck maintenance facility), the Tailings Basin, and the Railroad Construction Area. These are addressed separately below. Specific chemicals to be used and stored on site and the measures to be taken to prevent spills or other releases are discussed individually in response to Question 20.

MINE SITE

<u>Soil Types</u> - A soil survey has not been completed for this portion of St. Louis County. A general description of the soils in Sections 1, 2, 3, 4, 9, 10, 11, and 12, T59N, R13W was obtained from the USFS (Figure 19-1). As a result of discussions with the NRCS soil survey team for St. Louis County, the following information is provided to describe the soils in the vicinity of the Mine Site:

The ongoing NRCS Soil Survey considers the area to lie within St. Louis County Geomorphic Area 28, the Allen and Wampus Moraines. These are minor glacial moraines of the Rainy lobe from the Automba phase of Wisconsinian glaciation. The material deposited by this glacial lobe is generally coarse-textured and stony and bouldery. Textures of the fine soil fraction are loamy sand to sandy loam, but rock material, including gravel, cobbles, and stones and boulders, can range from 35 up to 70 percent by volume. The surface relief of the area in question is gently rolling, with local relief ranging from about 10 to 30 feet. Slopes are mostly short and irregular. The landscape includes many closed depressions, most of which contain peatlands.

The soils have formed in the coarse-textured till, and a much denser till lies about 40 inches below the surface. The topographic sequence of mineral soils (starting with the highest topographic landscape position) include the well-drained Eveleth series, the moderately well-drained Eaglesnest and Whalsten series, and the somewhat poorly-drained Babbitt series (the official description for Babbitt series is yet to be developed but it is reportedly similar to the Brimson series). The topographically lowest member of the sequence is the very poorly-drained Bugcreek series. The organic soils in the nearby peatlands are primarily the Rifle and the Greenwood series, with the Rifle having generally mixed vegetation compared to the black-spruce dominated Greenwood.

Water erosion is not likely to be a problem with the soils because of the subdued topography and the stoniness of the soil material, which has an armoring effect. The surface horizons of the soils on higher parts of the landscape (Eveleth, Eaglesnest, and Babbitt) are thin (3 to 4 inches in thickness) with about 3 to 5 percent organic matter, and they are slightly more erosive than the underlying horizons. The whole-soil erosion factors (K) for soils fall into 14 classes (up to 0.64), and the erosion factors for the soils in these sections all fall in the lower half of those 14 classes.

Because of the dense underlying till, most of the mineral soils in the landscape (with the possible exception of the Eveleth) experience perched water tables during late spring and very early summer at a depth of 1 to 3 feet. The water table usually disappears relatively quickly following tree leaf-out, but may reappear for brief periods following unusually heavy precipitation. Excavation of these soils in the spring and early summer would likely intercept areas of perched water that will accumulate in the bottom of an excavation. The intercepted water will likely need to be collected to allow for orderly construction.

PLANT SITE

Soil Types - A soil survey has not been completed for this portion of St. Louis County. The native soils in the vicinity are likely to be typical of those found in the region (see Mine Site soils discussion, above). The soils in the Plant Site have been extensively disturbed, filled and compacted by almost 50 years of mining-related activity. The majority of the area is covered by buildings with deep and substantial foundations, paved road/parking lots, railroad tracks, gravel roads/part storage areas and by the large circular tailings thickeners.

TAILINGS BASIN

Soil Types - A soil survey has not been completed for this portion of St. Louis County. The native soils underlying the Tailings Basin are likely to be typical of those found in the region (see discussion of soils in the Mine Site, above). However, the soils beneath the Tailings Basin are now overlain by up to 200 feet of tailings deposited over many years of the Cliffs Erie facility's operation as Erie Mining Company and LTV Steel Mining Company.

Current plans call for no substantial alteration in the configuration of the existing basin unless tailings are needed for dam construction. Lined containment cells will be located on Cell 2W which has approximately 200 feet of tailings in it. As described previously in Section 6, Hornfels, a potentially acid-generating material, was transported to the tailings basin and buried in taconite tailings in the general area of the Reactive Residue facility. The location of the Hornfels is shown in Figure 5-5. Monitoring wells were installed. Data from the monitoring wells will be evaluated and any potential for the reactive residue facility to impact the hornfels or groundwater beneath the basin will be evaluated in the EIS. The goal is to design the lined reactive residue facility so that there are no impacts to the hornfels or groundwater, and this will be evaluated as part of EIS preparation.

RAILROAD CONSTRUCTION AREA

Soil Types - A soil survey has not been completed for this portion of St. Louis County. The native soils underlying the road and railroad corridors are likely to be typical of those found in the region (see discussion of soils in the Mine Site, above). These soils are not known to be highly erosive or permeable, and the typical presence of a layer of dense underlying till further reduces the risk of groundwater contamination in the event of a chemical spill.

POTENTAIL FOR GROUNDWATER CONTAMINATION FROM SPILLS

The highest potential for groundwater contamination could occur is associated with reactive runoff water management of the stockpiles, leakage from the unlined tailings basin, and spills from fueling operations of mine equipment. Management of reactive runoff from stockpiles and tailings basin leakage was previously discussed in response to EAW Question 18. The following discussion identifies PolyMet's plans to prevent groundwater contamination from fueling operations.

Detailed operational checklists will be developed and provided to all operators during fueling of storage tanks, transfer from storage tanks to mine fueling transports and fueling of mining equipment. Checklist items will include: confirming reserves in tanks before fueling; examination of transfer lines and other equipment to ensure they are in good condition; requirement that driver is out of the truck monitoring operations; vehicles are not moved until all lines are stowed, valves and covers checked and secured; and transfer and fueling is observed by Company personnel trained in operation and maintenance of equipment to prevent discharges and response to discharges.

Fuel transfer operations to and from permanent storage facilities will take place in designed low permeability and curbed areas to contain any releases. Any releases will be collected by facility personnel and managed in a manner appropriate to the material recovered. Containment area drainage features will be closed during transfer operations.

Fueling operations for mobile equipment will occur within areas capable of containing any released material to prevent direct discharge to surface waters. Soils impacted by released materials will be removed, evaluated for proper management, and directed to appropriate licensed facilities.

The facility will have emergency equipment and materials on-site to allow communications and to contain and recover any released materials. The equipment and materials will include radio and telephone communications and intercom systems, various material absorbents, booms, and spill kits. Also personnel protective equipment will be available on-site. In the case of a release the State Duty Officer would immediately be notified. Two additional actions will occur immediately and simultaneously; identify the source of the release and deploy personnel and equipment to contain the release.

Proposed Treatment of Topic in EIS:

Information on soils, including hydraulic conductivity, will be developed as part of the hydrogeological study to be conducted during the EIS. This data, along with the predicted water quality from the tailings basin and reactive stockpiles will be used to evaluate the potential for groundwater contamination and chemical transport.

20. Solid wastes, hazardous wastes, storage tanks

a. Describe types, amounts and compositions of solid or hazardous wastes, including solid animal manure, sludge and ash, produced during construction and operation. Identify method and location of disposal. For projects generating municipal solid waste, indicate if there is a source separation plan; describe how the project will be modified for recycling. If hazardous waste is generated, indicate if there is a hazardous waste minimization plan and routine waste reduction assessments.

Seven main waste streams or by-products/residues would be generated by the proposed project. These are: 1) surface overburden, 2) non-reactive waste rock, 3) reactive waste rock, 4) lean ore, 5) flotation tailings from the crushing, grinding and flotation of the ore, 6) hydrometallurgical residue, and 7) gypsum. None of these materials are listed hazardous waste under 40 CFR 261or MR 7045, since all mine wastes are excluded under Bevill amendment. However, with the exception of surface overburden, all wastes will be included in a mine waste characterization program. Mine waste characterization will be included as part of the EIS.

Surface overburden and non-reactive waste rock would be used for the construction of roads and other necessary infrastructure at the Mine Site or may be placed in stockpiles adjacent to the pit. As required by Minnesota Rules surface overburden would also be placed on the completed tops and benches of lean ore and waste rock stockpiles to enhance reclamation potential. The reactive waste rock and lean ore would be placed in lined, engineered waste rock stockpiles adjacent to the pit at the Mine Site. Alternatives for providing an impermeable base to the stockpiles are under consideration. The flotation tailings are proposed for disposal at the Cliffs Erie taconite flotation tailings basin near the Plant Site. The hydrometallurgical residue would be placed in a lined Reactive Residue Facility located in a closed taconite flotation tailings basin at the Plant Site. Initially gypsum would be placed in the Reactive Residue Facility. If a market can be developed, the gypsum would be placed in a temporary storage facility until sold.

As part of the EIS and permit to mine, PolyMet will develop a waste characterization program for all geological and plant process wastes. The estimated amounts, compositions and management practices for storage of these wastes and a general category of “other” wastes are described below. PolyMet has made these estimates based on the current 20 year mine plan, and the amount and type of material may change as additional drilling information and waste characterization data is generated.

Grade Control

A key component of the NorthMet mining operation is grade control. In this context grade control is the term applied to the process of characterizing the rock mass, prior to mining, to determine whether it should be sent to the Plant Site for processing, to a waste stockpile, or a lean ore stockpile. Grade control would allow ore of different grades and quality to be blended for optimal processing and enable differentiation between reactive and non-reactive waste rock. Once material has been characterized, production engineers can plan, schedule and control production to ensure that material is hauled to the appropriate destination.

It is important to reliably and accurately identify ore grade mineralization ahead of mining to extract maximum value and to avoid contamination of stockpiles with high sulfur material. Because of the size of equipment used, it is not uncommon in open pit mining for “mixing” to occur during excavation at the boundaries between areas designated as ore, lean ore, and waste. Depending on the point of reference, this mixing can result in “dilution” of ore with waste or lean ore; alternatively, material that should have been mined as ore may be “lost” to waste or to a lean ore stockpile.

The methods that PolyMet would use for mining, grade control, production scheduling and on-going waste classification are described in response to Question 6b of this EAW. While difficult to predict at this early stage of project development, best practice is for dilution not to exceed 5% of the total volume of ore mined and ore losses would not be expected to exceed 2% of the total volume of ore mined. These projected ore losses are toward the lower end of general mining standard due to large size of mineralized zones compared to the size of excavating equipment. The issue of grade control for waste rock management will be addressed in the EIS.

Surface Overburden

Surface overburden consists of “naturally occurring unconsolidated material overlying bedrock consisting of broken rock fragments or organic materials” (MR 6132.0100: Subp. 32). Generally this means glacial till and peat, which represent the parent material from which the local natural soils have developed.

The average thickness of the glacial till at the Mine Site is 13 feet. Based on PolyMet’s September 2004 block model and currently available drill core data, it is estimated that 10,300,000 in-place cubic yards of surface overburden will be generated over the projected 20-year mine life. Assuming a density of 2.43 tons per cubic yard, this equates to 25 million tons of overburden. This estimate will be refined in the EIS.

Excavated glacial till represents an important construction material for subsequent use in mine development and closure and management practices for these materials are oriented toward the control of erosion and sedimentation. These practices are described in the response to Question 16.

Rock Materials

The NorthMet deposit is located within the Duluth Complex. In this area the Complex is a series of seven grossly layered igneous intrusive rock units. These units are composed of augite troctolite to anorthositic troctolite (varieties of “gabbro”) separated by relatively thin ultramafic (olivine rich) horizons. The lowermost unit is the main “ore zone”, however, the upper parts have isolated zones or pods of ore grade sulfide mineralization. While overall sulfide mineralization is much less in the upper units, where it does exist it contains a high proportion of material with some metal value, and therefore PolyMet indicates they intend to mine this material as ore rather than waste. An economic analysis of the feasibility of this approach will be provided in the EIS.

It is expected that some of the footwall Virginia Formation (geological unit below the Duluth Complex) would be moved for pit access road and ramp construction. The Virginia Formation is a sedimentary rock (mudstone), unmineralized Virginia Formation is commonly moved and stockpiled in the Mesabi Range taconite mines. In the area of the NorthMet deposit, it has been contact metamorphosed to the point of partial melting by the intrusion of the Duluth Complex. Size of the entrained pieces within the Duluth Complex varies from inches to one hundred feet or more in drill core. Waste rock characterization data submitted by the company indicates that more than 10 million tons of Virginia Formation rock, with an average sulfur content of 2.9%, will be excavated. This material has a high potential to produce acid drainage and plans tailored to manage materials of this high degree of reactivity will be provided in the EIS.

The gross igneous layering of these rock units is geologically important in interpreting the genesis and geometry of the deposit, but in mining, the economic criteria described below will ultimately be the only discriminators between ore and waste.

Major sulfide minerals in the deposit include: cubanite and chalcopyrite (copper-iron sulfides), pentlandite (nickel-iron sulfide) and pyrrhotite (iron sulfide).

Rock Characterization

Material (rock) management in the mine is based on an initial economic criterion, then subdivision of that criterion based on economics and sulfur content. The economic criterion is called “cut-off”, which is the sum of all the metal values (positives) and all costs (negatives) applied to mining a quantity of rock. Rock masses with values below the metals value cut-off are waste, those above it are ore. The long-term mine plan is based on conservative, long range metal values, while short term mining plans are constantly re-evaluated to reflect current metals prices. The deposit will produce the following rock materials:

Ore-sorted first by metals value:

Ore - a dynamic criterion based on metals value, subject to change over time
Lean ore - a dynamic criterion based on metals value, subject to change over time

Waste rock –rock that may or may not contain metallic mineralization, but is in either case not profitable to process using known technologies:

> Non-reactive waste –Non-reactive waste rock is rock that can be placed on the surface and the drainage from the rock will not adversely impact natural resources, although settling ponds may be needed to remove suspended solids and turbidity.
>
> Reactive waste - rock that is shown through characterization studies to release substances that adversely impact natural resources.

Tailings are from the processing of ore. Although the proposed flotation process would be designed to concentrate metal sulfides for further processing, the composition of these tailings is not yet known. The Pilot Plant Process will generate tailings that will be subjected to waste characterization studies to determine tailings composition and reactivity.

Non-Reactive Waste Rock

"Waste rock" consists of "rock that may or may not contain metallic mineralization, but that is in either case not profitable to process using known technologies" (MR 6132.0100: Subp. 34). Non-reactive rock is rock that can be placed on the surface and the drainage from the rock will not adversely impact natural resources, although settling ponds may be needed to remove suspended solids and turbidity.

The determination of non-reactive waste rock is important to protecting water quality and preventing long- term maintenance associated with mineland reclamation. Sulfur content of waste rock is an indicator of whether water runoff would contain metals and require treatment. Other criteria, including trace metals, may also be needed. Although existing data can be used to estimate the chemical content could produce runoff requiring treatment, there are many variables in the chemistry of geologic formations that make these estimates unreliable. As stated earlier a waste characterization study is proposed using rock material from the NorthMet deposit to get a better understanding of how this rock will behave when exposed to air and water.

For project planning and based on existing data, a preliminary criterion of $\leq$ 0.05% sulfur has been selected to represent non-reactive waste rock for the purposes of EIS scoping. If subsequent waste characterization studies determine that this criterion was too low the project will generate more non-reactive waste rock and less reactive waste rock. However, if waste characterization studies determine this criterion was too high, or there are other constituents of concern the project will generate less non-reactive waste rock and more reactive waste rock. Waste characterization studies will begin during the EIS. These studies are long term and will continue throughout the life of the mine.

Using the above criterion, PolyMet estimates that based on its September 2004 block model and currently available drill core data, 43 % of the total waste rock and lean ore generated during the projected 20-year mine life will consist of non-reactive waste rock. This corresponds to 121.2 million tons of non-reactive waste rock.

Table 20-1 provides a summary of the metals and sulfur composition of the non-reactive waste rock of the NorthMet Deposit using the most recent information.

Table 20-1 Metals and Sulfur Composition of Non-Reactive Waste Rock Stockpile Material

Non-reactive stockpile material	Copper percent	Nickel percent	Sulfur percent	Cobalt ppm	Zinc ppm
Mean	0.016	0.021	0.03	45	68
Median	0.016	0.020	.04	43	66
Maximum	0.047	0.044	0.05	89	116
Minimum	0.001	0.002	0.01	5	14

PolyMet data: values from drill interval samples within approximate 20 year pit design. Classifications based first on economic criterion, then sulfur value.

As with surface overburden, non-reactive waste rock represents an important construction material for routine use in mine development and closure. It is anticipated that this material would be used for the construction of roads, railroads, and other infrastructure at the Mine Site and for could be used as a pad for stockpile construction and used to extend side slopes on reactive material piles. Excess non-reactive waste rock may also be placed in stockpiles adjacent to the pit (Figure 5-3).

Reactive Waste Rock

Reactive waste rock is that rock not meeting an economic cut-off that is shown through characterization studies to release substances that adversely impact natural resources (see MR 6132.0100, Subpart 28). Thus, reactive waste rock when placed on the surface may generate acid mine drainage or drainage water that contains constituents that adversely impact natural resources. Based on the preliminary criterion for non-reactive waste rock, reactive waste rock would be rock below the metals value of lean ore and containing >0.05% sulfur. Again, if waste characterization studies determine different cutoff criteria for reactive waste rock, the estimates for the amount of reactive versus non-reactive waste rock will change.

Using the above criterion, PolyMet estimates that based on its September 2004 block model and currently available drill core data, 35% of the waste rock and lean ore generated during the 20-year mine life would consist of reactive waste rock. This corresponds to 98.3 million tons of reactive waste rock. Table 20-2 provides a summary of metals and sulfur composition of reactive waste rock.

Table 20-2 Metals and Sulfur Composition of Reactive Waste Rock Stockpile Material

Reactive stockpile material	Copper percent	Nickel percent	Sulfur percent	Cobalt ppm	Zinc ppm
Mean	0.037	0.022	0.45	45	96
Median	0.031	0.022	0.10	45	76
Maximum	0.115	0.046	7.45	101	898
Minimum	0.003	0.001	>0.05	2	16

PolyMet data: values from drill interval samples within approximate 20 year pit design. Classifications based first on economic criterion, then sulfur value.

PolyMet's proposal is to place reactive waste rock in lined, engineered waste rock stockpiles adjacent to the pit at the Mine Site (Figure 5-3). Drainage water from the stockpiles would be collected from the liner and subjected to treatment to comply with appropriate water quality standards as determined by PCA (See Response to EAW Question 18).

The following stages of construction and methods of drainage water management have been proposed for reactive waste rock stockpiles:

- Waste stockpiles would be built progressively on an "as required" basis to minimize the area of exposed liner that would collect precipitation and to minimize the impact of early stage capital expenditure on project economics.
- In general, waste rock stockpiles would be constructed on one or more subwatersheds to concentrate drainage at specific points down slope for collection.
- Vegetation would be cleared over the area where the relevant phase of stockpile construction is to take place; marketable timber would be harvested while smaller trees and shrubs may be mulched for use in future reclamation.
- The layer of topsoil, peat, vegetable matter and sediments down to the point where glacial till is encountered would be removed and stockpiled for use in future reclamation.
- Glacial till would then be removed to a depth that will depend on the overall depth of till and the volume of material required for construction of a surface water exclusion dike.
- Where adjacent wetlands might seep toward the stockpile base, the glacial till removed during the previous construction step would be used to build a dike that would be thoroughly compacted during construction. By placing the material on the dike in layers and compacting each layer successively, the impermeability of the dike itself would be enhanced to a specified design criterion.
- Water that does infiltrate the dike from an adjacent wetland would not have come into contact with any waste rock and can therefore be collected in a channel and conveyed to a settling pond prior to monitoring and discharge to the Partridge River.

- Mining will be scheduled to provide inert, non-reactive waste rock (mostly from Unit 3) for the construction of a base layer or platform for what would become the main waste rock stockpile. The upper surface of this "base" will be graded to a low point that would become a future drainage collection point. Having established the basic shape of the platform, a layer of screened surface overburden, sand or possibly taconite tailings will be spread over the base to provide a protective layer on which an impermeable barrier of liner would be placed. This in turn will be covered with an upper protective layer of screened surface overburden, sand or tailings before run-of-mine reactive waste rock is placed on top of it.
- Any drainage from a reactive waste rock stockpile would be collected on the liner or impermeable barrier and drain to a lined basin.
- Drainage water will be pumped from the lined basin to a treatment plant located at the Mine Site prior to discharge to the Partridge River.

Additional detail on stockpile construction as well as alternative designs and layouts will be included in the EIS.

Lean Ore

Lean ore is defined by rule as rock containing metallic mineralization that is not profitable to process using technologies that exist at the mining operation (MR 6132.0100, Subpart 14). Regardless of its metal content, most of the lean ore would have a sulfur concentration above the preliminary and conservative criterion of >0.05% and be considered reactive. Thus, lean ore may generate acid mine drainage or drainage water that contains constituents in excess of the State's water quality standards.

PolyMet estimates that based on its September 2004 block model and currently available drill core data, 21 % of the waste rock and lean ore generated during the 20-year mine life would consist of lean ore. This corresponds to 60.1 million tons of lean ore that would be generated during the 20-year mine life. Table 20-3 provides a summary of the metals composition of lean ore.

Table 20-3 Metals and Sulfur Composition of Lean Ore Stockpile Material

Lean ore stockpile material	Copper percent	Nickel percent	Sulfur percent	Cobalt ppm	Zinc ppm
Mean	0.096	0.043	0.35	61	82
Median	0.097	0.042	0.21	59	79
Maximum	0.256	0.093	4.91	168	236
Minimum	0.007	0.010	0.01	12	12

PolyMet data: values from drill interval samples within approximate 20 year pit design. Classifications based first on economic criterion, then sulfur value.

As with reactive waste rock, lean ore would be placed in lined, engineered waste rock stockpiles adjacent to the pit at the Mine Site (Figure 5-3). Drainage water from the lean ore stockpiles will be collected from the liner and subjected to treatment to comply with applicable water quality standards as described in the response to Question 18. The construction sequence and methods of drainage water management for lean ore stockpiles are envisioned to be the same as that described for reactive waste rock stockpiles.

It may be possible to process the "lean ore" through the concentrator and metal production stages after mining stops at a deposit. Assuming the plant is operational and mining has ceased, this material is then not displaced by (or in competition with) material of higher value in the production process, and the mining costs have been largely covered in the original material movement.

Ore

As with the other parts of the deposit, the silicate portion of the ore is relatively constant, the metals composition is presented here in Table 20-4. This also represents the feed to the plant, the parent material of the tailings. Since there will be unrecoverable ore grade material in the floor and walls of the pit at the end of mining, the ore concentrations would provide a worse case estimate of the composition of pit floor and walls at the end of mining. Pit wall and floor composition as a function of time will be evaluated as part of the EIS.

Table 20-4 Metals and Sulfur Composition of Ore

Ore	Copper percent	Nickel percent	Sulfur percent	Palladium ppm	Platinum ppm	Gold ppm	Cobalt ppm	Silver ppm	Zinc ppm
Mean	0.44	0.11	1.00	0.425	0.110	0.060	78.9	1.6	83.8

PolyMet data: values from drill interval samples within approximate 20 year pit design. Classifications based first on economic criterion, then sulfur value.

Flotation Tailings

Flotation tailings are the waste-by-products of the mineral beneficiating processes, consisting of rock particles, which have undergone crushing, grinding and flotation, from which the profitable mineralization has been separated. The silicate portion of the flotation tailings will be the same as the ore feed (Table 20-1) Because sulfide minerals, including most iron sulfides, will be separated from tailings in the flotation process, the flotation tailings are projected by PolyMet's metallurgical simulations to be approximately 0.17 % sulfur. Additional testing will be conducted to better estimate the actual sulfur content of the tailings. This data will be developed for the EIS.

Testing pilot plant of flotation tailing at Lakefield Research indicated tailings with a sulfur concentrations between 0.20 and 0.28%, however most of these metallurgical tests were performed so as to minimize pyrrhotite and other non copper-nickel sulfides recovery to the concentrate. Subsequently, PolyMet has elected to design the flotation process to emphasize total recovery of all sulfide mineral phases thereby providing for the projected reduced export of sulfur to tailings. PolyMet believes that tailings produced by a total sulfide recovery will be non-reactive and additional testing has been planned as part of the EIS. The actual composition and classification as reactive or non-reactive nature of flotation tailings will be determined by waste characterization of tailings generated in the Pilot Plant Process, and this information will be available for EIS preparation. Physical characteristics of the tailings and their suitability for use in dam construction will also be evaluated as part of the EIS.

PolyMet estimates that based on its September 2004 block model, 11,300,000 tons of flotation tailings would be generated annually. Table 20-5 provides a summary of the metals and sulfur values in the flotation tailings.

Table 20-5 Metals and Sulfur Composition of Flotation Tailings from Lakefield Testing

Flotation Tailings	Copper percent	Nickel percent	Sulfur percent	Gold ppm	Cobalt ppm	Silver ppm	Zinc ppm
Bulk Composite Concentration[1]	0.03	0.038	0.26	<0.02	61	21	110
Projected Concentration[2]	0.0255	0.035	0.17	0.0149	52.3	-------	22.8

[1]*Data taken from SGS Lakefield Limited Progress Report No. 6. Sulfur is median based on ten samples.*
[2]*Data from MetSim process simulation model.*

PolyMet proposes to discharge the flotation tailings to the Cliffs Erie taconite flotation tailings basin at the Plant Site. Use of this basin will be evaluated as part of the EIS. The management, treatment and discharge of water from the tailings basin are described in the response to Question 18. The design, construction, operation and management of the flotation tailings basin and related dams is described in the response to Question 6.b.

Hydrometallurgical Residue

PolyMet estimates that 355,000 tons of hydrometallurgical residue would be generated annually. This residue consists of four materials:

1. Autoclave residue from the leach residue filter
2. Iron/aluminum precipitate from the Fe/Al removal filter
3. Magnesium hydroxide precipitate from the Mg Removal thickener
4. Crud solids from crud removal

As the hydrometallurgical leach residue exits the autoclave, it is inherently acidic and needs to be subsequently subjected to elementary neutralization to neutralize the material to a near neutral pH (slightly alkaline) prior to placement in a lined, engineered disposal facility at the Plant Site (Figure 5-5). This Reactive Residue Facility will be designed to standards specified by the MPCA. Liquid associated with the hydrometallurgical residue will be recycled back into the hydrometallurgical process from the Reactive Residue Facility in a closed loop. There will be no water/liquid discharge from this facility.

Currently there is limited data available regarding the composition of the hydrometallurgical residue. Whole rock analysis of leach residue filter solids indicates that it primarily consists of compounds made up of iron, silicon, aluminum, calcium and sodium (> 85 %) and approximately13 % volatile matter such as sulfur, carbonates, water and organic compounds (SGS Lakefield Progress Report No. 7). Whole rock analysis of the iron/aluminum precipitate indicates that it primarily consists of compounds made up of iron, silicon, aluminum, and calcium (> 54 %), volatile matter (>27 %) and other components (> 27%) that are not determined in whole rock analysis (SGS Lakefield Progress Report No. 7). All materials will be characterized as part of the EIS.

"Crud" is a colloquial term used in the industry to describe the result of contamination of the organic/aqueous reagents by dust, silica and even insects. To enable filtration of the crud, a pre-coat/filtration medium (clay) is added to a makeup tank and gravitates to a holding tank prior to being mixed with the other constituents before being pumped to a small filter press. The filter cake containing unwanted solids and residual organic material will be discarded to the Reactive Residue Facility. The composition of the clay (Desiccite 25) is 97-99 % bentonite and 1-3 % silica. The composition of the contaminants removed by the clay has not been determined but it will likely consist primarily of aluminum, silica, and organic debris.

Gypsum

After precious metals recovery, the hydrometallurgical leachate solution is brought to pH > 2 using limestone in a three-tank neutralization cascade. Slurry from the precipitation tanks is pumped to a thickener, with the thickener underflow filtered using an automatic plate and frame pressure filter. The filter cake solids will consist of market-grade gypsum that is commonly used to make gypsum board (or sheet rock) for the construction trades. The composition of the gypsum will be >97 % $CaSO4\ 2H20$ with the remainder consisting of impurities. The filtrate from the filter press is recycled back into the process for copper extraction.

PolyMet estimates that 370,000 tons of gypsum would be produced annually. Current plans are to place this product in the lined Reactive Residue Facility at the Plant Site (Figure 5-5).

The quality of gypsum recovered from the process will be confirmed in future pilot testing that is scheduled to occur in 2005. In the event that an adequate market is available within reasonable haul distance, the gypsum will be placed in a temporary storage facility at the Plant Site. (If the gypsum is not marketable, the gypsum will be placed in the reactive residue facility.) Gypsum disposal will be addressed in the EIS.

Ongoing Waste Characterization Studies

As a part of the upcoming application for the permit to mine, PolyMet is preparing a waste characterization study. This study will include characterization of non-reactive waste rock, reactive waste rock, lean ore, ore, and flotation tailings. Hydrometallurgical residue and gypsum will be the focus of a separate, but similar study. The studies will include: 1) chemical analysis of each waste/product; 2) mineralogical and petrological analysis of mine materials; and 3) laboratory tests describing the acid generation and dissolved solids release from the materials.

The scope of work for the waste characterization study will be available for use in defining the EIS scope of work. In addition, results from the waste characterization study will be completed in a time frame that will allow the EIS contractor to incorporate the findings of the study into the Draft EIS.

The characterization of mine wastes/products will be an important element of the Draft EIS and in addition to planned studies described above there are numerous other sources of relevant information to support the EIS. This includes research conducted by the MDNR Division of Minerals. This work includes analyses of waste rock and drainage waters associated with samples of the Duluth Complex in both laboratory and field settings. PolyMet has also conducted several studies in the last five years. Finally, other agencies and mining companies have conducted studies of rock, tailings and drainage water associated with the Duluth Complex.

Other Wastes

As described in the response to Question 18, wastewater treatment plants would be operating at the Mine Site and Tailings Basin. These plants may generate treatment residue consisting of lime sludge, spent carbon and/or spent exchange resin. These materials contain metal values and other pollutants removed from water prior to discharge to surface waters.

Lime sludge would either be recycled into the hydrometallurgical process for recovery of metal values or will be disposed of in the Reactive Residue Facility. The annual generation of lime sludge is unknown at this time pending design of the wastewater treatment systems. Detailed information concerning the design and operation of the treatment systems will be provided in the NPDES permit application. This information will be available for inclusion in the EIS. Disposal of treatment sludges during and after operation will be addressed in the EIS.

Spent carbon and/or ion exchange residue would be managed by a commercial contractor for water treatment technology and related consumables. Spent materials would be transported off-site by the commercial contractor and the materials will be reprocessed by the contractor or other appropriately permitted facilities. The rejuvenated carbon and/or ion exchange media would be reintroduced into treatment service. The annual generation rate of spent carbon and/or ion exchange residue will be estimated during the design of the wastewater treatment systems and will be described in the NPDES permit application.

As described in Appendix A, steam plant(s) would be operated at the Plant Site to generate steam for autoclave preheating, slurry heating duties (Fe Removal and Cu Precipitation) and cathode washing in the copper stripping unit. Steam for autoclave preheating will be provided from the existing gas fired boilers. The other two duties will require either the addition of a small boiler or the modification of one of the (much larger) existing boilers to provide the smaller amount of required steam.

De-mineralized water is required for the steam boilers. Operation of a water de-mineralization plant(s) would generate a de-mineralization sludge. This sludge will consist of precipitated dissolved salts (e.g., Ca, Mg) removed from the steam plant water supply (Colby Lake via the Plant Reservoir). This sludge would be disposed of in the Reactive Residue Facility or Flotation Tailings Basin based on its characterization. The annual generation of de-mineralization sludge will be determined in later stages of the design process, but given the modest steam demand at the Plant Site the quantity of waste should be modest.

The existing Cliffs Erie Sanitary Waste Water Treatment Plant is not included in the area to be purchased by PolyMet. Therefore a new dedicated wastewater treatment plant would be provided at the Plant Site to allow treatment of sanitary wastewater streams prior to discharge to the environment. The discharge of treated sanitary wastewater from this plant is described in the response to Question 18. Operation of this plant would also generate a sludge that will require disposal. The composition of this sludge will be similar to other sanitary sludge in a work place setting. Using a per capita wastewater generation rate of 20 gallons/day , 200 employees at the plant site, and 5 to 10% solids content of the sludge, approximately 5 to 20 tons/year of sludge would be generated and require disposal. This sludge would be transported to the Hoyt Lakes wastewater treatment plant for treatment and management. Alternatively, the sludge may be treated and land applied as a part of stockpile reclamation activities. A sanitary wastewater system will also be provided at the Mine Site. The system could include a holding tank for sanitary waste. A commercial sanitary waste management contractor would be responsible for maintenance and operation of this system. The commercial contractor will remove sanitary waste from the holding tank on a regular schedule.

Small quantities of hazardous waste may be generated at the plant site in a manner similar to the taconite industry. These wastes may include solvents for machine shop degreasing, paint strippers, off-spec reagents, and other materials that may exhibit a characteristic of hazardous waste. Generated hazardous wastes are expected to be managed in accordance with the small quantity generator provisions of the hazardous waste rules (MR 7045.0206 Subp. 3 and 7045.0292 Subp. 5). Generator accumulation of hazardous wastes will occur inside a building with impervious flooring. Collection and transportation of the hazardous wastes will be by a licensed hazardous waste transporter and the materials would be sent to appropriate permitted hazardous waste treatment and disposal facilities.

Exhausted lead-acid batteries from plant vehicles would be stored inside a building with flooring to accumulate sufficient volume of batteries for shipment and recycling. Any battery noted as leaking or with a cracked casing would be containerized to prevent release to the environment. Battery accumulation would be conducted in accordance with the relevant provision of the hazardous waste regulations (40 CFR Part 266, Subpart G, or 40 CFR Part 273).

Cathodes and anodes used in copper electrowinning may be damaged as result of handling or corrosion attack. These materials would also be stored inside a building prior to shipment to an offsite scrap metal recycling facility.

A small amount of general trash would be generated at the Plant and Mine Sites. Trash may consist of rubbish, paper, cans, non-returnable consumable reagent containers, assorted filters, belts, hoses and similar materials acceptable management at permitted solid waste facilities. The trash would be placed in dumpsters and collected by a commercial contractor for management at a permitted solid waste facility. Receptacles for readily recyclable materials, e.g., aluminum cans, paper, etc. will be placed at convenient locations at the plant. The recyclable materials would be collected by a commercial contractor for transportation to appropriate recycling facilities. Returnable consumable containers would be collected by the commercial supplier of the consumable and recycled.

Operation of the NorthMet mine would require maintenance of a rubber tired loaders, haul trucks, service vehicles, etc. The maintenance activities will include replacement of worn tires. Waste tires would be managed at a waste tire management facility under a permit issued by the MPCA. Records at the waste management facility would document the annual generation of waste tires, and the volume and the ultimate disposition of waste tires. Commercial vendors would be engaged to transport waste tires to appropriate disposal or reuse facilities. No waste tires would not disposed of on PolyMet property.

It is anticipated that there will be periodic construction activities at the plant that would result in generation of demolition and construction wastes. Readily recyclable materials such as iron, steel, concrete would be evaluated for the feasibility of recycling based on the nature and volumes of material. Where feasible, these materials will be separated, temporarily stockpiled at the plant for accumulation and then transported to appropriate recycling facilities by a commercial contractor. Demolition and construction wastes not recycled would be temporarily stockpiled for accumulation and transported to appropriate permitted solid waste management facilities.

No ash will be generated by the project.

b. Identify any toxic or hazardous materials used at the site and identify measures to be used to prevent them from contaminating groundwater. If the use of toxic or

hazardous materials will lead to regulated waste, discharge or emissions, discuss any alternatives considered to minimize or eliminate the waste, discharge or emission.

A number of reagents and additives would be used in the process at the Plant Site. The reagents and materials would be stored in appropriate containers within buildings with impervious floors. The materials and containers would be separated as appropriate to prevent undesired reactions between the materials and threats to safety and the environment.

Petroleum fuels such as gasoline, fuel oil and diesel fuel will be stored on site for fueling plant vehicles. Storage of these fuels would be in above ground tanks designed, operated and maintained in accordance with applicable rules. Various lubricants would also be on site. These lubricants would be stored indoors or in tanks meeting regulatory requirements.

Used lubricating engine oil would be collected, stored in a tank meeting regulatory requirements, and recycled. The used oil would be managed in accordance with applicable used oil rules.

Risks from spills can be reduced by using paved or lined fueling/transfer pads, similar to those used at commercial gasoline filling stations. Stationary equipment can also be placed on paved or lined pads to minimize the potential for contamination from fuels, oil and lubricants.

Other materials that might be present on site would include fertilizers, pesticides or herbicides for vegetation management. These materials would also be stored in side a building with impervious flooring. All materials used in the processing circuit and plant, including steam plant, will be identified and evaluated in the EIS.

c. Indicate the number, location size and use of any above or below ground tanks to store petroleum products or other materials, except water. Describe any response plans.

A number of above ground tanks would be used at the Plant Site. These tanks would include both process and material storage tanks. The specific locations for tanks will be determined as the detailed design for Plant Site and Mine Site progresses. Figure 20-1 shows the general anticipated location of the tanks within the Plant Site, Area 1 and the Mine Site.

PolyMet will develop a Spills Prevention, Control, and Countermeasures Plan (SPCC Plan) for the Plant Site and the Mine Site in accordance with the applicable provisions of 40 CFR 112. Copies of the Plans would be kept at the Plant Site and Mine Site. The SPCC Plans address prevention, preparedness, and response factors, including spill prediction; containment; inspections and tests; personnel training; security; loading, unloading and transfer operations; facility drainage; and bulk storage containers.

Proposed Treatment of Topic in EIS:

The characterization, handling, and facility design for waste materials will be a significant issue addressed in the EIS. The three components of the project that will be the major focus of this discussion will be waste rock from the mine site, tailings from ore beneficiation process, and reactive residue from the hydrometallurgical processes. Below is a brief description of materials and issues that will be included in the EIS on each of these components:

Mine site waste rock:

- Amounts and composition of non-reactive waste rock, reactive waste rock, and lean ore as determined by the block model
- Determination of chemical composition of waste rock that will be the cutoff between non-reactive and reactive waste rock
- Determination of sulfide levels that will create acid mine drainage
- Evaluation of other constituents of concern in this material
- Details and effectiveness of the Grade Control Program including details on blast hole sampling for waste rock management
- Details and alternatives for reactive waste rock stockpile design and siting
- Development of a mine waste management plan
- Determination of the quantity and quality of drainage to be generated over time

Ore beneficiation process tailings:

- Characterization of tailings
- Suitability of disposal on existing unlined tailings basin
- Evaluation of alternatives for design, construction and siting
- Physical and chemical suitability of existing and new tailings for construction of tailings basin
- Determination of the quantity and quality of drainage to be generated over time

Hydrometallurgical processes reactive residue:

- Characterization and quantities of residue
- Design of reactive residue facility
- Suitability of reactive residue facility on existing tailings basin Cell 2W
- Evaluation of alternatives for design, construction and siting
- Determination of the quantity and quality of drainage to be generated over time.

Results from the Pilot Plant Processing study and the Waste Characterization Study will be used in conjunction with existing data to generate and characterize the above-described material. The Pilot Plant Processing study will generate tailings and reactive residue from a sample of the NorthMet Deposit using a pilot scale version of the proposed ore beneficiation and hydrometallurgical processes. The Waste Characterization study is a long-term study that would continue after the completion of the EIS. This study makes use of humidity cell test of rock and tailings from the NorthMet Deposit to determine the reactive or non-reactive nature of the materials. Initial results from these tests will be available for inclusion in the EIS. As part of the characterization study, PolyMet will conduct a complete chemical and mineralogical study of all of their waste. This information will be used to compare the predicted behavior of the PolyMet material with other samples of Duluth Complex material for which long-term data exists. Various methods to accelerate potential reactions and comparisons with existing data may be used to determine the suitability of the initial results.

Identification, handling, and facility design of other wastes will be included in the EIS.

21. Traffic. Parking spaces added: 0**.**
Existing spaces (if project involves expansion): See below

Estimated total average daily traffic generated: Estimated maximum peak hour traffic generated (if known) and time of occurrence

Provide an estimate of the impact on traffic congestion on affected roads and describe any traffic improvements necessary. If the project is within the Twin Cities metropolitan area, discuss its impact on the regional transportation system.

The LTVSMC/Cliffs Erie taconite facility operated for almost 50 years at the project location with approximately 2700 to 1300 employees depending on production rate. The proposed PolyMet facility would employ between 490 and 600 employees, so overall traffic impacts should be well below what has been experienced in the past.

Initially, all PolyMet access for both plant and mine would be via CR 666 to Hoyt Lakes. An alternate route for employees coming from the north is via the North Gate on County Highway 135. This could be used if demand justifies the expense of control at that location. Initially, mine employees would park at the plant and travel by bus or other company vehicle to the mine. Again access arrangements for entry from the east (to Babbitt) may be arranged if demand justifies the expense.

PolyMet plans to employ about 137 employees working five days per week and 270 persons working on three eight-hour shifts per day with shifts rotated to maintain operation 7 days per week. With reductions for weekends, each shift would have about 64 persons. The worst traffic situation would occur if the start or finish of the daytime employees coincided with shift change. The arriving and leaving shift workers and the day employees would combine to produce about 265 trips with 64 vehicles moving in one direction and 201 vehicles moving in the other direction. Delivery of materials and supplies to the plant might coincide with this peak traffic but peak hour traffic should be less than 300 vehicles per hour. This traffic count is well within the capacity of the existing paved two-lane county highway leading from Hoyt Lakes to the plant. Any arrangements for alternate entrances would reduce these minor traffic impacts.

During construction and startup it is possible that more workers would be present than during normal operation. The number of construction workers is unknown but should be less than 1,000 workers. Assuming a distribution of 33% day workers and 66% shift workers, with allowances for downtime for shift workers, the peak traffic would be less than 600 vehicles per hour (peak hour) during construction with a daily total of about 1900 trips per day. Again, this is well within the level of traffic experienced in the past when the taconite facility was operating.

Proposed Treatment of Topic in EIS:
No additional information will be provided on this topic besides what is already been provided in the Scoping EAW.

22. **Vehicle-related air emissions. Estimate the effect of the project's traffic generation on air quality, including carbon monoxide levels. Discuss the effect of traffic improvements or other mitigation measures on air quality impacts. Note: If the project involves 500 or more parking spaces, consult EAW Guidelines about whether a detailed air quality analysis is needed.**

Although a detailed analysis has not been completed, there is likely to be a negligible effect on air quality from project-related traffic. Arriving and departing traffic would be spaced over the peak hour and there are few traffic controls or conflicting traffic flows to cause long idling periods where CO emissions might become significant. The existing Plant Site parking lot has historically accommodated more than 500 vehicles but PolyMet staff would not require this many parking spaces.

Traffic from mine haul trucks and construction equipment is known to be a large source of fugitive particulate emissions at taconite plants and is considered to be part of the stationary source emissions and will be covered by response to Question 23 below.

Proposed Treatment of Topic in EIS:

No additional information will be provided on this topic besides what is already been provided in the Scoping EAW.

23. **Stationary source air emissions. Describe the type, sources, quantities and compositions of any emissions from stationary sources of air emissions such as boilers, exhaust stacks or fugitive dust sources. Include any hazardous air pollutants (consult *EAW Guidelines* for a listing) and any greenhouse gases (such as carbon dioxide, methane, nitrous oxide) and ozone-depleting chemicals (chloro-fluorocarbons, hydrofluorocarbons, perfluorocarbons or sulfur hexafluoride). Also describe any proposed pollution prevention techniques and proposed air pollution control devices. Describe the impacts on air quality.**

CURRENT AIR QUALITY OF PROJECT SITE

The project area is currently attainment with the National Ambient Air Quality Standards (NAAQS) for airborne particulate matter, nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, and lead and is currently attaining all Minnesota state air quality standards.

Recent monitoring data for sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) are not available. The existing ambient monitoring data for PM_{10}, ozone and carbon monoxide (CO) does not exactly reflect the current air quality at the project site, but it is the best available data geographically and temporally. The air around the project site may be somewhat cleaner than that in Duluth, Virginia, or at Hibbing Taconite, although ozone levels are actually higher at Voyageur National Park than in Duluth, which indicates that transport is a significant contributor to ozone concentration. Another indicator of the air quality in the project area would be background concentrations that MPCA has allowed to be used for modeling in the area. Because there is currently minimal industrial activity in the immediate vicinity, ambient concentrations may be close to background levels.

PROJECT SITE PERMITTING HISTORY

PolyMet would operate a portion of the currently idle Cliff Erie taconite process plant and adjoining tailings basin. The project would make use of existing structures and some equipment as well as the tailings basin. Existing equipment to be utilized includes the rail dump pocket, one of the primary crushers and the four associated secondary crushers, three tertiary crushers and the 6 associated quaternary crushers as well as 14 of the existing milling lines. The screens, conveyors, feeders and ore storage bins associated with the crushers and mills would also be operated by PolyMet as well as the existing boilers. The boilers are currently permitted to burn natural gas or No. 2 fuel oil, but they would only burn natural gas in the future.

Although the taconite plant is currently idle, a federal Title V permit is in force for the facility (Permit No. 13700009-001). This permit is valid through December 21, 2005. Table 23-1 below presents the currently permitted equipment that would be operated as part of the PolyMet operation based on the latest process design and the associated identification numbers from the permit and a description of the existing pollution control equipment:

Table 23-1
Currently Permitted Sources That Would Be Operated By PolyMet

EU I.D.	Process Description	Stack I.D.	Control Equipment I.D.	Control Equipment Description
EU 001	Boiler 3[1]	SV 001	NA	NA
EU 002	Boiler 4[1]	SV 001	NA	NA

[1] The current location of the boilers is not on PolyMet property, but they would be relocated to the processing plant.

EU I.D.	Process Description	Stack I.D.	Control Equipment I.D.	Control Equipment Description
EU 005	South 60" Crusher	SV 004	CE 002	Baghouse
EU 007	South 36" Pan Feeders to Conveyor 1A	SV 007	CE 005	Rotoclone
EU 008	South 36" Pan Feeders to Conveyor 1B	SV 008	CE 006	Rotoclone
EU 009	South Pan Feeders	SV 008	CE 118	Rotoclone
EU 011	Drive House 1 East Transfer	SV 010	CE 008	Rotoclone
EU 012	Drive House 1 West Transfer	SV 011	CE 009	Rotoclone
EU 136	Coarse Ore Storage	SV 111-114[2]	CE 139-142	Baghouse/Rotoclone
EU 013	Vibratory Feeders and Conveyors	SV 012	CE 119	Rotoclone
EU 018	Fine Crushing – West 1	SV 014	CE 012	Rotoclone
EU 019	Fine Crushing – West 1	SV 014	CE 122	Rotoclone
EU 020	Fine Crushing – West 1	SV 014	CE 123	Rotoclone
EU 021	Transfer Point – Conveyors	SV 014	CE 124	Rotoclone
EU 022	North Transfer Point	SV 015	CE 013	Rotoclone
EU 023	South Transfer Point	SV 016	CE 014	Rotoclone
EU 137	Fine Ore Storage – North	SV 115[3]	CE 143	Rotoclone
EU 138	Fine Ore Storage – South	SV 119-120	CE 147-148	Rotoclone
EU 024	Fine Ore Feeders – North 1-4	SV 017	CE 015	Rotoclone

[2] All of the stacks and rotoclones may not be utilized since a portion of the bin would be closed off. This is uncertain at this time.
[3] The remaining stacks and rotoclones associated with this emission unit would not be utilized.

EU I.D.	Process Description	Stack I.D.	Control Equipment I.D.	Control Equipment Description
EU 030	Fine Ore Feeders – South 3-4	SV 023	CE 021	Rotoclone
EU 031	Fine Ore Feeders – South 5-8	SV 024	CE 022	Rotoclone
EU 032	Fine Ore Feeders – South 9-12	SV 025	CE 023	Rotoclone
FS 008	Taconite[4], Rail Unload	Fugitive	NA	NA
FS 016	Tailings Road Dust	Fugitive	NA	Road Watering
FS 032	Tailings Basin	Fugitive	NA	NA

The facility as operated by PolyMet would not process taconite, but emission from crushing and related operations would be expected to be similar to when the facility was processing taconite. Tailings basin design and operation would be somewhat different because of the different characteristics of the floatation tailings and reactive residues produced from the processing of the non-ferrous ore.

At this point it is uncertain if the PolyMet facility would be permitted as a new or existing source. This could be a complex regulatory issue that will need to be worked out with MPCA. In any event, it is anticipated that a federal Prevention of Significant Deterioration (PSD) permit would be required to permit the new facility either as a new major source or as a major modification at an existing source. The PolyMet facility is also likely to be a major source of hazardous air pollutants (HAPs), so case by case Maximum Achievable Control Technology (MACT) requirements may apply.

DESCRIPTION OF STATIONARY EMISSION SOURCES

For the purposes of describing the air emission sources, it is useful to divide the proposed operation into functional areas including 1) the Mine Site, 2) the Dunka Road between the Mine Site, the Process Plant and the Area 1 Shops, 3) the Process Plant, 4) the Tailings Basin, and 5) the Area 1 Shops. The sections below describe the emission sources from each area in detail.

MINE SITE EMISSION SOURCES

The majority of emission sources at the Mine Site are fugitive in nature and reflect typical operations at an open pit mine. The first step in the mining process is the removal

[4] The facility would no longer process taconite, so this emission unit would likely be renamed.

of overburden which would be loaded into trucks using front end loaders and backhoes. This operation would generate particulate emissions as would the unloading of the trucks at the stock piles. Drilling and blasting of waste rock and ore would also generate particulate emissions as would the loading of waste rock and ore into trucks via backhoes and/or front end loaders. Waste rock would be hauled to stockpiles; ore would be hauled to the rail loading pocket. The dumping of the waste rock or ore at its destination would generate particulate emissions as would the mine truck traffic on the haul roads. The size of the haul trucks has not been decided upon at this time. For the worst case emission calculations, the smallest truck being considered, 150 ton capacity, was assumed to be used. This is the worst case because the emissions from unpaved road traffic are more strongly dependent on vehicle miles traveled than vehicle weight (i.e. more trips with smaller trucks would generate more dust). The ore would be transported to the Process Plant via rail. There would also be a minor amount of light truck traffic on the mine haul roads from transporting work crews, dispatching maintenance crews, and allowing site management to inspect mining activities. A fuel tanker would also travel on the mine haul roads to refuel the tracked vehicles that would operate in the mine pit. Particulate emissions from the handling of waste rock and ore would contain metals in the same proportion as these materials. Road surfaces would be constructed of non-reactive waste rock or other similarly inert materials with minimal metal content, so toxic air pollutant emissions are not expected from haul road traffic.

Ore would not be crushed at the Mine Site. All crushing and size separation would be performed at the Process Plant. However, non-reactive waste rock may be crushed and screened at the Mine Site, so that it can be used for road construction and other infrastructure construction related activities. It has been conservatively assumed that the entire projected amount of non-reactive waste rock generated would be crushed and screened. Toxic air pollutant emissions are not expected from the processing on non-reactive waste rock.

Two 10,000 gallon diesel fuel tanks would be located at the Mine Site. While the bulk of mine dewatering would be accomplished with electric pumps, diesel powered pumps would be used to access areas where power is not available. This is likely to occur only when the active mining area is changed or during similar occurrences. The remaining activities at the Mine Site are not expected to generate significant emissions. These activities would include equipment service and refueling facilities, office and toilet facilities, and other support activities. Dispensing equipment for lubricating and hydraulic oils as well as bulk storage tanks would be located at the field service facility.

Small boilers or heaters may be used for space heating in the office and toilet facilities and small hot water heaters may be used to produce hot water for personal use. These heaters would be fueled with liquid propane gas (LPG).

DUNKA ROAD

The section of the Dunka Road between the Mine Site, the Process Plant, and the Area 1 Shops would be used to transport equipment and personnel between the three sites. Access to the road is limited at both ends. The road is owned by Cliffs Erie, PolyMet would have legal access. Forest Service employees would also be allowed to use the road to access forest service lands in the area. Supervisory staff would be provided with field vehicles that would be allowed on the Dunka Road, but the remaining mine personnel would be transported from the processing facility to the mine via six passenger vans or similar vehicles. Private vehicles would not normally be allowed on the road.

Relevant air emissions along the Dunka Road would occur as a result of PolyMet vehicle traffic. This would include:

- Light truck traffic – including supervisor vehicles and personnel transport vans.
- Empty haul trucks going to/from the Area 1 Shops for routine maintenance.
- Disabled haul trucks transported with a truck retriever.
- Tracked mine equipment transported on a trailer.
- Truck traffic to haul tailings to the mine for stockpile liner construction.
- Fuel tanker traffic.

Emissions would consist of dust generated from the road surface. Toxic air pollutant emissions are not expected from the Dunka Road because it would be constructed of non-reactive waste rock or other similarly inert materials with minimal available trace metal content.

PROCESS PLANT

The Process Plant would include several different types of emission sources which can be divided into four main categories 1) Crushing, 2) Milling and Floatation, 3) Hydrometallurgical Plant and 4) Tailings Basin. The specific types of sources in each area are described below along with the basis for the emission calculations.

Crushing

The crushing operation would utilize the existing Cliffs Erie crushing plant. This would include primary crushing, secondary crushing, tertiary crushing and quaternary crushing operations as well as the associated screening, conveying, and ore storage equipment. Emissions would consist of ore dust which will contain metals in the same proportions as those found in the ore. Metals of interest from an air emission standpoint include: antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, phosphorus selenium, barium, boron, copper, molybdenum, vanadium, zinc, hafnium and tellurium.

The current process design calls for the use of only the equipment listed in Table 23-1 above. However, to maintain future operational flexibility, all or a portion of the remaining crushing equipment in the Cliffs Erie permit may be permitted as part of this project. The emissions rates below are based on two different operating levels: 1) operation of the full Cliffs Erie crushing plant at its maximum capacity, 2) operation of the proposed equipment at the projected mining capacity of 32,000 tpd.

Milling and Floatation

PolyMet intends to utilize 14 of the existing mill lines in the concentrator building. An additional 20 mill lines are currently present in the concentrator building. Milling operations of this type are not emission sources because a wet process is utilized.

The floatation process would have minimal emissions due to the reagents utilized. Fugitive dust emissions will be generated from handling materials in powder form. Volatile organic compounds (VOC) emissions would occur from the storage and use of organic compounds in a liquid or aqueous solution form.

Hydrometallurgical Process

The primary emissions sources in the hydrometallurgical plant are the autoclaves, the process tanks, and the electrowinning cells. These sources would be controlled by wet scrubbers. All of the sources that comprise the hydrometallurgical process are described in detail below.

There are three autoclaves in the hydrometallurgical process and each autoclave is vented, as is the associated flash vessel. The autoclave emissions are mostly carbon dioxide. Emissions from flash vessels include particulate matter, tracemetals from the ore, VOC, sulfuric acid mist, hydrogen fluoride (HF), hydrogen chloride (HCl), and hydrogen sulfide (H_2S). A cooling tower would be operated to cool the plant heating water. The only emissions are expected to be particulate matter entrained in the water droplets emitted by the tower.

The two iron reduction tanks would emit sulfur dioxide and sulfuric acid mist. The releach autoclave is expected to emit primarily steam and air. The pollutants emitted from the releach autoclave flash vessel would be the same as that described for the autoclaves flash vessels above. The three neutralization vents would emit carbon dioxide and sulfuric acid mist.

The copper electrowinning cells would emit sulfuric acid mist along with particulate matter and the tracemetals found in the ore. Only metal compounds soluble in an aqueous solution are expected to be emitted by this process.

The iron and aluminum removal process consists of a preheat tank, five iron removal tanks and two aluminum removal tanks. Sulfuric acid mist would be emitted from all of the tanks. Carbon dioxide would also be emitted from iron removal tanks T1, T2, T3, and T4 as well as the two aluminum removal tanks due to the addition of limestone.

The copper removal process includes a preheat tank, a deaeration tank and three copper removal tanks. All of these tanks would emit sulfuric acid mist. The copper removal tanks would also emit H_2S due to the addition of sodium hydrosulfide (NaHS).

The first and second stage hydroxide precipitation tanks would emit sulfuric acid mist. The precipitated hydroxide product would generate emissions from material handling, storage and bagging. These emissions would include particulate matter and the metals present in the ore, only in different proportions. This product would contain high quantities of nickel and cobalt, which are the desired products, as well as zinc.

Acid flocculent is used in the hydrometallurgical plant thickeners. It is shipped on site in solid form and prepared in a vendor-supplied package mixing plant including a storage silo, mix tank, storage tank and dosing pumps. Particulate emissions would occur when solid flocculent is added to the storage silo and when it is transferred to the mixing tank. After the mixing tank it would be in an aqueous solution and emissions would not occur. The silo would have a dedicated vent; the mixer emissions would be vented into the building and exhausted through general ventilation.

Sodium hydrosulfide is used in platinum group metals precipitation and copper removal. This chemical decomposes to H_2S. It would be shipped on site as a solid and mixed in a mix tank before being transferred to the storage tank. H_2S emissions would occur at the mix tanks, the storage tank, and when it added to the copper removal process as described above. The other point where sodium hydrosulfide is added to the process, the pipe reactor for precipitation of platinum group metals, is an enclosed system.

Guar gum is used in the copper electrowinning process. Solid guar gum would be mixed in a mix tank and then transferred to the storage tank. Minor amounts of fugitive emission would occur from addition to the mixer.

Hydrochloric acid would be added in the autoclave as a source of chloride. Emissions are expected from storage tank loading as well as from the tank vent and from the autoclave as described above. Sulfuric acid is also used in the process; emissions from tank loading and from the storage tank are also expected in addition to the process emissions described above.

Shellsol A100 would be used as a diluent for the copper extractant. It is a petroleum naphtha product that contains cumene and xylene (mixed isomers) in addition to trimethyl benzene (all isomers). Xylenes and cumene are HAPs. Working and breathing losses are expected from the 7900 gallon storage tank as well as fugitive emissions from the copper extraction process.

Cobalt sulfate would be used in the electrowinning process. Solid cobalt sulfate would be mixed with water and on-site in a combined mixing/storage tank. Small amounts of fugitive particulate emissions would result from adding the solid to the tank. The particulate emissions would contain cobalt.

Magnesium (MgO) oxide would be delivered to the plant via bulk tanker trucks or rail cars. The powdered MgO would be transferred to the storage silo via an enclosed pneumatic system, so the only emissions from loading would occur at the silo vent. Emissions into the building would also occur when MgO is transferred to the mix tank.

Lime would also be delivered in bulk trucks or railroad cars and would be transferred to the silo via an enclosed pneumatic system. Emissions would only occur at the silo vent.

Lime would be transferred from the silo to the lime mill via an enclosed conveyor, which would be vented. Milling would be conducted with a wet process, so particulate emissions would not occur downstream of the conveyor.

Crushed limestone would be delivered in bulk transport and unloaded into a storage bunker. A front end loader would transfer the limestone to a conveyor which would transport it to the limestone mill. Fugitive particulate emission would occur from unloading at the bunker, transfer to the conveyor, and where the limestone is added to the mill. Again, the milling process is wet, so emissions would not occur downstream of the conveyor, since the limestone would be in slurry form. The limestone contains a maximum of 2% crystalline silica which would be contained in the particulate emissions. In the hydrometallurgical process, the solids are separated via thickeners and filters, so crystalline silica is not expected to be emitted.

Steam would be required for autoclave preheating, slurry heating, and for the cathode washing unit in the copper stripping area. There are two existing 55 MMBtu/hr boilers (EU 001 and EU 002) at the site which would be used to meet all or some of these steam demands. Steam for building heating would be provided by the heat exchanger downstream of the scrubbers on the autoclave and flash vessel exhausts. The existing boilers can burn natural gas and No. 2 fuel oil, but PolyMet would only operate them on natural gas. The low projected utilization level of the boilers would mean that any cost savings from operating on interruptible natural gas service would not offset the additional issues related to fuel oil combustion. A small boiler may be installed in the plant to provide steam for the smaller demands. However, the emission calculations assume operation of the existing boilers at full capacity, which would generate far greater emissions than the actual steam demand regardless of whether the existing boilers or a new boiler are utilized to meet the demand.

Tailings Basin

Fugitive emissions would occur at the Tailings Basin from two processes: light truck traffic on unpaved roads and wind erosion from the portion of the Tailings Basin above the water level, not vegetated, and not treated with chemical dust suppressant. The emissions from the Tailings Basin would contain the same metals as the ore, but in different proportions.

Fuel Tanks

Diesel fuel and gasoline tanks for refueling company vehicles may be located at the Process Plant. Minimal VOC emissions would be generated by this activity and they have not been quantified at this point.

Area 1 Shops

Mine vehicle maintenance would be conducted in the Area 1 Shops. If PolyMet decides to contract with another company to operate the mine, the maintenance arrangements may be different. The activities at the shops would not generate appreciable air emissions. Activities that would potentially generate large amounts of emissions, such as spray painting, would not be done in these shops.

Small natural gas fired heaters provide space heat in the Area 1 Shops. Hot water heaters may also be utilized to produce hot water for personal use. These activities are considered insignificant per Minnesota Rules, so no appreciable emissions are expected.

PROPOSED POLLUTION CONTROL EQUIPMENT AND PRACTICES

As part of the air permitting process, the applicability of the federal prevention of significant deterioration program (40 CFR 52.21) and Title 2 Section 112 of the Clean Air Act (regulating hazardous air pollutants), will be determined. Any portions of the facility subject to these regulations would be required to add controls in compliance with these regulations. Control equipment may be required to model compliance with the National Ambient Air Quality Standards.

The sections below describe the proposed control equipment and control practices. It should be pointed out the determination on how the project will be permitted will effect the types of control practices used.

MINE

The major emission source at the Mine Site is the haul roads. Particulate emissions would be controlled through roadway watering except during freezing conditions where this could create safety hazards. During freezing weather, emissions would be controlled by the use of chemical dust suppressants, application of snow on the road surface, application of new road material, the scarifying of the road service or other measures. The final control efficiency will be confirmed with MPCA. The PolyMet mine would not be a taconite mine, but road construction practices would be similar as will the effectiveness of various dust control strategies.

DUNKA ROAD

The only source of emissions would be the dust generated from traffic on the road. The control practices utilized for the mine roads would also be used on the Dunka Road. The Dunka Road would be generally closed to personal vehicle traffic, which would minimize traffic levels and help reduce dust generation. Most of the mine workers would be bused from the processing plant to the mine. Additional control measures may be required to meet ambient air quality standards along the road, where a buffer is not present. This may include the application of chemical dust suppressants. The need for additional control measures would be evaluated during the PM_{10} modeling to be completed as part of the air quality permit application.

CRUSHING

At this point, it has been assumed that the existing control equipment would be utilized for the crushing operation. The control equipment for the entire Cliffs Erie crushing plant is discussed in this section, although PolyMet may only utilize the equipment listed in Table 23-1. Changes to the control equipment may be required to meet BACT and/or MACT requirements. At this stage in the process, the only toxic air contaminants would be metals that make up a portion of the rock dust that would be emitted. Therefore, the control efficiency for the toxic compounds would be the same as that for particulate matter. This is true of all of the sources in the crushing portion of the processing plant. Existing controls range between 97% to 99% control efficiency.

When LTV Steel Mining Company was operating, a major replacement program of emission control system ductwork and control devices in the tertiary and quaternary crusher area was underway. As part of the reactivation of the facility, PolyMet plans to complete this program.

MILLING AND FLOATATION

VOC emissions would occur from the storage and use of the frother solution which contains isopropyl alcohol and methyl isobutyl carbinol (MIBC). Total VOC emissions from all of these activities are less than 0.5 tpy, so no control equipment is being considered at this time.

The sodium isopropyl xanthate (SIPX) mixing and storage tanks would be kept under a slight negative pressure to collect any offgas which would be routed to a dedicated pollution control device to control carbon disulfide emissions along with any other sulfur compounds produced from the decomposition of the SIPX. The final design of the control device may be dictated by the need to address impacts from the carbon disulfide emissions or to comply with MACT requirements if applicable.

Minor amounts of particulate emission would be generated by the addition of flocculent and dextrin to their respective mix tanks. Any emissions generated would be inside the building and whatever does not settle out would be exhausted via the general building exhaust. No add-on control equipment is specified for these activities. However, the dextrin mix tank would be enclosed and it would be equipped with an enclosed bag splitter to minimize emissions.

HYDROMETTALURGICAL PLANT

Each autoclave and flash vessel would have a dedicated scrubber to remove the majority of the entrained particulate matter and acid gasses. The scrubber is expected to be of venturi type with raw water as the scrubbing liquor. The exhaust stream would contain a large amount of steam at this point. The combined gas from the autoclave scrubbers would be routed to a heat exchanger used to produce hot water. The hot water would be used for building heating in the winter months. Any hot water not needed for heating would be cooled in the cooling tower. A large amount of steam would be condensed in the heat exchanger. Additional particulate matter and acid gasses would be removed with the condensate. The remaining gasses would be routed to the main scrubber which would be of venturi design also with water as the scrubbing liquid. Other scrubbing liquors may be considered, such as an alkaline solution, if additional removal of acid gasses or mercury is required to meet BACT or MACT requirements.

The iron reduction tanks would be covered and kept under negative pressure with emissions controlled by the main scrubber. The efficiency of the venturi scrubber would be at least 90% for sulfur dioxide and 99% for sulfuric acid mist. If scrubbing liquids other than water are utilized, the control efficiencies should be higher.

The releach autoclave and the associated flash vessel would share control equipment with the other autoclaves. The emissions would be routed to one of the autoclave scrubbers with a damper in place to allow the venting to an alternate scrubber if one system is down for maintenance. The exhaust gas would then go to the heat exchanger and main scrubber. The pollutants and the control efficiencies would be the same as for the other autoclaves.

Control equipment has not been specified at this time for the cooling towers. Methods of reducing liquid water droplet drift may be implemented as a result of the BACT determination.

Emissions from the copper electrowinning process would consist of droplets of the electrolyte which become airborne. This solution would contain sulfuric acid and dissolved particulate compounds, including metals. Each electrowinning cell would be covered with emissions routed to one of four wet scrubbers.

The iron and aluminum removal tanks emit sulfuric acid mist with some also emitting carbon dioxide (greenhouse gas). The preheat tank, the five iron removal tanks and the two aluminum removal tanks would all be covered and kept under negative pressure. The collected offgas would be routed to the main scrubber.

The three copper removal tanks would emit sulfuric acid mist and H_2S. The associated preheat tank and deaeration tank would emit only sulfuric acid. The tanks would all be covered and kept under negative pressure. Emissions will be controlled by the main scrubber.

Particulate emissions would be generated by the handling and bagging of the hydroxide product. This product also contains large amounts of nickel, cobalt, and zinc along with other metals. Emissions would be controlled with the use of fabric filters or equivalent controls.

Particulate emissions from the vendor-supplied acid flocculent storage silo would be controlled with a fabric filter. The fugitive emissions from transferring the powdered flocculent to the mix tank would be emitted into the building with any emissions not settling out going out through building ventilation. These emissions would not be controlled.

The sodium hydrosulfide mixing tank and storage tank would be sealed and kept under negative pressure. An enclosed bag splitter would be installed above the mixing tank to minimize particulate emissions from the addition of solid sodium hydrosulfide to the mix tank. The offgas would be routed to a wet scrubber with water as the scrubbing liquor.

Fugitive emissions would be emitted into the room from transferring bulk containers of guar gum and cobalt sulfide to the mix tanks. Any particulate matter that does not settle out into the building would be emitted through the building ventilation. No control equipment is planned for these sources.

Small quantities of pollutants would be emitted from the diluent tank, the sulfuric acid tanks, and the hydrochloric acid tank. Emissions from the tanks are less than 1 tpy, so the installation of pollution control equipment is not planned. Fugitive emission of the diluent would also occur in the copper extraction area. Potential emissions are estimated as 2.6 tpy of VOC. Due to the relatively small quantity of emissions and fugitive nature which would make effective control difficult, these emissions would not be controlled.

The magnesium oxide storage silo would be controlled with a fabric filter. At least 99% control would be achieved. A small amount of fugitive emissions into the building may occur when magnesium oxide is transferred to the mixing tank. These emissions would go out the general building ventilation and add-on control equipment would not be utilized. However, a screw feeder would be used to transfer the magnesium oxide to the enclosed mix tank, which would minimize emissions.

The lime silo would also have a fabric filter to control emissions with 99% removal efficiency. The enclosed conveyor used to transport the lime to the mill would be vented to another fabric filter with the same collection efficiency. Collected lime dust would be added to the mill. Emissions would not be generated from the lime milling operation because this is a wet process.

The limestone storage and handling equipment would not have pollution control equipment. Much of the emissions would be fugitive in nature and emissions are not expected to be significant because the limestone would be in the form of crushed rock, not a pulverized mineral. Emissions would not be generated from limestone milling because this would be a wet process.

Fugitive emissions would be generated from the filling of the liquid SO_2 tanks. The tank would be pressurized and sealed during normal operation and appropriate steps would be taken to minimize emissions to the atmosphere during loading both to minimize emissions and to ensure worker safety. Any SO_2 spilled into the containment area would be pumped to the process areas where it is normally used.

The boilers would not have pollution control equipment, but emission would be minimized by only burning natural gas. Restrictions on operating hours or fuel combusted may also be accepted to keep emissions below the PSD significant level. If a new small boiler is installed it would also be only natural gas fired and relatively small in size, so emissions would not be significant. If a new boiler is installed with a capacity greater than 10 MMBtu/hr, it would be subject to a MACT limit for CO, but the limit would be met through good combustion practice as opposed to add-on control equipment.

TAILINGS BASIN

Dust emissions from the unpaved roads in the Tailings Basin would be controlled in the same manner as the mine haul roads. A 60% control efficiency has been assumed as a conservative first estimate. The final control efficiency would be confirmed with MPCA. Emissions from the Tailings Basin would not be directly controlled, but the design would seek to minimize the area above the water line. Portions of the basin that are inactive for extended periods of time would be seeded or covered with mulch. Areas that are inactive for shorter amounts of time would be sprayed with dust suppressant. Dusting would be minimal during the freezing months because recently applied tailings would freeze and become covered with snow while inactive areas would be covered in snow.

Fugitive dust emissions from the reactive residue cells would be minimized through the design of the cells. Water levels would be maintained above the residue and residue would be discharged below the water level.

AREA 1 SHOPS

As described above, emissions from the Area 1 Shops would be insignificant. Pollution control equipment would neither be necessary or practical for this portion of the project.

AIR EMISSION LEVELS

Tables 23-2 and 23-3 present the emission levels for various potions of the project as well as the entire project including the processing plant, the Dunka Road and the mine. Fugitive emissions for this type of facility are not included in the determination of PSD applicability. However, fugitive emissions would have to be included in any determination of ambient air impacts, so emissions totals are given for point sources (Table 23-2) and point source plus fugitive emissions (Table 23-3).

Emission levels are presented for criteria as well as toxic air pollutants. The list of toxic pollutants includes any HAPs that would be emitted plus any additional compounds that would be evaluated in the air emissions risk analysis (AERA) based on the initial review of process reagents and emissions.

DISCUSSION OF PROJECT IMPACTS ON AIR QUALITY

Several lines of investigation are open for evaluating the significance of the impact from air emissions on human health and the environment from the proposed project. First, as part of this Scoping Environmental Assessment Worksheet, the proposer has completed an Air Emissions Risk Analysis (AERA) which investigates the impact from "air toxics." Under the AERA process, a proposer estimates the concentrations of pollutants emitted by the project and compares those concentrations to a list of pollutant-specific health benchmarks established by the Minnesota Department of Health. This provides regulators a tool to estimate the overall impact from a very long list of pollutants. Based on this evaluation, the impacts associated with air emissions, that are reasonably expected to occur from this project, do not have the potential for significant environmental or health effects. Because many assumptions were necessary to complete the AERA at this stage of the project, the AERA will be re-evaluated during the Environmental Impact Statement to verify that the original work was valid.

Second, the air emissions permitting and EIS will require that the proposer address the National Ambient Air Quality Standards (NAAQS) for the "criteria" pollutants. The criteria pollutants are: carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), particulate matter (PM_{10}), particulate matter ($PM_{2.5}$), and sulfur dioxide (SO_2). The NAAQS are set at levels that are intended to be protective of human health (including sensitive groups) and the environment. As such, compliance with the NAAQS is a good indicator of insignificant impact of a project on the environment. Third, the proposer will also have to address the impact of air emissions on visibility and acid deposition in pristine areas.

CLASS I AREAS

There are four Class I areas that are potentially impacted by this project: Boundary Waters Canoe Area Wilderness (approximately 20 miles north), Voyageurs National Park (approximately 50 miles northwest), Isle Royal National Park (approximately 130 miles east-northeast), and Rainbow Lake Wilderness (approximately 90 miles south).

The specific requirements for the Class I area impact analysis will be negotiated with MPCA and the Federal Land Managers as part of the Air Quality Permitting process. This will be done in compliance with applicable federal regulation.

CRITERIA POLLUTANT EMISSIONS (CLASS II AREAS)

PM_{10} would be the primary criteria pollutant of concern for this project. There are several unresolved issues at this point relating to criteria pollutant dispersion modeling, so the evaluation of air quality impacts for this pollutant will be deferred until the air quality permit application and/or the EIS. The project will be required to model compliance with the ambient air quality standards at the ambient boundary.

SUMMARY

Emissions from criteria pollutants, with the exception of PM_{10}, are not a significant issue for this project. SO_2, NO_x, CO, lead, and VOC do not require additional review. Other PSD pollutants that do not require further evaluation include: fluorides, H_2S, and total reduced sulfur compounds.

Class I area impacts are expected to be minimal, but the scope of any impact analysis will have to be negotiated with the Federal Land Managers (FLMs) for the nearby Class I areas. At a minimum, a Class I area increment analysis at the Boundary Waters for PM_{10} emissions is likely to be required. The results of the analysis agreed upon with the FLMs will be discussed in the air quality permit application and/or the EIS.

Further analysis of the impact on ambient air quality standards as well as the Class II increment due to PM_{10} emissions will be included in the air quality permit application. A demonstration that impacts are acceptable will be included in the application and possibly the EIS. A BACT analysis for PM_{10} is also expected to be required. This will be included with the permit application. Changes to the proposed pollution control equipment may be discussed in the EIS.

A BACT analysis may also be necessary for sulfuric acid mist emissions. This will be included with the air quality permit application if required. Impacts from sulfuric acid mist emissions will be evaluated in the AERA and also the Class I area impact analysis if required by the FLMs. Changes to the proposed pollution control equipment may be discussed in the EIS.

A case by case MACT determination may also be required for some of the sources. Any required analysis will be included with the air quality permit application. If changes to the proposed pollution control equipment are required, this may be discussed in the EIS.

To assist the MPCA in commenting on the scope of the Northmet Project Scoping EAW, the MPCA requested that an Air Emissions Risk Analysis (AERA) be prepared for the project. An AERA was submitted to the MPCA by the project proposer. The MPCA hired consultant: reviewed the AERA, dispersion modeling and emissions; assessed whether all parts were completed in accordance with MPCA guidance; identified gaps, recommended areas where additional refinement of the information or impact analysis related to air emissions should happen during the EIS; and presented their findings to the MPCA project manager. The MPCA project manager drafted an agency recommendation that went to the MPCA Risk Managers who then finalized and signed the recommendation.

Proposed Treatment of Topic in EIS
The EIS will include descriptions of air emissions sources, potential control technologies and any impacts to Class I and Class II areas.

A BACT analysis will by completed for PM_{10} and sulfuric acid mist. A MACT applicability analysis will be completed. A case by case MACT determination may be required for some sources. Other sources may have to comply with a MACT standard for their source category if one has been promulgated.

The EIS will verify the results of the previously completed Air Emission Risk Analysis (AERA). This verification will include the following analysis:

> Conduct source-specific air dispersion modeling of those units that could influence the final risk estimates, specifically focusing on the risk drivers from the AERA (crusher/grinding operations and Hydromet plant; nickel and nickel compounds, hydrogen chloride, NO2, manganese) and/or conduct a quantitative sensitivity analysis of the critical sources using the new design parameters (location, height, exit velocity, emission database) to determine if the overall risks calculated in this AERA are still conservative estimates.

The EIS will also contain a Class I and Class II increment analysis for air emissions from the project

24. Odors, noise and dust. Will the project generate odors, noise or dust during construction or during operation?_x_Yes __No

If yes, describe sources, characteristics, duration, quantities or intensity and any proposed measures to mitigate adverse impacts. Also identify locations of nearby sensitive receptors and estimate impacts on them. Discuss potential impacts on human health or quality of life. (Note: fugitive dust generated by operations may be discussed at item 23 instead of here.)

Odors

Odors are not expected from the mine, with the possible exception of diesel exhaust odors. The potential impacts of vehicle emissions are treated in response to Question 23.

Mineral flotation tailings such as would be deposited in the tailings basins are reported to be essentially odor-free. The smaller containment cells at the tailings basin would contain other PolyMet process residues, but these are not expected to produce odors.

The ore processing facility is another potential source of odor. Odors at the plant, however, are not expected to be a problem. The chemical processes involved in the PolyMet operation do not have the potential for significant odor generation. The flotation reagents used in the process have a slight odor, but the flotation process is conducted within a closed facility. Despite the presence of sulfates in the ore that would be processed, the PolyMet process does not generate significant amounts of gasses that smell of sulfur or sulfide. The air scrubbers that would be in place are expected to eliminate any offensive odors from the stack emissions.

(Other potential impacts of the air emissions from the ore processing facility are discussed in response to Question 23.)

Dust

Fugitive dust emissions from ongoing operations, including ongoing construction of stockpiles, are inventoried and discussed in response to Question 23.

Dust production is expected during initial clearing and stripping of the mine if weather is dry. Because of the large numbers of wetlands and high surficial water table, soils are expected to be wet during much of initial mine development (overburden stripping). Construction of mine facilities, including roads, loading pocket, railroad spur and local building(s) would generate dust typical of large construction projects. Similarly, the construction of the railroad extension and new building construction at the ore processing facility may also result in dust production for a several months. The nearest residential receptor for dust impacts would be at a distance of approximately five miles. It appears highly unlikely that construction-related dust impacts would be significant

Dust generation from the tailings basin is discussed in response to Question 23. The potential for dust lift off caused by dry, windy conditions would be managed under a Fugitive Dust Control Plan that would include minimizing unvegetated beach and dike area, application of temporary seeding to areas that would be inactive for a substantial time, application of mulch to areas that would be inactive for short terms, and application of dust suppressants to problem areas.

Noise

Noise impacts from the NorthMet site would be expected to be similar to impacts experienced from the existing Peter Mitchell Mine which is located approximately one mile north of the proposed mine and from ongoing logging activities in the National Forest.

A typical mine truck to be used at the project would be the Cat 793C. The Caterpillar Company supplied noise levels using the ISO6393 test specifications. According to Caterpillar, the static level of a standard version 793C OHT is 121 dB. A model of the 793 equipped with extra noise suppression (793C XQ) produces 110 dB (static) or 115 dB dynamic (ISO6395 spec) 112 dB uphill - fully loaded and 117 dB downhill - fully loaded. While these are very loud, the noise level at the nearest receptor (the Boy Scout camp at a distance of greater than 5 miles) would be expected to be below the nighttime state noise standard of not exceeding 50 dB fifty percent of the time (L_{50}).

In addition to violation of noise standards, an additional concern is simple audibility. A person can hear and discern sounds at much lower levels than the noise standards. In general, people do not expect an environment completely lacking in human-produced sounds. However, an exception to this is wilderness areas, where visitors expect to have only natural sounds. Whether a noise is audible depends on the acuity of the listener, the sound level and tonal structure of the noise of interest and the sound level and tonal quality of other background sound that may tend to mask the noise. Predicting the limits of audibility is therefore, a complex issue.

Railroad horns should not be a significant source of noise to local residents. Although all of PolyMet's ore would be delivered by 10 to 20 trains per day, there is only one, private, at-grade crossing on the rail line between the Mine Site and the Processing Facility. It is on the existing rail line and has been used in other mining operations. This line was used for more frequent trips with greater tonnage hauled during operations of LTV Steel Mining Company. Under the proposed project this crossing would see less traffic of lesser tonnage than it previously experienced.

Truck Noise

Ongoing and persistent noise is of most concern. Of particular interest, therefore, is the noise coming from trucks and excavators, which would be operating nearly continuously during the years the mine is in service.

The NorthMet mine is not likely to carry into the Boundary Waters Canoe Area (BWCA), the nearest portion of which is located approximately 20 miles to the northeast. Prevailing winds are from the northwest, so that areas to the northeast of the Mine Site are acoustically sheltered.

During winter, it is predicted that noise from 170-ton trucks would not be detectable at distances greater than 22 miles. During summer, truck noise is expected to be inaudible at a distance of 19 miles. Even in winter, therefore, noise from mine activities would be expected to be very infrequently audible in the BWCA, and then only in the BWCA's southwestern most fringe. Mitigation of this potential impact could be achieved by increasing the size and effectiveness of mufflers on the haul trucks. Additional mitigation for nearby receptors, if required, could be accomplished by placing a barrier between the truck and the potential receptor.

Preliminary modeling of noise emissions from the mine was done by PolyMet to confirm the general findings of the Regional Copper-Nickel Study.

Preliminary simulations, conducted by PolyMet, with these assumptions indicated that the operation would be inaudible at the nearest edges of the BWCA. With such conservative assumptions, it is likely that the actual attenuation effects would be greater than assumed, reducing noise levels further. Preliminary calculations indicated that the L_{50} levels allowed by Minnesota law would not be exceeded outside of 2,500 meters (1.55 miles) from the site. Residences in the area are well outside this radius from the Mine Site.

Consideration of the Boy Scout camp was also made in the preliminary model. Sound reaching the Boy Scout camp would have traveled over 5 miles. The model used includes airborne and ground attenuation, giving an overall level of approximately 18 dB at the Boy Scout camp. This level may be audible on a calm, quiet night.

The mine area's nearest permanent noise receptors, in this case private residences in the City of Babbitt, are approximately six miles away. The above information indicates that mine truck noise at this location is likely to be well within the limits of Minnesota noise standards and less than 18 dB. The City of Babbitt is located on the other side of the Giant's Ridge formation and would be topographically shielded from noise. Any noise from the NorthMet site likely would blend into the existing background community noise and be lower than levels from the NorthShore mine, which is located between the Mine Site and Babbitt.

Other residences near the Mine Site, in Hoyt Lakes and Skibo, are farther from the Mine Site than the Boy Scout camp. Additionally, they are crosswind of prevailing winds from the Mine Site, giving some added attenuation to the noise level received. Using the simulation, which does not take into account their crosswind location, Hoyt Lakes and Skibo would experience levels of approximately 12 and 16 dB, respectively. This noise is well within the limits of Minnesota law.

Blasting Impacts

As described in Section 6, blasting would be required to mine the ore. Much of the area has previously experienced blasting during the operation of the Cliffs Erie (operating as Erie Mining Company and LTV Steel Mining Company) and NorthShore Mining Company taconite mining operations. Blasts at PolyMet are expected to be significantly smaller than those at taconite mines so, in general, blast disturbances are expected to be smaller than those that have occurred previously at mines. In addition, most of the taconite mines in the area are significantly closer to homes and businesses than the proposed PolyMet mine; therefore the smaller impacts would be dissipated over a greater distance before reaching a receptor. Therefore, impacts are predicted to be significantly smaller than those previously experienced at communities in the area.

Blasting safety (i.e., impacts to employees within the mining area) is regulated by the Mine Safety and Health Administration of the U.S. Department of Labor. Safety procedures would include strict restrictions on site access, closure of access roads and gates where the public or other mine workers might attempt to enter the site and evacuation of personnel and equipment to safe areas well before blasting. Supervisors in radio-equipped vehicles would monitor the site and its immediate access. Train movements and any nearby logging operations would be coordinated and temporarily halted as required to maintain safe clearance.

The environmental impacts of blasting at non-ferrous mining operations are regulated by the Minnesota Department of Natural Resources (MDNR) under Minnesota Rules Section 6132.2900 to ensure that effects of air overpressure and ground vibrations from production blasts will not be injurious to human health or welfare and property outside mining areas.

Five categories of potential impacts of blasting in surface mines are ground vibration, air blast, flyrock, dust, and fumes. Minnesota has a ground vibration limit of 1.0 inches/second with no specified frequencies. The distance (approximately 6 miles) from the PolyMet site to the nearest home makes vibration damage extremely unlikely. A seismic monitoring program is required by law and is considered standard practice in major mining operations. PolyMet proposes to implement a seismic monitoring program for this project. Minnesota rules required monitoring at a location adjacent to the nearest structure located on lands not owned or controlled by the mining company and where the MDNR considers necessary to investigate complaints.

Air blast is the shockwave propagated through the atmosphere. Minnesota regulations limit air blast to 130 dB. Glass breakage is the first sign of excessive air blast and generally occurs at 140 dB or above. Minnesota Rules require that the operator must monitor all open pit blasts. As with ground vibration, the air blast monitoring station is required to be located adjacent to the nearest structure located on lands not owned or controlled by the mining company. Air blast can be affected by wind direction as well. In unusual conditions air blast can be deflected and focused by atmospheric conditions, including temperature inversions. Erie Mining Company/LTV Steel Mining Company conducted an air blast monitoring program. The practice was to explode a small test shot to check atmospheric conditions for air blast; PolyMet proposes to implement a similar air blast monitoring program.

Flyrock is rock that is blown loose from the free face of the rock and travels beyond the area intended for blasting. Both air blast and flyrock can be minimized by proper blasting planning, including drill hole placement, sequencing velocity, face orientation, and monitoring of explosive weight. Air blast can be affected by wind direction as well. In unusual conditions air blast can be deflected and focused by atmospheric conditions, including temperature inversions. Erie Mining Company/LTV Steel Mining Company conducted an air blast monitoring program. The practice was to explode a small test shot to check atmospheric conditions for air blast; PolyMet proposes to implement a similar air blast monitoring program.

Dust and gases are usually not a major problem outside the immediate blasting area. As with air blast, wind direction is important. When necessary, dust and gas production can be reduced by wetting the area to be blasted. Excessive fumes can be avoided by good explosive design and usage. It is typical of the large blasts used at taconite operations that explosives must sometimes sit in the ground a long time because of the large sizes of the patterns, long drilling times, and waiting for favorable weather, etc. This is not likely to be as significant at PolyMet where blast sizes would be smaller.

Proposed Treatment of Topic in EIS:

This topic is minor, but will be discussed with limited information beyond that in the EAW. The EIS will include additional information on potential sources and verify simulations and assertions. Operational and structural mitigation to prevent potential impacts will be discussed.

25. Nearby resources. Are any of the following resources on or in proximity to the site?

Archaeological, historical or architectural resources? _x_Yes __No
Prime or unique farmlands or land within an agricultural preserve?
__Yes _x_No
Designated parks, recreation areas or trails? __Yes _x_No
Scenic views and vistas? __Yes _x_No
Other unique resources? __Yes _x_No

If yes, describe the resource and identify any project-related impacts on the resource. Describe any measures to minimize or avoid adverse impacts.

HISTORICAL AND ARCHEOLOGICAL RESOURCES

PolyMet hired cultural resource specialists from the 106 Group to conduct background research and visit the project site in August and September 2004. Based on this information the 106 Group developed a report that was used to address this EAW Question.

Archeological Resources
In 1999, a cultural resources survey was conducted within the proposed Mine Site by Foth & Van Dyke prior to exploration drilling in the location of the proposed mine pit. During this survey, archaeologists excavated 166 shovel tests along proposed drill hole transects in Sections 2, 3, and 10, T59N, R13W. No archaeological resources were identified in this area (Foth & Van Dyke 1999). This survey included only the proposed pit area and did not include the stockpile, Plant Site or Tailings Basin areas.

In 2004 the archaeological assessment by the 106 Group included background research, a visual reconnaissance, and assessment of archaeological potentials within the project area, including the Mine Site, Plant Site, Rail Construction Area and Tailings Basin.

The assessment concluded that there is low potential for the presence of archeological resources in the processing facility, Tailings Basin, and proposed Railroad Construction Area. The Plant Site has been heavily disturbed by the previous construction and operations of the taconite processing facility and is considered to have little to no potential for containing intact archaeological resources.

The 106 Group concluded that portions of the Mine Site have low potential, while other areas have unknown potential for containing archaeological resources, because so little survey work has been completed in this region of the state.

Historical Resources
In 2004 the 106 Group conducted a preliminary architectural history assessment that included background research, a visual reconnaissance of the project area, particularly the mill complex and associated tailings basins, waste rock stockpiles, and railroads.

The processing facility, tailings basins, and proposed railroad spur incorporate buildings, structures, and objects of the former Erie Mining Company processing facility. This assessment-level investigation shows that this property has the *potential* to be historically significant and eligible for listing on the National Register of Historic Places. Further study and evaluation at the Phase II level would be necessary to confirm this. The Erie Mining Company Railroad is the only architectural resource within the proposed mining area, and the potential historic significance of this resource would be evaluated within the context of the Erie Mining Company processing facility.

In subsequent discussions with the staff of the Minnesota Historical Society and the U.S. Army Corps of Engineers, it was proposed that the following steps would be undertaken to satisfy the requirements of the National Historic Preservation Act:

- The conceptual design of the southeast stockpile area has been modified to avoid the apparent location of site 21SLmn (01-314 [Knot Camp]) and provide a 200-foot buffer from the site as shown on 1937 and 1939 air photographs. A Phase I investigation will be completed during the preparation of the Draft Environmental Impact Statement to locate the boundaries of the site and ensure that through avoidance the project will avoid either direct or indirect impacts to the site.

- As part of the preparation of the Draft Environmental Impact Statement, a Phase I reconnaissance level survey will be conducted on the portions of the proposed Mine Site not previously evaluated by Foth and Van Dyke to assess those areas identified by the 106 Group as having "unknown" potential for containing archeological resources. Such areas were defined as the undisturbed portions of the study area:
    - within 500 ft. (150 m) of an existing or former water source of 40 acres (19 hectares) or greater in extent, or within 500 ft. (150 m) of a former or existing perennial stream;
    - located on topographically prominent landscape features;
    - located within 300 ft. (100 m) of a previously reported site; or
    - located within 300 ft. (100 m) of a former or existing historic structure or feature (such as a building foundation or cellar depression).

  Areas defined as having a relatively low potential for containing intact archaeological resources included inundated areas, former or existing wetland areas, poorly drained areas, and areas with a 20 percent or greater slope. Low potential areas and areas in which Holocene (less than 10,000 years old) deposits have been significantly disturbed are defined as having little or no potential for containing intact archaeological resources.

- As part of the Environmental Impact Statement, the direct and indirect effects of the proposed project on the Cliffs Erie plant site (former Erie Mining Company Plant site) will be defined. This step will include collection of additional background data on the plant and evaluation of the possible strategies for mitigation of these effects. These strategies could include data recovery and inclusion of historical considerations and review in the project design process.

OTHER NEARBY RESOURCES

The soils on site do not include prime or unique farmlands and no such lands are believed to exist in the vicinity of the project.

A hiking trail is identified on national forest maps in Section 17, T58N, R12W between Big Lake and Stone Lake. Campsites and a Boy Scout Camp are identified adjacent to Big Lake and Stone Lake. The nearest of these resources would be approximately 5 miles from the mine site.

Proposed Treatment of Topic in EIS:

The topic is minor, but will be discussed with limited information beyond that in the EAW. The EIS will verify the location of Knot Camp to avoid disturbance. The historical significance of the Cliff's Erie plant site will be evaluated and mitigation proposed if warranted. The EIS will also provide additional information on areas of "unknown" potential for containing archeological resources. Any resources identified will be discussed and mitigation to prevent impacts will be proposed.

26. Visual impacts. Will the project create adverse visual impacts during construction or operation? Such as glare from intense lights, lights visible in wilderness areas and large visible plumes from cooling towers or exhaust stacks? __Yes _X_No

If yes, explain.

Mine Site
Mining will continue on a 24-hour per day basis; site lighting will include both fixed lighting and vehicle lighting. Hauling to the top of stockpiles may cause vehicle lighting to be visible in the surrounding landscape. For purposes of this discussion, stockpiles were assumed to be as high as 320 feet above the local terrain so lights could be visible for a significant distance. The actual height of stockpiles will likely be less as this estimate of height was using previous information that indicated a higher striping ratio and larger volume of waste rock than more current estimates (see EAW Question 20).

The terrain rises sharply to the north so receptors to the north, including those in the BWCA will be unlikely to see the stockpiles or vehicle lights on top of these piles. The nearest receptors for visual impacts would be homes and campsites south of the site at a distance of about 5 miles. Assuming the mine stockpiles were 320 feet high, and including the effect of the earth's curvature, the top of the stockpile would about 0.7 degrees above the horizon, equivalent to an object one foot high at a distance of 100 feet. In the wooded terrain, most persons would not be able to see the stockpiles unless they were on a high hill or were otherwise elevated above the surrounding trees and brush.

This is comparable to previous visual impacts experienced from stockpiles adjacent to existing pits, including the Peter Mitchell Pit directly north of the site, the Erie pits to the northwest of the site and the Dunka Pit to the northeast of the site. The impacts from this project would be less because the mine is located on lower terrain, rather than the height of land of the Mesabi Range and the site is more isolated from nearby residences than those pits. Since the Boundary Waters Canoe Area Wilderness is at least 20 miles away, and since other mines are closer to the Boundary Waters than the proposed mine, no significant visual impacts are predicted from mining facilities.

Plant Site
No significant changes are anticipated to the existing large buildings at the plant site. The proposed autoclave building will be smaller and lower than the surrounding buildings formerly used for the concentrator and pellet plant. Therefore, no off-site visual impacts are predicted.

Tailings Basin
The tailings basin is potentially visible to rural residences on County Road 358, about one mile north of the tailings basin. The continued use of the tailings basin will widen the silhouette of the low mound on the southern horizon. This is not anticipated to be a significant visual impact.

Proposed Treatment of Topic in EIS:
The EIS will not contain any additional information beyond what is included in the EAW.

27. Compatibility with plans and land use regulations. Is the project subject to an adopted local comprehensive plan, land use plan or regulation, or other applicable land use, water, or resource management plan of a local, regional, state or federal agency?
_X_Yes __No.

If yes, describe the plan, discuss its compatibility with the project and explain how any conflicts will be resolved. If no, explain.

St. Louis County has a comprehensive land use plan that was adopted in January 1996. The land use plan sets general goals for the County. The majority of the project area (with the exception of a small portion of the Tailings Basin, see below) is outside of the area regulated by the St. Louis County comprehensive land use plan.

The project's mining area and some transportation corridors are within the jurisdiction of the City of Babbitt. The project's processing facilities, and portions of the transportation corridors are within the jurisdiction of the City of Hoyt Lakes. The tailings basin is primarily within the jurisdiction of the City of Hoyt Lakes, although the northernmost portion of the Tailings Basin is within Waasa Township.

According to Jim Lasi of City of Babbitt, the City has adopted a comprehensive plan and both 1) the mining activities, and 2) transportation (along the existing road and railroad corridors) of ore from the Mine Site to the Plant Site, are consistent with the comprehensive plan.

According to Richard Bradford of the City of Hoyt Lakes, the City has not developed a comprehensive plan, and as a result, the operation of the processing facility and use of the Tailings Basin is not subject to an adopted comprehensive plan. Similarly, the use of Dunka Road and the railroad for transportation of ore and other mining-related activities is not subject to an adopted comprehensive plan.

The St. Louis County comprehensive land use plan includes Waasa Township. The portion of the Waasa area in which the Tailings Basin is located is zoned for industrial use. As such, the use of this area for the Tailings Basin is compatible with the land use plan.

Proposed Treatment of Topic in EIS:

The topic is minor, but the EIS will include limited information beyond that in the EAW. The EIS will evaluate mineland reclamation strategies to develop those designs that are most compatible with surrounding land uses and local community goals.

28. Impact on infrastructure and public services. Will new or expanded utilities, roads, other infrastructure or public services be required to serve the project? __X__ Yes __ No. If yes, describe the new or additional infrastructure or services needed. (Note: any infrastructure that is a connected action with respect to the project must be assessed in the EAW; see *EAW Guidelines* for details.)

In general, the project makes use of existing infrastructure at the Plant Site and Tailings Basin. Electrical, gas, and water supply infrastructure is already in place and modifications and upgrades are not anticipated. Access to the Plant Site is available via existing local railroads, roads and highways.

Transportation of vehicles between the Plant Site and the Mine Site would take place via the existing (private) Dunka Road. Mining personnel would commute to and from the Plant Site and home area in their own vehicles using existing local roads and highways.

The ore would be transported from the Mine Site to the Plant Site along an existing railroad corridor. Only a relatively small railroad connection (see Figure 5-1) would need to be constructed for this project; this would be a private project on private property. Potential impacts of that railroad construction are addressed elsewhere in this EAW.

As acknowledged in the responses to Questions 17 and 18, options for the management and treatment of discharges from the Plant Site and Mine Site include pumping to the Hoyt Lakes and/or Babbitt POTWs. Both facilities have some available capacity to treat additional wastewater. If PolyMet were to pursue wastewater treatment at either facility and depending on the discharge flow rate, expansion of the capacity of a POTW may be necessary. Detailed plans regarding wastewater management and treatment for the Plan Site and Mine Site will be provided in the NPDES permit application and will be available for use in the EIS. If these plans call for discharge to a POTW, the POTW will be consulted as part of EIS preparation and prior to completion of the NPDES permit application so that details regarding required pretreatment and flow limitations (or required POTW expansion) can be resolved and described in the EIS and permit application.

Operations at the Mine Site would require electrical power. This would likely require the placement of an electrical substation at the Mine Site and the location of a short transmission line to the substation. Minnesota Power was recently requested to provide a conceptual plan for such an installation. When the conceptual plan is available, it will be evaluated for potential impacts. The results of this evaluation and any potential mitigations or alternatives will be included in the EIS.

Treatment of Topic in EIS:
The EIS will include an evaluation of wastewater treatment alternatives that propose to

use existing Hoyt Lakes or Babbitt POTW's. If any of these alternatives are deemed suitable for further evaluation, the EIS will include details about existing plant capacity and discuss options for increasing capacity and meeting NPDES permit conditions.

The EIS will also include additional detail on the electrical line and substation associated with the mine site. Potential impacts will be identified as well as mitigation of alternatives to prevent or minimize impacts.

29. Cumulative impacts. Minnesota Rule part 4410.1700, subpart 7, item B requires that the RGU consider the "cumulative potential effects of related or anticipated future projects" when determining the need for an environmental impact statement. Identify any past, present or reasonably foreseeable future projects that may interact with the project described in this EAW in such a way as to cause cumulative impacts. Describe the nature of the cumulative impacts and summarize any other available information relevant to determining whether there is potential for significant environmental effects due to cumulative impacts *(or discuss each cumulative impact under appropriate item(s) elsewhere on this form).*

CUMULATIVE IMPACTS

Cumulative impacts analysis addresses the combined effects of the proposed project and the effects of past, present and reasonably foreseeable future actions. These effects are analyzed by evaluating whether the affected resource, ecosystem or human community has the capacity to accommodate additional effects. These include both direct and indirect effects on a given resource, ecosystem and human community and include actions by private and governmental bodies. Cumulative impacts may occur when similar impacts accumulate or when diverse impacts have a synergistic effect. Cumulative impacts should be analyzed over the entire life of the potential project impact and not just the life of the project. Finally, cumulative impacts analysis should focus on truly meaningful effects.

The affected resource of interest for cumulative effects analysis is important in determining the geographic and temporal boundaries of the analysis. This in turn helps identify the past, present and reasonably foreseeable actions that will also be included in the analysis. For example, cumulative effects related to water quality would be limited to the watershed of interest and would not consider the effect of a nearby action in a different watershed.

INVENTORY OF POTENTIAL CUMULATIVE EFFECTS

The first step in a cumulative impacts analysis is the identification of potential cumulative effects associated with the proposed project. Review of previous responses in this scoping EAW and general consideration of other proposed actions in the Arrowhead Region resulted in the following tabulation of potential actions having potential cumulative effects:

- Air quality and visibility impairment related to mining and industrial emissions from multiple sources
- Ecosystem acidification related to industrial plant emissions from multiple sources
- Ecological (and human) health impairment resulting from the bioaccumulation of mercury as related to industrial plant emissions from multiple sources
- Wetland loss related to mine construction activities
- Water flow changes related to wetland losses caused by construction activities at multiple mines and by water appropriation/discharges at multiple industrial facilities
- Water quality impairments related to wetland losses caused by construction activities at multiple mines and by industrial plant and mine discharges from multiple sources
- Wildlife habitat loss or fragmentation (and potential effects on threatened or endangered wildlife) related to mine construction activities
- Threatened or endangered plant species loss related to mine construction activities
- Employment and economic output related to construction and operation of multiple industrial facilities
- Tax revenue changes related to construction and operation of multiple industrial facilities
- Social structure changes related to construction and operation of multiple industrial facilities

INVENTORY OF POTENTIALLY AFFECTED RESOURCES

To avoid vagueness, cumulative impacts should be analyzed in terms of the specific resource, ecosystem and human community being affected. In addition, the cumulative impacts analysis should focus on those impacts that are significant enough to be meaningful. The following is a general inventory of resources that could be potentially affected by the PolyMet project and the extent of those resources beyond the zone of direct impact:

- Air quality in Class II areas adjacent to the Cliffs Erie site and in federally administered Class I areas (e.g., BWCAW, Voyageurs National Park)
- Deposition of sulfates, nitrates, and mercury to low buffering capacity aquatic and terrestrial ecosystems in federally administered Class I areas (e.g., BWCAW, Voyageurs National Park)
- Water quality and flow in the upper Partridge River, upper Embarrass River and in Colby Lake, Second Creek, Sabin Lake, Wynne Lake
- Wetlands in the vicinity of the mine and in its related watershed - Partridge River Watershed
- Wildlife habitat at the mine site and greater surrounding area
- Populations of state and federal listed threatened, endangered and special concern plant species at the mine site and the related populations throughout

Minnesota
- Aquatic biota and fish in Partridge River and Embarrass river watersheds as a portion of the Lake Superior basin
- Economy and tax base of Babbitt, Hoyt Lakes, Aurora and in the local region
- Community structure and well being of Babbitt, Hoyt Lakes, Aurora and the local region

Note that the "project impact zone" and the "extent of the resource beyond zone of direct impact" can be different for each resource. For instance, the project's impact on a plant species is most likely limited to the immediate vicinity where direct or indirect impacts are great enough to cause a loss of individual plants. The extent of the plant species beyond that area would include all areas where the species is found in Minnesota. On the other hand, the project impact zone for particulate emissions to the air would likely be larger than the immediate project area, although the extent of the resource beyond the project impact area might be defined as northeastern Minnesota. Impacts in Federal protected areas (e.g. the BWCA) must meet more stringent standards and thresholds than elsewhere in the region. Because the project is located in the Lake Superior Basin, more stringent water quality standards, particularly for mercury, apply through the GLI.

It should be noted that noise impacts are of local significance and are not easily treated as cumulative impacts. According to Brian Timerson, MPCA (personal communication, 2005) cumulative impacts for noise are extremely unlikely. Because of the logarithmic nature of noise measurements, a doubling of sound energy (i.e., a second equal source) only produces about a 3 dB increase in sound levels. Therefore, for a cumulative impact to occur and cause an exceedance of noise standards, there would have to be two sources, both producing sound at levels just below the standard at the receptor of interest. In practice, noise sources are usually so different that one predominates and the other is insignificant. Therefore, given the distance separating the proposed projects at the Cliffs Erie Site, it is unlikely for potential noise impacts to be cumulative and noise is not considered further in this section of the EAW.

"OTHER ACTIONS" THAT MAY AFFECT RESOURCES

To the extent that a resource may be impacted by PolyMet, it must also be determined whether other actions or projects will affect that resource. These "other actions" include both governmental actions and private actions (which may also have governmental approvals). The following is a list of past, present and reasonably foreseeable actions that may have impacts on the resources listed above:

Governmental Actions

- City of Babbitt wastewater treatment discharges to the Embarrass River
- City of Hoyt Lakes wastewater treatment discharges to the Partridge River
- Logging of the Superior National Forest lands.
- Logging of state and county lands in the Arrowhead Region

- Implementation of taconite MACT standards by facilities in the Arrowhead Region
- Implementation of Electric Utility MACT Standards for coal-fired power plants in Minnesota
- Implementation of the Regional Haze Rules to reduce emissions of SO2, NOx, and fine particles in Minnesota, adjoining states, and states found to contribute significantly to visibility impairment in the Class I areas in Minnesota.
- Implementation of the Best Available Retrofit Technology (BART) rule to be proposed in April 2005 to reduce emissions of SO2, NOx, and fine particles in Minnesota, adjoining states, and states found to contribute significantly to visibility impairment in the Class I areas in Minnesota.
- Implementation of Minnesota's Regional Mercury TMDL in the Partridge and Embarrass Rivers

Future governmental actions are generally included in agency plans and budgets and can be predicted with some certainty.

Private Actions

- LTV Steel Mining Company (LTVSMC) closure in the Embarrass and Partridge River Watersheds
- Erie Mining Company establishment in the 1950's and development of the City of Hoyt Lakes in the Partridge River watershed
- Northshore Mining Company mine site crusher operations in the Partridge River watershed and Arrowhead Region airshed
- Other taconite plant operations (with proposed modifications, if appropriate) located in other watersheds but in the Arrowhead Region airshed
- Operation of Whitewater Reservoir in the Partridge River watershed
- Minnesota Power Syl Laskin Energy Center operations in the Partridge River watershed and the Arrowhead Region airshed
- Minnesota Power Taconite Harbor power station operations in the Arrowhead Region airshed
- Minnesota Power Hibbard power station operations in the Arrowhead Region airshed
- Logging on private lands (Minnesota Power land -former LTVSMC property, Cliffs Erie land, other private land) in the Partridge River Watershed
- Proposed Cliffs Erie Railroad Pellet Transfer Facility construction and operation in the lower Partridge River watershed and the Arrowhead Region airshed
- Proposed Mesabi Nugget construction and operation in the lower Partridge River watershed and in the Arrowhead Region airshed
- Proposed Mesaba Energy power generation station construction and operation in the Arrowhead Region airshed and Partridge River watershed (if located at the Cliffs Erie site)

- Other speculative non-ferrous mines in the Partridge River watershed and Arrowhead Region airshed
- Proposed Minnesota Steel Industries, LLC (MSI) DRI/steel plant construction near Nashwauk, MN, and operation in the Arrowhead Region airshed
- Shutdown of LTVSMC furnaces in the Arrowhead Region airshed

Private actions are more prevalent in the project area. Past private actions include the operation of Northshore Mining Company's crusher at the Peter Mitchell mine and its processing plant at Silver Bay and Minnesota Power Company's operation of three power generation stations: Syl Laskin, Hibbard and Taconite Harbor. With regard to air emissions, major regional sources, including taconite processing plants and power plants, were considered for inclusion in the cumulative effects evaluation. Other past and present private actions were also considered for cumulative impacts to other potentially affected resources.

Future private actions are less certain; projects may be studied for feasibility and then abandoned. A number of projects have been officially brought to the notice of the State of Minnesota and, in some cases, of the Federal government.

> Mesabi Nugget Company, LLC, is currently actively pursuing permits for construction of the iron conversion project at the Cliffs Erie site; it will be located in an old mine pit near the PolyMet Plant Site.
>
> Cliffs Erie is currently planning the construction and operation of a taconite pellet railroad load- out facility near the PolyMet Plant Site.
>
> Excelsior Energy Inc. of Minnetonka, MN, has been selected by the Department of Energy to receive $36 million for the development of a 531-megawatt Mesaba Energy Project in northern Minnesota. The project will produce more than 1,000 local construction jobs over three years and at least 150 permanent jobs when commercial operations commence. Depending on the location of the project, this proposed future action may be relevant to several cumulative impact issues. One location under consideration is near Hoyt Lakes but the final location for this facility remains unresolved. Because this proposed project has not advanced to the feasibility stage, it was not considered further for inclusion in the cumulative impacts analysis. If this project (Mesaba Energy) advances, MN Rules will require environmental review of the impacts related to Mesaba Energy.
>
> Permitting has commenced on the opening of a two new mines at the Ispat Inland taconite facility near Virginia with mine dewatering discharged to a tributary to the Embarrass River.
>
> Additional non-ferrous mining ventures have been discussed in the general vicinity of the PolyMet project. These include the Teck Cominco and Birch Lake projects. Except for ore sample collection, neither project has commenced detailed planning activities for full-scale operations. They remain speculative at

this time. Teck Cominco notified state officials in 2004 that active efforts to develop its project have been tabled indefinitely. Because neither proposed project has advanced to the feasibility stage, they were not considered further for inclusion in the cumulative impacts analysis. If either project advances, MN Rules will require the future preparation of a mandatory EIS for each project. Cumulative impacts related to these projects will be addressed at that time.

Minnesota Steel Industries, LLC (MSI) has proposed to reactivate the former Butler Taconite mine and tailings basin near Nashwauk, and construct a new crusher, concentrator, pellet plant, direct reduction plant, and steel mill consisting of two electric arc furnaces, two ladle furnaces, two thin slab casters, and hot strip rolling mill to produce sheet steel. This project will be located in the Mississippi River watershed.

SUMMARY OF CUMULATIVE IMPACT ISSUES TO BE ADDRESSED

Twelve cumulative impact issues will be addressed in the EIS. Each of these issues is discussed below. Each discussion provides background on the issue, a description of the approach to evaluate the issue, and a description of the data needs to perform the analysis.

1. Hoyt Lakes Area Projects and Air Concentrations in Class II Areas

Background
There are currently three projects that have submitted permit applications or environmental review information to state agencies for their planned operations at the former LTVSMC (now Cliffs Erie) operations near Hoyt Lakes, Minnesota.: PolyMet, Mesabi Nugget, Cliffs Erie Pellet Handling. For environmental review purposes, the major area of concern with the close proximity of these three projects is on air quality outside of the LTVSMC ambient air boundary where people actually live and wildlife habitat is present. Given the close proximity of these three projects there is the potential for cumulative effects on air quality outside of the Cliffs Erie site boundary. The potential cumulative impact of these three projects on ambient air quality outside of the Cliffs Erie site is recognized as an issue for the environmental review process and an analysis of the cumulative impacts of the three proposed projects will be completed for the EIS.

Approach to Evaluation
An air dispersion modeling study will be performed. Background information on the study will be provided:

- Description of the air dispersion modeling protocol (including relevant assumptions). If the number of stacks becomes cumbersome from a modeling standing point, professional judgment will be used to consolidate stacks or emissions as appropriate given available modeling guidance from regulatory agencies.

    - Summary of estimated emissions of SO2, NOx, and PM10 by emission unit (if available) for each of the three projects proposed for the Cliffs Erie site (including relevant assumptions). Emission estimates will be provided by project proponents. If necessary, an emission scenario will be developed for projects lacking the necessary modeling details.
    - Description of the air dispersion model; a regulatory approved model will be used for the analysis (either ISCST3 or ISC PRIME).
    - Description of the receptor grid; the receptor grid will be established outside of the Cliffs Erie site boundary, from the site boundary out to 10 kilometers. Receptors will be placed on the Cliffs Erie site boundary with a 100 meter spacing. Receptors will have a 100 meter spacing from the site boundary out to 2 kilometers. Receptors will have a grid spacing of 1 kilometer starting at 2 kilometers from the Cliffs Erie site boundary out to 10 kilometers.
    - Description of meteorological input data; 1972-1976 Hibbing data will be used for the analysis.
- Modeling results will be tabulated and summarized and compared to the national and state ambient air quality standards (NAAQS/MAAQS)
    - Background air concentrations will be added to the modeled air concentrations. By including background air concentrations in the analysis it is assumed that past and present actions will be reflected in these background air concentrations. Depending on the availability of data, this assumption may need to be revisited upon actually conducting the study.
- Timeframe: the proposed facilities are assumed to be constructed and at full operations by 2008
- Report preparation and submittal to the MPCA and EIS contractor so that results can be evaluated and included in the EIS.
    - Model input/output files made available to the MPCA.

The impact analysis will be completed based on the results of the modeling study. Background information (see above) and final modeling results will be summarized in a report to be submitted to the MPCA and the EIS contractor. Description of air emissions control technologies is expected to be a significant section of the report. Uncertainties in the modeling study will be identified and discussed. The modeling and results will be verified by the MPCA (this may be delegated to the EIS contractor). Results of the cumulative analysis will be incorporated into the EIS by the contractor with guidance from the MPCA.

Data Needs for Analysis of Cumulative Impacts

- Emission estimates of SO2, NOx, and PM10 by emission unit (if available) from each of the projects proposed to be located at the Cliffs Erie site: to be provided by project proponents
- Stack parameters and locations for units emitting SO2, NOx, and PM10; to be provided by project proponents
- Descriptions of relevant pollution control technologies proposed for each

project; to be provided by project proponents
- Data for emission reductions related to shut down of LTV furnaces; to be provided by MPCA
- Modeling receptor grid outside of the Cliffs Erie site boundary
- Hibbing meteorological data (1972-1976)
- Modeling guidance from regulatory agencies for multi-facility air modeling projects
- Ambient air monitoring data for SO2, NOx, and PM10 from the nearest appropriate site.

2. Class I Areas PM10 Increment

Background
PolyMet is expected to trigger Prevention of Significant Deterioration (PSD) permitting for PM10 emissions only. Therefore, it is expected that PolyMet will be required to evaluate its potential impact on PM10 increment in the Class I areas. For Class I areas, the Federal Land Manager (FLM) guidance for assessing a project's potential impact on the PM10 increment requires that emissions of PM10, SO2, NOx, and primary sulfate be included in the analysis. The FLM guidance requires that the secondary pollutants ammonium sulfate and ammonium nitrate, which are formed from the primary emissions of SO2 and NOx, be counted as particulate and added to the air concentrations estimated for PM10. Therefore, due to the FLM procedures for assessing PM10 increment impacts, PolyMet will also include its SO2 and NOx emissions in the modeling evaluation.

This analysis will incorporate PM10 emissions speciation data (coarse particulate, fine particulate, etc), as well as SO2, NOx, and primary sulfate emissions for the project, and use the CALPUFF modeling system per FLM guidance to estimate ambient air concentrations in Class I areas within 250 kilometers of the project site. Specific details of the increment modeling for Class I areas will be resolved with the FLMs. Results will be summarized in a Class I areas report to be submitted to the FLMs (with state agencies receiving a copy as well) as part of the PSD permitting.

Recent Class I evaluations (e.g., Mesabi Nugget and Northshore Mining Company) have identified exceedances of the 24-hour PM10 Significant Impact Level (SIL)[1] in the BWCAW. The FLMs have expressed concerns about exceedances of the SIL. Given the results of these previous modeling studies and the close proximity of the project site to the BWCAW, PolyMet will provide an assessment in the EIS of potential impacts from multiple facilities with regard to PM10 in Class I areas. This assessment will include an evaluation of the potential emission reductions from in-state and out-of-state sources that are likely to result from implementation of the Regional Haze Rule and the Best Available Retrofit Technology (BART) rule and the potential decrease in air pollutant concentrations in Minnesota's Class I.

Approach to Evaluation
A semi-quantitative assessment of Class I Areas PM10 Increment will be performed.

Background information on Class I Areas PM10 Increment in Minnesota will be summarized:

- Summary of long-range regional transport issues for PM2.5 (fine aerosol), sulfate, and nitrate
- Summary of the IMPROVE monitoring network data for particulates (including ammonium nitrate, ammonium sulfate, coarse particulate, and elemental carbon and organic carbon for the period of record for the Voyageurs National Park site and the BWCAW site
- Summary of the PM10 air concentrations available from any nearby state monitoring sites
- Summary of air modeling studies conducted to date and the available results, with particular emphasis on major source contributions of fine particulate from in-state sources and out-of-state sources (national studies, CENSARA, other state efforts)
- Summary of current and foreseeable future federal regulatory controls to PM2.5, PM10, sulfates, nitrates: implementation of the Taconite MACT standard (PM10 as a surrogate for metals); Regional Haze Rule; NOx SIP call (40 CFR parts 51, 72, 75, 96; Clean Air Interstate Rule; EPA proposed rule (Federal Register, Vol. 70, No. 35) for NOx in Class I Areas); EPA "to-be" proposed rule for Best Available Retrofit Technology, BART (April 2005)
- Summary of current and foreseeable future state regulatory controls and/or actions (State acid rain rule and statewide SO2 emissions cap; Title IV of the 1990 Clean Air Act Amendments, affected MN sources
- Timeframe: Emissions projections (increases, decreases) from the proposed facilities, as well as from existing facilities subject to the various regulatory requirements, will be through the year 2020.

Estimates of current PM10, SO2, and NOx emissions from sources in Minnesota will be summarized based on the most current emission inventory available. Emissions will be reported for major geographic areas in the state (Twin Cities, Iron Range, etc.). The trend of state-wide emissions will be assessed using existing historical emission inventory data. This analysis will cover the period of record for such data. Background monitoring data (PM 2.5) for Voyageurs National Park and Ely (Fernberg Road) will also be summarized as will PM10 monitoring data from nearby sites.

Cumulative impacts will be based on projections of the potential increases or reductions in SO2, NOx, PM10 emissions from current Minnesota sources.. Emission estimates from the following reasonably foreseeable actions will be included in the analysis:

- Existing Taconite Plants w/Proposed Modifications
- Proposed Mesabi Nugget Plant
- Proposed Cliffs Erie Railroad Pellet Transfer Facility
- Proposed MSI DRI/Steel Plant
- Implementation of Taconite MACT Standards
- Shutdown of LTVSMC Taconite Furnaces
- Implementation of the Regional Haze Rule and BART rule (to be proposed)

The assessment will summarize the potential implications for PM10 increment in the BWCAW. Results will be summarized in a report to be submitted to the MPCA and the EIS contractor. Description of air emissions control technologies is expected to be a significant section of the report. The results will be verified by the MPCA (this may be delegated to the EIS contractor). Results of the cumulative analysis will be incorporated into the EIS by the contractor with guidance from the MPCA.

Data Needs for Analysis of Potential Cumulative Impacts

- Monitoring data from the IMPROVE Network for Voyageurs National Park and the BWCAW
- Air modeling studies (national, CENSARA, other state efforts)
- PM10, SO2, and NOx emission inventory data (total facility) from the MPCA
- PM10 monitoring data for existing nearby sites
- Estimated potential emission increases from reasonably foreseeable actions

Notes:
[1] The exceedance of a SIL, by itself, does not indicate that adverse impacts will be associated with a project's emissions. The SILs were established by U.S. EPA as a threshold for decision-making with regard to potential cumulative impacts from one or more projects. A SIL is set at 4 percent of the Class I area increment. U.S. EPA's working assumption is that as long as no individual source contribution exceeds 4 percent of a Class I increment, it is unlikely that the accumulation of sources over time will exceed that increment. In other words, if all new/modified sources model impacts below the respective SILs, there is reasonable assurance that cumulative potential impacts from all new/modified sources would not exceed the available increment. The need for a cumulative analysis with regard to increment consumption is made on a case-by-case basis, taking into account numerous factors, including the level of air emissions controls for the project sources (this information provided in the project's BACT report), significance of the exceedance of a SIL, economic feasibility to install additional air emission controls, and magnitude of emissions from the project as compared to emissions from existing sources.

3. Ecosystem Acidification Resulting From Deposition of Air Pollutants

Background
Acid deposition is a long-range pollution transport problem caused by local, regional, national and international emissions of nitrogen oxides and sulfur dioxide. Acid deposition, has two parts: wet and dry. Wet deposition refers to acidic rain, fog, and snow. Dry deposition refers to acidic gases and particles; approximately 50 percent of acid deposition is due to dry deposition. Prevailing winds blow the compounds that cause both wet and dry acid deposition across state and national borders, and sometimes over hundreds of miles. The strength of the combined effects of wet and dry deposition depend on many factors, including how acidic the water is (pH and hydrogen ion, H+), and the chemistry and buffering capacity of the aquatic and terrestrial ecosystems, including watershed vegetation and soils.

Minnesota has been a leader in the assessment of acid deposition impacts and regulation of pollutants contributing to ecosystem acidification. Acid deposition is currently regulated under Minnesota Rules through an acid deposition standard of 11 kilograms per hectare per year and a statewide SO2 emissions cap (Mn. Rules Chapter 7021) and federal rules (Title IV of the 1990 Clean Air Act Amendments and 40 CFR Parts 72 and 75). These regulations generally apply only to large electrical generating units (EGUs).

Acid deposition is an ongoing concern for states with low buffering capacity ecosystems. Most (90%+) of the acid deposition in Minnesota is due to out-of-state sources. Minnesota has low-buffering capacity lakes (typically seepage lakes with no inlets or outlets). Minnesota's terrestrial ecosystems (soils, vegetation, etc.) have been found to be less sensitive to acid deposition than the aquatic ecosystems. Seepage and headwater lakes are found within 10 kilometers of the Cliffs Erie site. Therefore, an assessment of potential cumulative effects should be provided in PolyMet's EIS for aquatic ecosystems.

PolyMet's projected emissions of pollutants from the processing plant that contribute to acid deposition are relatively low (3.6 tons per year (tons/yr) of SO2, 12.42 tons/yr of sulfuric acid mist/SO3, and 78 tons/yr of NOx; see Question 18 in this EAW). In spite of these low emissions, the (FLMs) may request that PolyMet conduct an assessment of its estimated project emissions for potential sulfur and nitrogen deposition for Class I areas within 250 kilometers of the project. If such an analysis is performed, the Class I modeling results will then be included in the acid deposition cumulative impact discussion.

Approach to Evaluation

A semi-quantitative assessment of cumulative acid deposition in Minnesota will be performed. Background information on acid deposition in Minnesota will be summarized:

- Summary of the long range pollutant transport issue (National Acid Precipitation Assessment Program; NAPAP)
- Summary of Minnesota's assessments of ecosystem buffering capacity (1980 – 2000)
- Summary of Minnesota's air modeling studies of source contributions (1986)
- Summary of Minnesota regulatory controls to protect sensitive ecosystems
- Summary of current and foreseeable future federal regulatory controls
- Timeframe: Emissions projections (increases, decreases) from the proposed facilities, as well as from existing facilities subject to the various regulatory requirements, will be through the year 2020.

Trend analysis will be conducted for SO2 and NOx statewide emissions (using existing state wide emission inventory data) and for deposition monitoring data at three sites in northern Minnesota. These analyses will cover the period of record for such data and will include comparisons to the state wide emission cap and the deposition standard (11 kilograms/hectare/year) which were established to protect Minnesota's aquatic terrestrial ecosystems.

The potential cumulative impacts will be based on projections of the potential increases or decreases in sulfate and nitrate deposition to Minnesota ecosystems from reasonably foreseeable actions:

- Existing Taconite Plants w/Proposed Modifications
- Existing Power Plants
- Proposed Mesabi Nugget Plant
- Proposed MSI DRI/Steel Plant
- Implementation of the Clean Air Interstate Rule.
- Implementation of the Regional Haze Rule and BART rule (to be proposed)
- Shutdown of LTVSMC Taconite Furnaces

The results of the cumulative impacts assessment will be compared to the Minnesota annual acid deposition standard which was promulgated to protect sensitive ecosystems. The assessment will summarize the potential implications for Minnesota ecosystems.

Results will be summarized in a report to be submitted to the MPCA and the EIS contractor. Description of air emissions control technologies is expected to be a significant section of the report. The results will be verified by the MPCA (this may be delegated to the EIS contractor). Results of the cumulative analysis will be incorporated into the EIS by the contractor with guidance from the MPCA.

Data Needs for Analysis of Cumulative Impacts

- Existing studies assessing Minnesota's ecosystem buffering capacity
- Existing air modeling results that identify Minnesota source and/or out-of-state contributions to deposition in Minnesota
- State air emission inventory data for SO2 and NOx emissions; 1975 to 2005
- Deposition monitoring data from the National Atmospheric Deposition Program (NADP) for Voyageurs National Park, Fernberg Road (Ely), and Wolf Ridge (Finland).

4. Mercury Deposition and Bioaccumulation in Fish

Background

Mercury emissions, deposition, and bioaccumulation in fish tissue have been the focus of researchers, state and federal regulators, and the public for more than a decade. Mercury is a long-range transport pollutant. In most areas of Minnesota, up to 90% of the mercury entering a lake or river comes from a wide variety of natural and man-made pollution sources located throughout North America and the rest of the world; 10% or less of the mercury falling on Minnesota's water is estimated to be from Minnesota sources. Conversely, most of the mercury from Minnesota's air emission sources tends to be transported outside the state. Water discharges of mercury account for less than 1% of the mercury which reaches Minnesota waters. In addition, microbial activity within aquatic and terrestrial ecosystems affects the amount of methylmercury that is available for uptake by biota. Therefore, there is not a direct relationship between 1) Minnesota mercury air releases, 2) the amount of mercury entering Minnesota lakes, and 3) concentration of mercury (as methylmercury) in fish.

Air emissions of mercury in Minnesota have been regulated by the Voluntary Mercury Reduction Initiative (Minnesota Statutes, section 116.915). In 1999, the legislature allowed Minnesota businesses, in cooperation with the MPCA, to voluntarily reduce mercury emissions from a 1990 baseline by 70% by 2005. According to the MPCA's 2002 progress report to Legislature on the Mercury Reduction Program (January 2002) and the emissions data provided in the preliminary mercury TMDL (http://www.pca.state.mn.us/water/tmdl/tmdl-mercuryplan.html#statewideplan), that has been accomplished due largely to reduction in purposeful uses of mercury in consumer products (e.g. latex paints, fungicides, etc.).

Lake sediment data, deposition monitoring data, and fish tissue data that have been collected in Minnesota since the early 1990s indicates that mercury deposition and subsequently fish tissue concentrations in Minnesota have declined since the 1970s in some areas, but have not declined in others. In order to attain water quality standards, the MPCA has recently proposed to require a 93% reduction in mercury emissions from in-state mercury air emission sources and a similar reduction from outside-of-Minnesota emission sources. The preliminary draft of the mercury TMDL contains information on mercury deposition and mercury in water and fish tissue, as well as state-wide, national and worldwide inventories.

Given Minnesota's emphasis on reducing mercury emissions and fish tissue concentrations, the fact that the proposed PolyMet project will have mercury emissions (albeit <2 lbs/yr), and the presence of numerous lakes in the Hoyt Lakes area, a cumulative analysis for mercury will be provided in PolyMet's EIS.

Approach to Evaluation
A semi-quantitative assessment of cumulative mercury deposition will be performed. Background information on mercury deposition in Minnesota will be summarized:

- Summary of the long range transport issue
- Summary of studies assessing mercury deposition and bioaccumulation in fish tissue in Minnesota's aquatic ecosystems
- Summary of air modeling results for source contributions (national, state efforts).
- Summary of state actions and the state's proposed statewide TMDL (93% reduction in MN emissions)
- Summary of current and foreseeable future federal regulatory controls
- Timeframe: Emissions projections (increases, decreases) from the proposed facilities, as well as from existing facilities subject to the various regulatory requirements, will be through the year 2020.

The assessment of potential impacts will be completed through mercury emission trend analyses using existing state wide emission inventory data and trend analyses of annual wet mercury deposition monitoring data at two sites in northern Minnesota. These analyses will cover the period of record for such data and will include comparisons to natural background.

Cumulative impacts will be based on projections of the potential increases or reductions in mercury emissions from general source categories (e.g., electric utilities, mining, products, etc). Emission estimates from reasonably foreseeable actions will be included in the analysis:

- Existing Taconite Plants w/Proposed Modifications
- Existing Power Plants w/Proposed Modifications
- Proposed Mesabi Nugget Plant
- Proposed MSI DRI/Steel Plant
- Implementation of Taconite MACT Standards
- Shutdown of LTVSMC Taconite Furnaces
- Implementation of the Electric Utility MACT standards
- Implementation of Minnesota's regional Mercury TMDL

Potential emissions of mercury from current and reasonably foreseeable future projects will be subject to the statewide TMDL. The implementation plan for the TMDL will specify the actions necessary to control mercury emissions so as to meet water quality standards.

Results will be summarized in a report to be submitted to the MPCA and the EIS contractor. Description of air emissions control technologies is expected to be a significant section of the report. The results will be verified by the MPCA (this may be delegated to the EIS contractor). Results of the cumulative analysis will be incorporated into the EIS by the contractor with guidance from the MPCA.

Data Needs for Analysis of Cumulative Impacts

- Existing studies assessing mercury deposition and bioaccumulation in fish tissue Minnesota
- Existing air modeling results that identify contributions from Minnesota and/or out-of-state emission sources to mercury deposition in Minnesota
- Available statewide mercury emissions estimates for 1990, 2000, and 2005 from the state.
- Deposition monitoring data from the National Atmospheric Deposition Program (NADP) for the Marcell Experimental Forest (near Grand Rapids) site and the Fernberg Road (Ely) site.

5. Visibility Impairment

Impairment of visibility is caused by very small particles, including solid particles and aerosols. Like acid deposition and mercury deposition, emission of pollutants that cause visibility impairment are generated from natural sources, as well as anthropogenic sources in Minnesota, the United States and throughout the world. Visibility impairment can be caused by direct emissions of SO2 (aerosol), primary SO4 (particulate) and elemental carbon (particulate). However, secondary formation of chemicals (e.g., ammonium sulfate and ammonium nitrate) also contributes significantly to visibility impairment. Visibility is of primary concern in the Class I areas - national parks and wilderness areas.

In addition to the regulations under PSD for Class I areas, US EPA has promulgated regulations aimed to reduce "regional haze". States have joined regional planning organizations or RPOs to develop state budgets for pollutants leading to the formation of fine particles, and to require states to develop state implementation plans (SIPs) by 2008 to reduce emissions to within those budgets. Minnesota is a member of the central states RPO called CENRAP. However, because it borders two other RPOs – the Midwest RPO to the east and the western RPO (WRAP) to the west, inventories of emission sources in Minnesota are included in all three RPOs.

Visibility monitoring is conducted in Minnesota's Class I areas (Voyageurs National Park; Boundary Waters Canoe Area Wilderness, BWCAW) as part of the IMPROVE network.

Given the proximity of the proposed facility to the BWCAW, as well as the close proximity of other known projects to the BWCAW, an assessment of potential cumulative visibility impacts will be included in PolyMet's EIS, taking into account the planned government actions to reduce regional haze and improve visibility in the Class I areas.

Due to the long-range transport of pollutants that affect visibility, the federal regulations intended to improve visibility in the Class I areas will also result in improvements to visibility in Class II areas.

Approach to Evaluation

A semi-quantitative assessment of cumulative visibility impacts will be performed. The assessment will focus on Minnesota's Class I areas. Background information on visibility pollution in Minnesota will be summarized:

- Summary of long range transport issue
- Summary of IMPROVE monitoring network in Voyageurs Nat. Park and Boundary Waters Canoe Area Wilderness
- Summary of air modeling results for source contributions (national, CENSARA, other state efforts).
- Summary of current and foreseeable future federal regulatory controls
- Timeframe: Emissions projections (increases, decreases) from the proposed facilities, as well as from existing facilities subject to the various regulatory requirements, will be through the year 2020.

The assessment of potential impacts will be completed through statewide SO2, NOx, and PM10 emission trend analyses using existing statewide emission inventory data (listing of sources and ton/yr emissions). Trend analysis will provide breakout of emissions by geographic area of the state (Twin Cities, Iron Range, etc.) In addition, a trend analysis of background monitoring data from Voyageurs National Park and Ely (Fernberg Road) will be provided, including plots of light extinction and other pertinent parameters, depending on data availability.

Cumulative impacts will be based on projections on the potential increases in SO2 and NOx emissions in Minnesota from current and reasonably foreseeable actions. Emission estimates (or decreases) from the following past, current and reasonably foreseeable actions will be included in the analysis:

- Existing Taconite Plants w/Proposed Modifications
- Proposed Mesabi Nugget Plant
- Proposed Cliffs Erie Railroad Pellet Transfer Facility
- Proposed MSI DRI/Steel Plant
- Implementation of Taconite MACT Standards
- Shutdown of LTVSMC Taconite Furnaces
- Implementation of the Electric Utility MACT standards
- Emission reductions in other parts of Minnesota (Metropolitan Emission Reduction Project)

Results will be summarized in a report to be submitted to the MPCA and the EIS contractor. Description of air emissions control technologies is expected to be a significant section of the report. The results will be verified by the MPCA (this may be delegated to the EIS contractor). Results of the cumulative analysis will be incorporated into the EIS by the contractor with guidance from the MPCA.

Data Needs for Analysis of Cumulative Impacts

- IMPROVE Network monitoring data for Voyageurs National Park and the BWCAW
- Existing studies assessing cumulative visibility impacts in Minnesota
- Existing air modeling that identifies contributions from Minnesota sources
- State emission inventory data pertaining to SO2, NOx, and PM10

6. Loss Of Threatened And Endangered Plant Species

It is assumed that the development and operation of the Mine Site will result in the taking of several species of special concern and at least one state-listed threatened or endangered species. Therefore, a cumulative impacts analysis will be performed to assess the cumulative loss of those specific species populations.

Approach to Evaluation

A semi-quantitative analysis of cumulative impacts will be performed. Because the Minnesota Department of Natural Resources is charged with administering the program to protect state-listed threatened and endangered species and managing species with the potential to become threatened or endangered within the state of Minnesota, the entire state will be defined as the geographic boundary for analysis. While the range of most of the potentially affected species extends beyond the state boundary, the regulatory program does not, and it would be difficult to determine "truly meaningful effects" within the species natural ranges that extend into other states and Canada. The species that will be addressed in the analysis are listed in Table 29-1.

Table 29-1: Rare species present within or near the PolyMet Mine Site

Common Name	**Scientific Name**	**State Status[1]**	**PolyMet Mine Site Observations**	**Approx. # of Individuals**	**Habitat**
Pale moonwort	*Botrychium pallidum*	E	4 pops .	58	Full to shady exposure, edge of alder thicket, along Dunka Road, and railroad and powerline right-of-way.
Ternate grape-fern	*Botrychium rugulosum (=ternatum)*	T	None identified		Disturbed habitats, fields, open woods, forests
Least grape-fern	*Botrychium simplex*	SC	20 pops .	1,337	Full to shady exposure, edge of alder thicket, forest roads, along Dunka Road, and railroad and power line rights-of-way.
Floating marsh marigold	*Caltha natans*	E	13 pops .	~150	Shallow water in ditches and streams, alder swamps, shallow marsh, beaver ponds, and Partridge River mudflat.
Neat spike-rush	*Eleocharis nitida*	T	11 pops .	~1,450 sf	Full exposure, moist ditches along Dunka Road, wet area between railroad grades, and railroad ditch.

Northern commandra	*Geocaulon lividum*	SC	11 pops .		On *Pleurozium* and *Sphagnum*moss mats under black spruce, open to partly shaded.
Lapland buttercup	*Ranunculus lapponicus*	SC	7 pops .	~825 sf	On and adjacent to *Sphagnum* hummocks in black spruce stands, up to 60 percent shaded with alder also dominant.
Clustered bur-reed (floating marsh marigold)	*Sparganium glomeratum*	SC	13 pops .	>100	Shallow pools and channels up to 1.5 feet deep in *Sphagnum* at edge of black spruce swamp, beaver pond, wet ditches, shallow marsh
Torrey's manna-grass	*Torreyochloa pallida*	SC	8 pops .	~800 sf	In muddy soil along shore and in water within shallow channels, beaver ponds, shallow marshes, along Partridge River.

[1] E - Endangered, T - Threatened, SC - Species of Concern

The life history of each species will be described including what is known about their preferred habitats, the role of disturbance in their life history, range, sensitivity to stresses, and the current level of understanding of the species. This characterization will differentiate between pioneering species and those that are part of mature communities.

Species losses from the following reasonably foreseeable actions will be included in the analysis as forecasted for 27-years consistent with the PolyMet projection of 2-years of construction, 20-years of operation and 5-years of closure:

- Proposed MSI DRI/Steel Plant

- Proposed Ispat Inland Mine Pits
- Proposed Cliffs Erie pellet railroad loading project
- Proposed Mesabi Nugget Project

Losses from other projects with the potential to affect the species of interest will also be included in the analysis if the necessary species population information is available at the time of the analysis and can be provided by MDNR.

The past projects will include projects for which the MDNR has issued takings permits for the species of interest.

Through compilation of known records of each species within the state from the Natural Heritage Information System, a distribution map for each species will be prepared. The data will be compiled to summarize the number of known populations, approximate numbers of plants, and locations. Takings permit information will be analyzed to determine the extent of past losses. The baseline condition will also include a description of how land use conditions affecting the various species have changed over time and how they are likely to change in the future; both with and without the proposed projects.

Impacts related to past, present, and reasonably foreseeable future impacts be evaluated through a semi-quantitative summary of number of populations and individuals of each species that may be affected and the magnitude of those effects based on the knowledge of the species within the state. This evaluation will include determining whether the various species are particularly vulnerable to decline. The "magnitude" of the effects will be evaluated within the context of the state, the affected region, and the MDNR regulatory program.

Alternative configurations of the project will be evaluated to determine if the projected impacts can be minimized.

If it is determined that unavoidable impacts will result to threatened species; plans will be made to mitigate for those impacts. The mitigation for the loss of state-listed threatened, endangered, or special concern species will be developed in consultation with the MDNR Natural Heritage and Nongame Research Program in administration of the state threatened and endangered species permit requirements (Minnesota Rules Chapters 6134 and 6212) pursuant to statutory authority Minnesota Statutes, section 84.0895.

Data Needs for Analysis of Cumulative Impacts

- Natural Heritage Information System records for the potentially affected species
- Takings permit information from throughout the state for the potentially affected species
- Life history information for the potentially affected species
- Specific threatened and endangered species survey information for reasonably foreseeable future projects

- Land cover and habitat characteristics for the proposed project site(s) before the proposed project and the likely land cover and habitats that will be present after the project is complete
- United States Department of Agriculture, Forest Service, Region 9 Sensitive Species List

7. Loss of Wetlands

The development and operation of the Mine Site will result in the loss of wetland resources. Therefore, an analysis will be performed to assess the cumulative loss of those specific wetlands and the past and projected loss of other wetlands in the Partridge River watershed.

Approach to Evaluation
A semi-quantitative analysis of cumulative impacts to wetlands will be performed. Because several of the primary functions performed by wetlands are directly related to watershed processes, the analysis will be performed on a watershed basis. The geographic area of analysis will be the Partridge River watershed. Historical activities within the Partridge River watershed that have affected wetland resources are primarily mining activities and urban development that started on a large scale in the early 1950's. The remainder and majority of the watershed have seen limited disturbance and loss of wetlands. The baseline condition for wetland resources will be established using the following approach.

The National Wetland Inventory data will be used to help establish the baseline wetland condition in the undisturbed areas of the watershed since it is the best data representing the extent of wetland resources in the Partridge River watershed. In the areas of the watershed that have been significantly altered, wetlands will be mapped and classified to the extent feasible using a number of historic data resources layered in a geographic information system including:

- 1930's aerial photographs
- Original U.S. Geological Survey 7.5 minute quadrangle topography maps from the early 1950's, prior to the onset of significant mining activities
- MDNR GIS data that incorporates notes from the original survey of the area and includes detailed wetland vegetation information

The baseline condition will also include a description of how conditions affecting wetlands have changed over time and how they are likely to change in the future; both with and without the proposed projects.

A similar wetland mapping effort may be conducted to establish wetland conditions at an interim point in time, (e.g., 1970) to help track trends in wetland loss.

The next step will be to prepare a mapping of wetland resources as they exist at the present time, before the start of any further projects in the Partridge River watershed.

This wetland mapping will be prepared using information from the National Wetland Inventory mapping and from site-specific wetland surveys that have been conducted within the areas of the Partridge River watershed. This wetland mapping will be compared to the historic wetland (baseline) mapping to quantify the effects of past activities on wetland resources within the analysis area.

Wetland losses from the following reasonably foreseeable actions in the Partridge River watershed will be included in the analysis as forecasted for 27-years, consistent with the PolyMet projection of 2-years of construction, 20-years of operation and 5-years of closure:

- Proposed PolyMet mine
- Portions of the proposed Cliffs Erie pellet railroad loading facility in the Partridge river watershed
- Future expansion of Northshore Mining Company's Peter Mitchell open pit mines

Losses from other proposed projects with the potential to affect wetland resources in the Partridge River watershed will also be included in the analysis if wetland impact information is available at the time of the analysis.

Impacts related to past, present, and reasonably foreseeable future actions will be evaluated through a quantitative summary of the number of acres of various wetland types that may be have been affected in the past and may be affected in the future and the magnitude of those effects within the watershed. Trends that may be discernible from evaluating the data will be evaluated. This evaluation will include determining whether various wetland types are particularly vulnerable to rapid degradation. The "magnitude" of the effects will be evaluated within the context of the overall wetland resources within the watershed.

Alternative configurations of the project will be evaluated to determine if the projected impacts can be minimized. Unavoidable wetland impacts will be mitigated in accordance with the state and federal wetland permitting programs.

Data Needs for Analysis of Cumulative Impacts

- National Wetland Inventory maps for the Partridge River watershed
- 1930's, 1970's and most recent good quality aerial photographs
- Original U.S. Geological Survey 7.5 minute quadrangle topography maps from the early 1950's, prior to the onset of significant mining activities
- MDNR GIS data that incorporates notes from the original survey of the area and includes detailed wetland vegetation information
- Wetland inventories from past and proposed projects within the watershed
- Future mine plans for the Northshore Mining Company mine
- Wetland mitigation plans for the past and reasonably foreseeable future projects

8. Loss or Fragmentation of Wildlife Habitat

Background
Since the state was established (1858), Minnesota's ecosystems have all been affected by both anthropic and natural disturbances. The drastic reduction in native prairie, which has been converted to row-crop agriculture, is a well-known example of anthropic disturbances. Much of the forested areas of the state are still forested and appear to have been less impacted by disturbance in that they remain forested with native species. However, both anthropic activities (e.g., mining, urbanization and logging) and natural disturbances (e.g., fire, windstorms, and insect infestation) have altered the character of the original ecosystems in the Arrowhead Region.

Assessment of the cumulative impacts of any single anthropic activity such as mining in the forested northern areas of the state is therefore difficult because that specific impact must be separated from all the other anthropic and natural disturbances that have occurred. An assessment of cumulative impacts to wildlife habitats is not only constrained by the available data, as are all such analyses, but by the interacting effects of anthropic and natural disturbances.

Approach to Evaluation
The approach to evaluation of habitat fragmentation will be to choose an appropriate analysis area, a baseline time and condition and then: 1) assess the cumulative disturbance (habitat loss) of past and current mining and associated infrastructure development on that baseline condition; and 2) assess the cumulative disturbance of past, current and proposed future actions on that baseline condition. Using other available information, a qualitative description of the habitat in areas disturbed by mining and habitat changes that were not associated with mining (e.g., logging, fire, windstorms, and insect infestation) will also be provided.

Marschner's map of the original vegetation of Minnesota (see Heinselman, 1975) will be used to define the baseline vegetation condition. This map was compiled from the U.S. General Land Office Survey Notes (GLO). This map is based on field notes of the GLO surveyors, who conducted the original land surveys of Minnesota during the period 1850 to 1905. It was drafted at a 1:500,000 scale. Marshner mapped 16 vegetative/ecosystem categories, ranging from marshes to pine groves. The map therefore is the best representation of the original ecosystems of Minnesota before the impact of European man.

The quality of historical records generally is directly proportional to the area considered (i.e., the average of small-scale errors tends toward zero as increasingly large areas are considered). The geographic boundary for impact analysis will therefore be necessarily large: the Arrowhead Region including the counties Cook, Lake, St. Louis, Carleton, Aitkin, Itasca, and Koochiching. For finer discrimination, albeit with more potential error, cumulative impacts in two subsections of Minnesota landscape, the Laurentian Highlands and the Nashwauk Uplands Subsections of the Northern Superior Uplands Ecological Section will be tabulated. These two subsections encompass most of the mining activity that has occurred in northern Minnesota. In addition, analysis of this large area ensures that affects to wide-ranging species, such as wolf, lynx, bear, and deer, and species groups that require large habitat areas (e.g., interior forest-dwelling birds and medium- to large-size mammals), are adequately considered in the analysis.

The actual acres of the various ecosystems mapped by Marshner (16 categories, ranging from marshes to pine groves) that have been disturbed by past and current mining and infrastructure development will be tabulated as will the relative loss by ecosystem category. These tabulations will also be summarized by ecological subsection. The area disturbed will be derived either from the "Forested Areas" map from the Manitoba Remote Sensing Centre (16 classes, including Urban/Industrial, Gravel Pits and Open Mines, and Roads and Improved Trails and Rail Lines), 2003 Mine Features GIS mapping layer available from MDNR, or if those map layers are not suitable, then from the "1990 Census of the Land" (9 categories including Urban and rural development and Mining). A similar assessment will be carried out overlaying a GIS layer of the projected cumulative disturbance 27 years in the future (total time of construction, operation and closure of PolyMet mine) as related to the following proposed future actions:

- Proposed PolyMet Mine
- Proposed Mesabi Nugget Plant
- Proposed Cliffs Erie Railroad Pellet Transfer Facility
- Proposed MSI DRI/Steel Plant
- Future mining plans for existing taconite operations

An interpretation of the extent of ecosystem loss will be performed for four categories of Minnesota wildlife: small-and-medium sized mammals, large mammals, birds, and herptofauna. In addition, an interpretation of habitat loss will be performed for populations of gray wolf, Canada lynx and bald eagle (species listed as threatened by U.S. Department of the Interior). All of these assessments will be qualitative and will be informed by previously completed studies in northern Minnesota (see below).

Previous assessments will be used to provide perspective on those changes in ecosystems that are associated with the cumulative effects of mining in contrast to those associated with other anthropic and natural disturbances (e.g., logging, fire, windstorms, and insect infestations). These assessments were not specifically targeted on the mining areas of the state, but instead considered either the entire forested area of the state or some sub-area in northern Minnesota. The following assessments will be reviewed to provide a brief qualitative perspective on ecosystem changes not related to mining:

- Friedman, S. K. 2001. Landscape scale forest composition and spatial structure: A comparison of the presettlement General Land Office Survey and the 1990 forest inventory in northeastern Minnesota. Ph.D. thesis, University of Minnesota, St. Paul. Friedman reconstructed the presettlement forest vegetation in northeastern Minnesota using General Land Office Survey Records and assessed change in this forest following the introduction of logging and the suppression of fire.
- Minnesota Generic Environmental Impact Statement Study on Timber Harvesting and Forest Management in Minnesota (GEIS). The GEIS analyzed impacts resulting from timber harvesting and associated management activities in Minnesota, such as logging, reforestation, and forest road construction. Four

sections of the GEIS may be useful in describing forest change not related to mining, including: Section 5.2.1 Forest Area and Cover Type Abundance, Section 5.2.4 Forest Fragmentation, Section 5.6.1 Forest Resources - Extent, Composition, and Condition, and Section 5.7.4 Cumulative Unmitigated Significant Impacts.

- Minnesota Forest Resource Council (MFRC) Landscape Project. The MFRC Landscape Project is a landscape level program and coordination effort. As part of the Project, a number of reports have been generated that may be used in this evaluation of cumulative impacts. All reports are available from the MFRC website http://www.frc.state.mn.us/Info/MFRCdocs.html, and include:
    - Changes in disturbance frequency, age and patch structure from pre-European settlement to the present in north central and northeastern Minnesota. LT-1203a
    - Contemporary forest composition and spatial patterns of north central and northeastern Minnesota: An Assessment using 1990s LANDSAT data (accompanying maps/plates). LT-1203b
    - Changes in forest spatial patterns from the 1930s to the present in north central and northeastern Minnesota: An analysis of historic and recent air photos (accompanying maps/plates). LT-1203c
    - Potential future landscape change on the Nashwauk Uplands in northeastern Minnesota: an examination of alternative management scenarios using LANDIS. LT-1203d
    - Background paper: relationships between forest spatial patterns and plant and animal species in northern Minnesota (Report) (Appendices). LT-1203f
- Forest Plan Revision Final Environmental Impact Statement for Chippewa and Superior National Forests. As part of their comprehensive planning process, the U.S. Forest Service developed an Environmental Impact Statement that discussed changes in forest conditions with time. Appendix H is a cumulative review that is most relevant. This document can be found at http://www.superiornationalforest.org/analyses/2004Plan/feis/index.shtml.

Data Needs for Analysis of Cumulative Impacts

- Marschner's map of the original vegetation of Minnesota – available from the DDNR Data Deli (http://maps.dnr.state.mn.us/deli/)
- The land cover map "Forested areas" from the Manitoba Remote Sensing Centre – available from the Minnesota Land Management Information Center (http://www.lmic.state.mn.us/chouse/land_use_comparison.html)
- The land cover map "1990s Census of the Land" – available from the Minnesota Land Management Information Center
- The map: "Ecological Subsections of Minnesota" – – available from the DDNR Data Deli
- 2003 Mine Features GIS mapping layer available from MDNR
- In addition, the reports cited above (Friedman, GIES, MFRC, and U.S. Forest Service) are necessary and available as noted.

Friedman, S. K. 2001. Landscape scale forest composition and spatial structure: A comparison of the presettlement General Land Office Survey and the 1990 forest inventory in northeastern Minnesota. Ph.D. thesis, University of Minnesota, St. Paul.

Heinselman, M.L. 1975. Interpretation of Francis J. Marschner's Map of the Original Vegetation of Minnesota. USDA Forest Service, North Central Forest Experiment Station, St. Paul, MN. Available from: MDNR - Division of Forestry's digitized GIS layer of Marschner's map.

9. Streamflow and Lake Level Changes

Background

Cumulative impacts to the physical character of streams and lakes can occur from increases or decreases in flow or changes in the pattern of flow. The causes can include both point discharges (e.g., mine dewatering discharges) and changes in watershed runoff caused by land use changes (e.g., timber harvest). The impacts of flow changes can include erosion, sedimentation, drought, and high velocities resulting in flushing of aquatic life. Changes in frequency of bankful flow can cause stream degradation. Changes to streams may accumulate over time, even for non-contemporaneous impacts if, for example, a stream is eroded and degraded by one event and then further eroded by a second event.

Flow impacts to streams and lakes are regulated under the MDNR's program for appropriations of water and for work in public waters. Physical impacts to wetlands are also regulated by the Corps of Engineers, the MDNR and the MPCA.

PolyMet will have point discharges of industrial wastewater to the Partridge River (from the Mine Site) and to the Embarrass River (from the Processing Facility and Tailings Basin). The discharges to the Embarrass River are expected to be relatively small in volume. The plant discharges from the tailings basin can be timed to coincide with the most appropriate flow conditions in the Embarrass River. Other changes to the Embarrass River that might be cumulative are limited to the small and intermittent discharge from the Babbitt Wastewater Treatment Plant, forest harvesting and the impacts of rural residential development in Embarrass Township. Again, these are relatively small impacts. Most mining-related discharges for Northshore Mining Company and Cliffs Erie are not to the Embarrass but to the Partridge. Therefore, the possibility of significant impacts to the Embarrass River via either direct discharge or cumulative impacts of discharge (including PolyMet) are believed to be small.

PolyMet's discharges to the upper Partridge River (including mine dewatering) are expected to be larger and not capable of being delayed because long-term storage of the mine dewatering discharge would require an impracticably large reservoir. In addition, PolyMet will appropriate water for the Processing Plant from Colby Lake (which is part of Partridge River drainage), raising the possibility of increases in discharge during wet weather and decreases in discharge during dry weather. Short-term peak discharges from the Mine Site will be mitigated by design of sedimentation and treatment basins to limit peak flows to appropriate pre-development flows. During reclamation, there will be a period of time when the PolyMet Mine Pit will be filling with water and the flow to the Partridge River will be reduced as water accumulates in the Mine Pit. Therefore, the cumulative impact of greater concern is the long-term flow regime of the Partridge River, including changes to the duration and frequency of exceedence of the bankful flow.

Approach to Evaluation

A quantitative assessment of cumulative impacts due to changes in flow will be performed for the Upper Partridge River (including Colby Lake).

Evaluation of hydrologic changes could be done with two major types of models: Changes in short-term flow patterns (e.g., storm runoff) are typically analyzed using hydrologic simulations models such as TR-20, HEC-1 (now HEC/HMS) or SWMM. Long-term flow patterns are most readily analyzed using models such as WATBUD, SWMM (in continuous simulation mode) or the Meyer model. As mentioned above, the changes to the long-term flow regime are more likely to have impacts so the latter class of models would be most applicable.

A stream evaluation conducted in 2004 found that the upper Partridge River was in good condition in the reaches evaluated. Therefore it is proposed to take the present condition as the baseline condition. The model will first be calibrated to available flow gaging data. This will include the effects of past and present actions (through the date of monitoring) including :

- Existing Cliffs Erie and discharges from pits (as of date of monitoring)
- Modification of land use (including wetland loss) by past mining practices within the upper Partridge River watershed
- Existing discharge from Northshore Mining Company Mine and Crusher area
- Existing Syl Laskin Energy Center discharges
- Existing discharge from City of Hoyt Lakes POTW
- Operation of Whitewater Reservoir
- Typical timber harvest activities on SNF, state and county lands and private lands.
- Existing runoff from the development of City of Hoyt Lakes

The hydrologic models will be modified to include actions since the date of the monitoring and potential future actions including:

- Changes to discharges due to closure of LTVSMC
- PolyMet Mine Site discharges to Partridge River and appropriations for PolyMet from Colby Lake
- Long-term flow management of PolyMet mine pit during and after filling of pit
- Implementation of Regional Mercury TMDL

- Potential future discharges and appropriations at Mesabi Nugget facility
- Appropriations, discharges and land use changes at proposed Cliffs Erie Railroad Pellet Transfer Facility construction and operation (parts of these impacts are not in upper Partridge watershed)
- Changes in runoff quantity due to future development of City of Hoyt Lakes
- Any reasonably foreseeable changes to discharges from Hoyt Lakes POTW due to development and/or treatment system changes
- Any potential changes in water discharge from Northshore Mining Company discharges in Partridge River watershed
- Any reasonably foreseeable changes to timber harvest activities on SNF, state and county lands and private lands.

The threshold of significance for this cumulative impact assessment for streams will be the likelihood of major change in stream morphology as defined by the Rosgen classification method or other applicable method (Rosgen, 1994). This analysis will be based on stream reconnaissance completed in 2004 by PolyMet as a base condition which will then be modified by predicted changes in streamflow.

The threshold for evaluation of cumulative impacts to Colby Lake will be significant changes to the range or frequency of high and/or low-water conditions in the lake as determined by the annual maximum and minimum stage-probability relationships for the lake.

Data Needs for Analysis of Cumulative Impacts

- Flow data for Partridge River
- Lake level data for Colby Lake
- Discharge data for Hoyt Lakes POTW
- Discharge data for Erie Mining Company and successors LTVSMC and Cliffs Erie discharges from pits
- Historic air photos or GIS coverages showing modification of land use (including wetland loss) by past mining practices within the upper Partridge River watershed
- Discharge data from Northshore Mining Company Mine and Crusher area and evaluation of possibility of changes to Northshore Mining Company discharges in future
- Appropriations and discharge data for Syl Laskin Energy Center discharges
- Operation plans and historic lake levels for Whitewater Reservoir
- Data on typical timber harvest activities on SNF, state and county lands and private lands.
- Estimates of existing and future land use for City of Hoyt Lakes
- Estimates of future PolyMet Mine Site discharges for mine development, operation and closure, including long-term flow management of PolyMet mine pit during and after filling of pit
- Estimates of potential future discharges and appropriations at Mesabi Nugget facility

- Water balance for proposed Cliffs Erie Railroad Pellet Transfer Facility construction and operation

10. Water Quality Changes

Background
Cumulative water quality impacts can occur from point or non-point discharges of pollutants to a given water. For most water bodies, cumulative impacts occur through simultaneous or near simultaneous discharges that are in reasonable geographic proximity. Accumulation of pollutants in sediments is an exception to this generalization. Point discharges of industrial or municipal wastewater are regulated under the MPCA's NPDES permit program. Non-point discharges above natural background levels occur when land use changes increase areal export of pollutants. In the project vicinity, these changes include filling of wetlands and construction of mining and other industrial facilities that may have lower-quality runoff. Impacts of both point and non-point discharges can be mitigated by treatment.

PolyMet will have point discharges of industrial wastewater to the Partridge River (from the Mine Site) and to the Embarrass River (from the Processing Facility and Tailings Basin).

Approach to Evaluation

A quantitative assessment of cumulative water quality impacts will be performed for the Upper Partridge River (including Colby Lake) and the Upper Embarrass River (including Wynn and Sabin Lakes). PolyMet's discharges will be treated to meet chronic aquatic toxicity-based standards but levels of metals such as nickel may be elevated above natural background levels. At the Plant Site and Tailings Basin, discharges from the Wastewater Treatment Plant may contain dissolved solids, hardness, chlorides and possibly sulfate at levels above background. Other common pollutants such as BOD, bacteria and suspended solids are not expected to be present in significant quantities in the discharges. The actual construction of the PolyMet facility can be expected to generate sediment but this impact is readily mitigated by sedimentation and will be of short duration. Therefore, this impact is not proposed as a suitable subject for cumulative impact analysis.

A number of models are available to analyze generation, fate and transport of pollutants in streams. Models recently used in Minnesota EIS's and NPDES permitting procedures include HSPF and QUAL2E and dilution models. Because toxic metals are largely conservative substances and a loss of these substances is not expected over the long term, an initial practical evaluation could be conducted using a conservative dilution model of the stream water quality. If this indicates that potential cumulative impacts may be experienced, a more comprehensive model could then be applied. It appears likely that the initial modeling phase will be required for the NPDES permit and will be available to the EIS contractor. In this phase, both streams will be modeled using the hydrologic loading of water from tributary subwatersheds (see previous discussion of cumulative impacts of flow changes) for dry, normal and wet conditions. The background loading of pollutants from the watershed will be estimated based on historic and recent monitoring results. For each hydrologic scenario, loading from the PolyMet facility will be included and the resultant concentrations will be calculated as a simple dilution model. Upstream and downstream additions of pollutants from other discharges will be evaluated for past, present and future actions by other parties

The models will first be calibrated to existing conditions monitoring data from 2004. This will inherently include the effects of past and present actions (through the date of monitoring) including:

- Embarrass River
  - Existing discharges from Babbitt POTW
  - Existing Cliffs Erie tailings basin seepage
  - Other existing sources within the former LTVSMC site (e.g. waste rock piles tributary to Spring Mine Creek)
  - Modification of land use (including wetland loss) by past mining practices within the Embarrass River watershed above Sabin and Wynne Lakes
  - Typical timber harvest activities on SNF, state and county lands and private lands
  - Existing rural and residential development in Embarrass township
  - Construction of Embarrass Wetland Bank by LTVSMC
  - Closure of LTVSMC

- Partridge River and Colby Lake
  - Existing Cliffs Erie discharges (overflow) from pits
  - Other existing sources within the former LTVSMC (e.g. waste rock piles adjacent to Wyman Creek)
  - Modification of land use (including wetland loss) by past mining practices within the upper Partridge River watershed
  - Existing discharge from Northshore Mining Company Mine and Crusher area
  - Existing Syl Laskin Energy Center discharges
  - Existing discharge from City of Hoyt Lakes POTW
  - Operation of Whitewater Reservoir
  - Typical timber harvest activities of SNF, state and county lands and private lands
  - Existing runoff from the development of the City of Hoyt Lakes

The hydrologic models will than be modified to include actions since the date of the monitoring and potential future actions including:

- Embarrass River
  - PolyMet tailings basin wastewater treatment plant discharge
  - Changes to existing discharges from Cliffs Erie tailings basin due to PolyMet's proposed collection and treatment of seeps

- Implementation of Regional Mercury TMDL
- Any reasonably foreseeable changes to discharges from Babbitt POTW due to development and/or treatment system changes
- Any reasonably foreseeable changes to timber harvest activities on SNF, state and county lands and private lands

- Partridge River and Colby Lake
  - PolyMet Mining discharges from Mine Site and long-term discharges from closed pit and stockpiles
  - Potential future discharge from Mesabi Nugget facility
  - Proposed Cliffs Erie Railroad Pellet Transfer Facility construction and operation
  - Any reasonably foreseeable changes to timber harvest activities on SNF, state and county lands and private lands
  - Changes in runoff quality due to future development of City of Hoyt Lakes
  - Implementation of Regional Mercury TMDL
  - Any reasonably foreseeable changes to discharges from Hoyt Lakes POTW due to development and/or treatment system changes

Minnesota water quality standards were promulgated to protect human health and aquatic life. The threshold for this cumulative impacts assessment will be Minnesota's chronic aquatic toxicity-based standards applicable to the respective waters being evaluated and the Class I drinking water standards that are applicable to Colby Lake as a drinking water source for the City of Hoyt Lakes. The future conditions scenarios will be completed for both operation and post-closure conditions, assuming that all other reasonably foreseeable actions have been completed.

Data Needs for Analysis of Cumulative Impacts

- Estimates of current and future hydrologic loadings from subwatersheds (see previous cumulative impacts discussion for flow)
- Water quality monitoring data for Embarrass and Partridge Rivers and Colby Lake
- Any reasonably foreseeable changes to discharges from Hoyt Lakes and Babbitt POTW's due to development and/or treatment system changes
- Estimate of reasonable scenarios of area and frequency of future timber harvests within the Partridge River and Embarrass River watersheds.
- Current discharge monitoring data for the Northshore Mining Company facilities and any reasonably foreseeable changes in discharges
- Data on past and existing Cliffs Erie tailings basin seepage and pit and plant discharges,
- PolyMet Mine Site discharges, including post-closure discharges
- Potential future discharges and appropriations at Mesabi Nugget facility

- Historic air photos or GIS coverages showing modification of land use (including wetland loss) by past mining practices within the Partridge and Embarrass River watersheds
- Data on typical present and future timber harvest activities of SNF, state and county lands and private lands
- Data on existing and potential future rural and residential development in Embarrass township
- Data on Embarrass Wetland Bank
- Data on existing Syl Laskin Energy Center discharges and possible future changes to these discharges
- Data on operation of Whitewater Reservoir
- Data on land use or other factors affecting existing or potential future runoff from the development of the City of Hoyt Lakes
- Typical timber harvest activities of SNF
- Changes in runoff quality due to future development of City of Hoyt Lakes
- Implementation of Regional Mercury TMDL
- Any reasonably foreseeable changes to discharges from Hoyt Lakes POTW due to development and/or treatment system changes

11. Economic Impacts

Background

Construction and operation of multiple industrial developments in the Arrowhead Region (Aitkin, Cook, Itasca, Koochiching, Lake, St. Louis and Carlton Counties) will create numerous jobs, increased tax revenues, and royalties to the state and private interests. The effects of the multiplication factor of jobs and the cash spent to operate such facilities would expand the demand for intermediate products. Thus, supplying firms output would increase and create additional jobs and tax revenue throughout the local and regional economy. Additional employees in various sectors of the economy would create demand for additional goods and services such as grocery stores, service stations and clothing stores that would also create an induced impact on the economy. In short, the construction and operation of multiple developments would generate direct, indirect and induced impacts to the local and regional economies. Therefore an assessment of the cumulative employment and economic effects of all proposed major projects will need to be performed as a part of each project's individual EIS.

Scope

The EIS requirement for cumulative impact analysis requires that "reasonably foreseeable" future projects be included in the analysis. A proposed criterion for "reasonably foreseeable" is that any State agency has received a permit application from the project proposer or the project proposer has formally initiated the environmental review process. This criterion should be applied to the projects listed in the following sections at the time the EIS scope is defined.

The geographic scope for this cumulative employment and economic impact analysis is proposed to be St. Louis County, MN due to the location of principal proposed projects and the anticipated geographical extent of their effects. Additionally, accepted economic models exist for the County and, the communities in this area will provide goods and services to the projects and those employed by the projects.

Approach to Evaluation

A quantitative assessment of cumulative employment and economic effects will be performed. Background information on employment and the economy of St. Louis County and the East Range will be summarized:

- Historical population trends by county and major population centers since 1970*
- Historical employment trends by county since 1970*
- Historical tax revenue trends by county since 1970*
- Summary of historical economic activity (major industries, major sources of employment) by county since 1970*
- Summary of population, employment, tax revenue and economic activity in 2002 (the baseline year)

* *Approximate date. Actual historical data will be collected based on availability of primary sources and the economic/fiscal impact model used for the assessment.*

Impact analyses will be completed through input-output mathematical modeling to estimate employment impact, output impact and value added measures in terms of total (direct, indirect and induced) impacts for the construction period, operations period and closure period. Analyses will also assess impacts to State, Local and Federal taxes and royalties. All prices will correspond with the most recent data available.

Baseline conditions will be based on the economic activity reported in the most recent tax year available in the County/East Range. Cumulative impacts will be assessed by combining the baseline economic activity and projections of average annual employment (year by year) and estimated construction cost (year by year) for each of the following future (if they meet the criterion for “reasonably foreseeable”) and past actions:

- Proposed NorthMet Project (PolyMet Mining Inc.)
- Proposed Erie Nugget Project (Mesabi Nugget, LLC)
- Proposed Mesaba Energy Project (Excelsior Energy, Inc.)
- Proposed Cliffs-Erie Railroad Pellet Transfer project (Cliffs-Erie, LLC)
- Proposed Soudan Deep Underground Science and Engineering Laboratory (University of Minnesota)
- Proposed NOνA Off-Axis Detector (University of Minnesota)
- Proposed expansions of existing taconite plants
- Shutdown of LTVSMC

The analysis will report findings for a typical year in four discrete periods: baseline year, construction period, operating period and closure period. Findings will be reported as employment, output impact (dollars), value added impact (dollars) and tax impact (dollars).

Data Needs for Analysis of Cumulative Economic Impacts

Data will be collected with the assistance the East Range Joint Powers Board (ERJPB) and the University of Minnesota – Duluth. Working with Iron Range Resources (IRR), St. Louis County Planning Department, Minnesota Department of Employment and Economic Development (DEED), and the Arrowhead Regional Development Commission (ARDC), the consultant team will collect data from the Townships, Cities, St. Louis County, the State of Minnesota and other sources including the individual projects listed above. Data pertaining to the following will be collected, examined and used in the impact modeling process:

- Input – Output mathematical model (e.g., IMPLAN Professional)
- Economic activity data files (e.g., IMPLAN Data Files)
- Average annual employment (year by year) and estimated construction cost (year by year) for proposed projects (see above).

12. Social Impacts

Background

The proposed project and the resulting economic and employment impacts will have some cumulative effects on the social structure and fabric of the East Range communities. In addition to the impacts upon the infrastructure systems and community services than can result from increased employment and utility needs, there are several aspects to be considered, including changes to social systems, cultural activities, community organizations, building/facility requirements, expressions of community identity and the esthetic and cultural character of communities. Therefore an assessment and characterization will need to be performed of the existing state of these aspects of the environment, forecasting how they may change if the foreseeable actions are implemented, and developing means of mitigating changes that are likely to be adverse from the point of view of the affected East Range population.

Scope

The EIS requirement for cumulative impact analysis requires that “reasonably foreseeable” future projects be included in the analysis. A proposed criterion for “reasonably foreseeable” is that any State agency has received a permit application from the project proposer or the project proposer has formally initiated the environmental review process. This criterion should be applied to the projects listed in the following sections at the time the EIS scope is defined.

St. Louis County (specifically the municipalities of Aurora, Babbitt, Biwabik, Cook, Ely, Hoyt Lakes, Mountain Iron, Orr, Soudan, Tower and Virginia as well as the surrounding cities and towns) is proposed to be the geographic scope for the cumulative social impact assessment because this area will see the most dramatic change in population and infrastructure needs due to the influx of construction and full time workers for the projects.

Approach to Evaluation

A qualitative assessment of cumulative social structure effects will be performed. Background information on social structure of the East Range will be summarized:

- Summary of 2002 (or latest available data year) population characteristics including: structure by age, sex, family size, ethnicity, income, type of employment (including unemployed)
- Summary of 2002 (or latest available data year) community structure for project area cities and towns, including: size of government organizations (cities, townships and counties); participation in voluntary associations (description of groups and linkage to national organizations, if any); and inequities (economic, social or cultural) among community groups.
- Summary of 2002 (or latest available data year) housing availability and community services in major communities, including: police protection, health care, elderly care, schools, libraries, retail centers, recreational facilities, gathering places, computer access facilities.

Impact analysis will be completed through trend analyses:

- Trend analysis of population characteristics (structure by age, sex, family size, ethnicity, income, type of employment - including unemployed).
- Trend analysis of change in community structure: size of government organization (cities, townships and counties); participation in voluntary associations (description of groups and linkage to national organizations, if any); and inequities (economic, social or cultural) among community groups.
- Trend analysis of projected changes in availability of housing and community services including: police protection, health care, elderly care, schools, libraries, retail centers, recreational facilities, gathering places, computer access facilities
- Assessment of stakeholder perception toward proposed projects as related to perceived changes in quality-of-life issues such as: health, safety, security (personal and economic), political power, family stability, use of the natural environment, environmental quality, displacement or relocation, and trust in political and social institutions (intended to gauge community and stakeholder consensus on the cumulative effects of proposed projects on their shared vision for the future of the East Range).

Baseline conditions will be based on the social structure of the East Range in 2002. Cumulative impacts will be assessed by combining the baseline social structure and projections of change related to the following future (if they meet the criterion for "reasonable foreseeable") and past actions:

- Proposed NorthMet Project (PolyMet Mining Inc.)
- Proposed Erie Nugget Project (Mesabi Nugget, LLC)
- Proposed Mesaba Energy Project (Excelsior Energy, Inc.)
- Proposed Cliffs-Erie Railroad Pellet Transfer project (Cliffs-Erie, LLC)
- Proposed Soudan Deep Underground Science and Engineering Laboratory (University of Minnesota)

- Proposed NOvA Off-Axis Detector (University of Minnesota)
- Proposed expansions of existing taconite plants
- Shutdown of LTVSMC

The analysis will report findings for a typical year in four discrete periods: baseline year, construction period, operating period and closure period. Findings will be reported as projected changes in population characteristics, community structure, public attitudes, and availability of housing and community services.

Data Needs for Analysis of Cumulative Impacts

Data will be collected with the assistance the East Range Joint Powers Board (ERJPB). Working with Iron Range Resources (IRR), St. Louis County Planning Department, Minnesota Department of Employment and Economic Development (DEED), and the Arrowhead Regional Development Commission (ARDC), the consultant team will collect data from the Townships, Cities, St. Louis County, the State of Minnesota and other sources, including the results of the IMPLAN modeling process. Data pertaining to the following will be collected, examined and used as the basis for the cumulative social impact assessment process:

- Population data by county as provided by DEED or similar database.
- Population change projections derived from projected employment changes.
- Projected change in government organization structure as determined by respective government units.
- Projected change in participation in voluntary organizations as determined by respective organizations.
- Description of inequities among community groups as determined by group representatives (responsive government units and responsive voluntary organizations as suggested by government units).
- Projected changes in housing availability as determined by economic input-output analysis.
- Projected changes in availability of community services resulting from projected population changes. Change in availability will be determined by responsible governmental units, school districts, care facilities, local Chamber of Commerce, and DEED, as appropriate.
- Identification and definition of stakeholders

30. Other potential environmental impacts. If the project may cause any adverse environmental impacts not addressed by items 1 to 28, identify and discuss them here, along with any proposed mitigation.

There are two areas of potential impacts that need to be identified that were not addressed elsewhere in this EAW.

- Potential for encountering asbestiform fibers in the NorthMet Deposit
- Mineland Reclamation

These issues will be addressed separately in this section.

Potential of Asbestiform Fibers

Asbestiform fibers have been linked to rare type of lung cancer called mesothelioma. There is some uncertainty in the public health community about whether the type of the fibers present in the Peter Mitchell Mine (Northshore Mining Company operation) have the same health effect as the fibers that come from exposure to commercial asbestos. There is also a concern about the impact of asbestiform fibers in drinking water. However, the ore to be mined from the NorthMet deposit is different from the ore obtained from the Peter Mitchell Mine and needs to be evaluated for the potential for asbestiform fibers.

Analysis of representative samples of the NorthMet deposit and the Duluth Complex show that the ore body is typically dominated by crystalline silicate minerals – calcic plagioclase feldspar, pyroxene, olivine, biotite, chlorite, serpentine and amphibole. Plagioclase feldspar (the predominant mineral accounting for approximately 55-60 percent of the ore body) is not known to be carcinogenic. Previous work has shown that some of these minerals split into cleavage fragments that meet the minimum definition of a fiber which is a length to width raito of 3:1. This deposit contains only minor amounts of amphibole minerals – the minerals most likely to produce long thin fibers similar to those associated with commercial asbestos.

A characteristic of non-asbestiform crystalline habits is that when pressure is applied to the crystal, the crystal fractures, forming crystals or cleavage fragments of the acicular variety. Cleavage refers to the preferential breakage of crystals along certain planes of structural weakness. Such planes of weakness are called cleavage planes. A mineral with distinct cleavage planes will preferentially fracture along these planes and will produce acicular fragments. Acicular crystals are long and needle like but are thicker than the fibrous variety. The strength and flexibility of cleavage fragments are approximately the same as those of single crystals. Cleavage fragments do not have the strength, flexibility, or other properties of asbestiform fibers.

The rod mill feed and scavenger tail samples collected during initial pilot plant testing, using ore from the NorthMet deposit, were subjected to a separate analysis to determine the presence of asbestos. The corresponding mineralogical evaluation of the rod mill feed and scavenger tail samples collected from pilot plant testing, using ore from the NorthMet deposit, showed that both samples were dominated by crystalline silicate minerals – calcic plagioclase feldspar, pyroxene, olivine, biotite, chlorite, serpentine (scavenger tail only), and amphibole – with only minor amounts of sulfides (primarily pyrrhotite and cubanite) and trace amounts of carbonate minerals. Plagioclase feldspar, the major mineral occurring in the ore body, has not been shown to be carcinogenic. Amphibole minerals present in any ore body can occur in an asbestiform or non-asbestiform habit. McMaster University Occupational and Environmental Health Laboratory reported that no asbestos was identified in samples collected during the initial pilot plant testing. However, tailings samples will be collected and analyzed during the processing tests conducted in 2005. This information will be available for use in the EIS.

PolyMet proposes to limit any potential for exposure to asbestiform fibers by controlling emissions from process steps that are likely to produce particulate emissions. A description of these process steps follows:

- Primary crushing: particle emissions controlled by fabric filters (99%+ control efficiency).
- Secondary crushing: particle emissions from the pan feeders are currently controlled by Type W rotoclones (conservatively assuming 97% control efficiency for emission calculation purposes; vendor information indicates 98.8% control efficiency).
- Ore storage: emissions from the coarse ore storage bin are controlled by 2 Type W rotoclones and 2 fabric filters (assumed average control efficiency of 98% for emission calculation purposes).
- Tertiary and quaternary crushing; feeders, conveyors, transfer points: particle emissions currently controlled by Type W rotoclones (97% control efficiency for emission calculation purposes).
- Fine Ore Storage: Particle emissions from the North and South bins are currently controlled by Type W rotoclones (97% control efficiency for emission calculation purposes).
- Fine ore feeders (feed ore to the milling lines): particle emissions currently controlled by Type W rotoclones (97% control efficiency for emission calculation purposes).
- Each autoclave and flash vessel is planned to have a dedicated venturi-type scrubber to remove entrained particulate matter and acid gases; raw water is to be used as the scrubbing liquor.
- Steam condensation in a heat exchanger, which is expected to remove additional particulate and acid gases.
- Remaining gases routed to the main scrubber, which will be of venturi design, also with water as the scrubbing liquor.

Proposed Treatment of Topic in EIS:
Although mesothelioma is an important issue, the low probability of encountering asbestiform fibers in the NorthMet deposit will limit the need for detailed analysis of the

issue in the EIS. Additional testing for asbestiform fibers is proposed to occur as part of the Pilot Plant Processing study, and the results of these tests will be included in the EIS. If the results of these tests are consistent with current understanding of the NorthMet deposit, no additional analysis or mitigation will be developed. Existing information about the cleavage fragments crystals related to risk of mesothelioma will be reviewed and summarized in the EIS.

Mineland Reclamation

The goal statement from Minnesota Rules Chapter 6132.3200 Closure and Postclosure Maintenance is, "The mining area shall be closed so that it is stable, free of hazards, minimizes hydrologic impacts, minimizes the release of substances that adversely impact other natural resources, and is maintenance free". There are three components to PolyMet's proposal that require careful consideration for successful mineland reclamation. These components are the mine pit itself, waste rock stockpiles, and the tailings basin. The following discussion identifies some of the closure issues with each of these components.

<u>Mine pit</u>- The size and shape of the mine pit would be dependent on the location of ore and economic factors. PolyMet as part of the Definitive Feasibility study is evaluating the ultimate depth and configuration of the mine pit. A current estimate on pit size is approximately 600 acres and the depth is approximately 900 feet deep. These estimates are subject to change as the ore body is better defined. Significant issues that must be addressed as part of reclamation planning are refilling of pit, pit outflow, water quality of pit, and potential for construction of littoral zones to enhance productivity.

<u>Waste rock and lean ore stockpiles</u>- The size, location, design, and composition of waste rock and lean ore_stockpiles will be critical to developing a reclamation plan that is protective of the environment while minimizing long term maintenance costs. As discussed earlier the determination of non-reactive waste rock versus reactive waste rock will be an important outcome of the waste characterization study. The design of reactive waste rock stockpiles is also significant as it will need to balance the need for protection of water quality with the desire to prevent long-term maintenance costs. Large lined reactive waste rock stockpiles that generate significant water treatment demands are not likely to achieve this balance. Minnesota rules require that appropriate methods for stockpiles containing reactive mine waste, are either to 1. modify the physical or chemical characteristics of the mine waste, or store it in an environment, such that the waste is no longer reactive, or 2. during construction to the extent practicable, an at closure, permanently prevent substantially all water from moving through or over the mine waste and provide for the collection and disposal of any remaining residual waters that drain from the mine waste in compliance with federal and state standards.

<u>Tailings basin</u>- As described in EAW Question 20, the characterization of the flotation tailings will be critical to determining a suitable design and reclamation for the basin. Potential wastewater treatment of seeps and pond overflow will need to be addressed.

Vegetation and eventual land use of project components will also be important considerations in mine planning. Although the time frame for mining is 20 years and additional time will be needed for reclamation there is potential to reclaim the site such that many impacts from the previous disturbance can be mitigated.

Watershed restoration-

To the extent practicable, all lands disturbed by mining will be reintegrated into their original watersheds. Pre-mining flows and water balance will be reestablished to minimize impacts on the watershed and down stream users.

Proposed Treatment of Topic in EIS:

The EIS will evaluate the proposal with consideration for compliance with DNR rules for mineland reclamation. Minnesota Rules for nonferrous metallic metal mining (Chapter 6132) describe the DNR's policy for nonferrous mines, "…that mining be conducted in a manner that will reduce impacts to the extent practicable, mitigate unavoidable impacts, and ensure that the mining area is left in a condition that protects natural resources and minimizes to the extent practicable the need for maintenance." Alternative designs, layouts, and siting will also be evaluated to determine the most feasible reclamation strategy. The three criteria that will be used in this evaluation will be protection of natural resources, minimization of long-term maintenance, and eventual land use objectives.

As part of the permit to mine, a detailed financial assurance analysis will be conducted. This will include final closure and will also address premature shut down. An evaluation of reclamation costs and its effect on facility design, construction and closure will be discussed in the EIS.

Scoping Environmental Assessment Worksheet: Tables

Table 12-1: Wetland delineation summary - mine site
PolyMet Mining Corp.

Wetland ID	Circular 39 Wetland Classification	Cowardin Wetland Classification	Area (acres)
1	Type 2	PEMB	0.07
2	Type 2	PEMB	0.42
3	Type 2	PEMB	0.61
4	Type 2	PEMB	0.49
5	Type 2	PEMB	0.35
6	Type 2	PEMB	0.62
7	Type 2	PEMB	0.68
8	Type 2/3	PEMB/C	8.62
9	Type 2/3	PEMB/C	6.74
10	Type 2/3	PEMB/C	1.17
11	Type 2/3	PEMB/C	1.84
12	Type 2/3	PEMB/C	229.18
13	Type 2/3	PEMB/F	5.03
14	Type 2/7	PEM/FO	0.48
15	Type 2/7	PEM/FOB	2.79
16	Type 3	PEMC	0.31
17	Type 3	PEMC	1.12
18	Type 3	PEMF	17.63
19	Type 3	PEMF	1.68
20	Type 3	PEMF	12.86
21	Type 3/6	PEM/SSC	1.92
22	Type 3/7	PEMC/FO	8.71
23	Type 3/8	PEMB/C	29.81
24	Type 3/8	PEMB/C	119.59
25	Type 3/8	PEMB/C	11.93
26	Type 3/8	PEMB/C	20.84
27	Type 3/8	PEMB/C	1.45
28	Type 3/8	PEMB/C	0.71
29	Type 3/8	PEMB/C	1.21
30	Type 3/8	PEMB/C	0.80
31	Type 3/8	PEMB/C	2.27
32	Type 6	PFO1/2B	8.85
33	Type 6	PSSB	5.79
34	Type 6	PSSB	8.17
35	Type 6	PSSB	1.69
36	Type 6	PSSB	2.84
37	Type 6	PSSB	0.88
38	Type 6	PSSB	0.50
39	Type 6	PSSB	10.07
40	Type 6	PSSB	13.15
41	Type 6	PSSB	8.22
42	Type 6	PSSB	1.66
43	Type 6	PSSB	1.25
44	Type 6	PSSB	0.62
45	Type 6	PSSB	0.16
46	Type 6	PSSB	0.44
47	Type 6	PSSB	2.39
48	Type 6	PSSB	1.15
49	Type 6	PSSB	1.11
50	Type 6	PSSB	15.41
51	Type 6	PSSIC	30.58
52	Type 6/2	PSS/EMB	3.95
53	Type 6/3	PSSB/EM	4.75
54	Type 6/7	PSS/FO4	89.06
55	Type 6/7	PSS/FOB	36.43
56	Type 6/7	PSS/FOB	2.91
57	Type 6/7	PSS/FOB	4.05
58	Type 6/7	PSS/FOB	1.99

Table 12-1: Wetland delineation summary - mine site
PolyMet Mining Corp.

Wetland ID	Circular 39 Wetland Classification	Cowardin Wetland Classification	Area (acres)
59	Type 6/7	PSS/FOB	132.33
60	Type 6/7	PSSB/FO	10.24
61	Type 6/8	PSSB	3.45
62	Type 6/8	PSSI/FO	2.79
63	Type 6/8	PSSI/FO	83.16
64	Type 6/8	PSSIB/F	32.96
65	Type 7	PEMB/C	9.35
66	Type 7	PF01B	1.81
67	Type 7	PFO/2B	2.33
68	Type 7	PFO1/2B	2.50
69	Type 7	PFO1/2B	3.96
70	Type 7	PFO1/2B	7.87
71	Type 7	PFO1/2B	4.00
72	Type 7	PFO1/2B	5.75
73	Type 7	PFO1/2B	0.31
74	Type 7	PFO1/2B	20.57
75	Type 7	PFO1/2B	8.67
76	Type 7	PFO1/2B	4.59
77	Type 7	PFO1/2B	13.91
78	Type 7	PFO1B	0.88
79	Type 7	PFO2B	6.12
80	Type 7	PFO5B	21.13
81	Type 7	PFOB	1.51
82	Type 8	PBO4B	2.97
83	Type 8	PEMB	6.21
84	Type 8	PF04B	3.98
85	Type 8	PFO1/2B	0.81
86	Type 8	PFO1/2B	2.39
87	Type 8	PFO2/4B	0.29
88	Type 8	PFO4B	5.57
89	Type 8	PFO4B	12.89
90	Type 8	PFO4B	1.68
91	Type 8	PFO4B	17.28
92	Type 8	PFO4B	24.71
93	Type 8	PFO4B	4.47
94	Type 8	PFO4B	1.41
95	Type 8	PFO4B	2.47
96	Type 8	PFO4B	2.32
97	Type 8	PFO4B	4.64
98	Type 8	PFO4B	2.54
99	Type 8	PFO4B	3.53
100	Type 8	PFO4B	9.12
101	Type 8	PFO4B	1.40
102	Type 8	PFO4B	17.07
103	Type 8	PFO4B	567.93
104	Type 8	PFO4B	164.13
105	Type 8	PFO4B	3.57
106	Type 8	PFO4B	11.38
107	Type 8	PFO4B	15.80
108	Type 8	PFO4B	13.53
109	Type 8	PFO4B	129.55
110	Type 8	PFO4B	0.03
111	Type 8	PFO4B	15.09
112	Type 8	PFOB	20.32
113	Type 8/3	PFO4B/O	312.68
114	Type 8/7	PFO4/2B	32.02
Total			**2,543.97**

Table 12-2: Projected wetland impact summary - mine site
PolyMet Mining Corporation

Wetland ID	Circular 39 Wetland Classification	Cowardin Wetland Classification	Area (acres)
1	Type 2	PEMB	0.07
2	Type 2	PEMB	0.42
3	Type 2	PEMB	0.61
5	Type 2	PEMB	0.35
6	Type 2	PEMB	0.62
7	Type 2	PEMB	0.68
8	Type 2/3	PEMB/C	8.62
9	Type 2/3	PEMB/C	6.74
10	Type 2/3	PEMB/C	1.17
11	Type 2/3	PEMB/C	1.82
12	Type 2/3	PEMB/C	1.13
13	Type 2/3	PEMB/F	5.03
14	Type 2/7	PEM/FO	0.48
15	Type 2/7	PEM/FOB	2.79
16	Type 3	PEMC	0.31
18	Type 3	PEMF	17.63
19	Type 3	PEMF	1.68
20	Type 3	PEMF	12.86
21	Type 3/6	PEM/SSC	1.92
22	Type 3/7	PEMC/FO	2.51
23	Type 3/8	PEMB/C	29.81
24	Type 3/8	PEMB/C	0.73
25	Type 3/8	PEMB/C	11.93
27	Type 3/8	PEMB/C	1.45
28	Type 3/8	PEMB/C	0.71
29	Type 3/8	PEMB/C	1.21
30	Type 3/8	PEMB/C	0.80
31	Type 3/8	PEMB/C	2.27
32	Type 6	PFO1/2B	8.85
33	Type 6	PSSB	5.79
34	Type 6	PSSB	8.16
35	Type 6	PSSB	1.69
36	Type 6	PSSB	2.84
37	Type 6	PSSB	0.88
38	Type 6	PSSB	0.50
39	Type 6	PSSB	10.07
40	Type 6	PSSB	13.14
41	Type 6	PSSB	8.22
42	Type 6	PSSB	1.66
44	Type 6	PSSB	0.62
45	Type 6	PSSB	0.16
46	Type 6	PSSB	0.44
47	Type 6	PSSB	2.39
48	Type 6	PSSB	1.15
49	Type 6	PSSB	1.11
50	Type 6	PSSB	2.59
51	Type 6	PSSIC	30.58
53	Type 6/3	PSSB/EM	4.75
54	Type 6/7	PSS/FO4	89.07
55	Type 6/7	PSS/FOB	36.43
56	Type 6/7	PSS/FOB	2.91
57	Type 6/7	PSS/FOB	4.05
59	Type 6/7	PSS/FOB	24.22

Table 12-2: Projected wetland impact summary - mine site
PolyMet Mining Corporation

Wetland ID	Circular 39 Wetland Classification	Cowardin Wetland Classification	Area (acres)
60	Type 6/7	PSSB/FO	4.86
61	Type 6/8	PSSB	3.45
62	Type 6/8	PSSI/FO	2.79
63	Type 6/8	PSSI/FO	72.27
64	Type 6/8	PSSIB/F	32.95
66	Type 7	PF01B	1.81
67	Type 7	PFO/2B	2.33
68	Type 7	PFO1/2B	2.50
69	Type 7	PFO1/2B	3.96
70	Type 7	PFO1/2B	7.88
71	Type 7	PFO1/2B	4.00
72	Type 7	PFO1/2B	5.75
73	Type 7	PFO1/2B	0.31
74	Type 7	PFO1/2B	20.57
75	Type 7	PFO1/2B	8.67
77	Type 7	PFO1/2B	13.91
78	Type 7	PFO1B	0.88
79	Type 7	PFO2B	6.12
80	Type 7	PFO5B	2.29
81	Type 7	PFOB	1.51
82	Type 8	PBO4B	2.97
83	Type 8	PEMB	6.20
84	Type 8	PF04B	3.97
85	Type 8	PFO1/2B	0.81
86	Type 8	PFO1/2B	2.39
87	Type 8	PFO2/4B	0.29
88	Type 8	PFO4B	5.57
89	Type 8	PFO4B	12.89
90	Type 8	PFO4B	1.68
91	Type 8	PFO4B	17.27
92	Type 8	PFO4B	3.68
93	Type 8	PFO4B	4.47
94	Type 8	PFO4B	1.41
95	Type 8	PFO4B	2.47
96	Type 8	PFO4B	2.32
97	Type 8	PFO4B	4.64
98	Type 8	PFO4B	2.54
99	Type 8	PFO4B	3.53
100	Type 8	PFO4B	9.12
101	Type 8	PFO4B	1.40
102	Type 8	PFO4B	17.07
103	Type 8	PFO4B	185.29
104	Type 8	PFO4B	159.52
105	Type 8	PFO4B	3.57
106	Type 8	PFO4B	11.38
107	Type 8	PFO4B	15.80
108	Type 8	PFO4B	4.41
109	Type 8	PFO4B	129.55
110	Type 8	PFO4B	0.03
111	Type 8	PFO4B	15.09
112	Type 8	PFOB	15.98
114	Type 8/7	PFO4/2B	32.02
Total			**1256.76**

Table 12-3: Wetland delineation summary by wetland type
PolyMet Mining Corp.

Circular 39 Wetland Classification	Number of Wetlands	Area (acres)
Type 2	7	3.2
Type 2/3	6	252.6
Type 2/7	2	3.3
Type 3	5	33.6
Type 3/6	1	1.9
Type 3/7	1	8.7
Type 3/8	9	188.6
Type 6	20	114.9
Type 6/2	1	4.0
Type 6/3	1	4.8
Type 6/7	7	277.0
Type 6/8	4	122.4
Type 7	17	115.3
Type 8	31	1069.1
Type 8/3	1	312.7
Type 8/7	1	32.0
Total	**114**	**2,543.97**

Table 12-4: Projected wetland impact summary by wetland type
PolyMet Mining Corp.

Circular 39 Wetland Classification	Number of Wetlands	Area (acres)
Type 2	6	2.7
Type 2/3	8	24.5
Type 2/7	2	3.3
Type 3	4	32.5
Type 3/6	1	1.9
Type 3/7	1	2.5
Type 3/8	8	48.9
Type 6	12	100.8
Type 6/3	1	4.8
Type 6/7	7	161.5
Type 6/8	4	111.5
Type 7	15	82.5
Type 8	28	647.3
Type 8/7	1	32.0
Total	**98**	**1256.7**

Table 17-2
Average (April and May) Water Quality of Streams and Rivers in Proximity to the Proposed PolyMet Mine Site, Plant Site, and Tailings Basin

Parameter	Sampling Location (See Figure 17-2)															
	PM-1	PM-2	PM-3	PM-4	PM-5	PM-6	PM-7	PM-8	PM-9	PM-10	PM -11	PM-12	PM -13	PM-14	PM-15	PM -16
Alkalinity, Total (mg/L)	94	49	42	14.5	101	61	359	255	209	329	129	18	31	77	48	31
Aluminum, Total (ug/L))	10	53	80	186	13	45	11	30	24	10	28	122	347	16	54	121
Antimony, Total (ug/L)	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Barium, Total (ug/L)	<10	<10	<10	<10	<10	<10	17.6	11.5	20.5	63.5	16.1	<10	15.4	12.2	<10	<10
Beryllium, Total (ug/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Boron, Total (ug/L)	90.3	36.4	41.9	<35	49.4	<35	211.5	259.0	281.0	268.5	154.5	<35	40.5	209	114	39.0
Cadmium, Total (ug/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2
Calcium, Total (mg/L)	24.7	13.6	11.4	4.4	25.4	16.3	63.1	39.5	37	47.1	22	4.95	7.55	25.45	16.3	8.95
Carbon, Total Organic (mg/L)	1.9	12.4	15.7	20.5	5.1	7.1	4.8	5.2	6.5	6.1	8.6	17.1	16.7	6.8	11.9	17.5
Chloride (mg/L)	1.1	1.3	3.0	1.1	2.0	1.0	18.5	20.2	20.0	21.9	11.1	2.2	4.3	51.8	28.7	2.3
Chromium, Total (ug/L)	<1	1.3	1.2	1.1	<1	<1	1.1	1.3	1.1	1.2	1.3	1.9	2.9	<1	1.5	2
Cobalt, Total (ug/L)	<1	<1	<1	<1	4.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
COD (mg/L)	12.5	39	47.5	43.5	9.4	25	2.65	9.85	8.05	17	21.5	39.5	30.5	24.75	38	43.5
Copper, Total (ug/L)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cyanide, Total (mg/L)	<0.02	<0.02	<0.02	<0.02	<0.02	4.96	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Disolved Oxygen (mg/L)	12.3	10.0	11.7	10.8	11.4	8.6	12.1	10.5	9.7	9.5	10.5	9.8	10.2	11.1	11.1	10.8
Fluoride (mg/L)	0.14	0.12	0.11	<0.1	0.12	0.15	3.05	2.05	1.36	1.5	0.97	0.11	0.2	0.18	0.13	0.1
Hardness (mg/L)	48.8	82.7	50.4	190	211	154	335	143	213	222	109	19	35.6	91.9	68.3	30.3
Iron, Total (mg/L)	0.03	0.63	1.08	0.81	0.24	0.92	0.25	0.39	0.24	0.455	0.33	0.48	0.73	0.28	0.43	0.89
Lead, Total (ug/L)	<1	<1	<1	1.1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Magnesium, Total (mg/L)	10.25	5.15	4.75	2.9	20	9.9	63.8	49.7	41.8	49.7	23.5	2.75	6.15	14.15	9.4	4.1

Parameter	Sampling Location (See Figure 17-2)															
	PM-1	PM-2	PM-3	PM-4	PM-5	PM-6	PM-7	PM-8	PM-9	PM-10	PM -11	PM-12	PM -13	PM-14	PM-15	PM -16
Manganese, Total (mg/L)	0.01	0.07	0.11	0.05	0.15	0.12	0.24	0.08	0.05	0.68	0.05	0.02	0.04	0.06	0.1	0.08
Mercury, Total (ng/L)	1.5	3.2	3.05	4.75	2	1.05	1.05	1.6	4	1.85	2.3	6.6	4.6	1.5	3.4	3.5
Molybdenum, Total (ug/L)	<5	<5	<5	<5	<5	<5	21.5	47.1	19.8	13	18.6	<5	<5	<5	<5	<5
Nickel, Total (ug/L)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Nitrite Plus Nitrate, Total (mg/L)	0.17	<0.1	<0.1	0.12	0.43	<0.1	<0.1	0.14	0.11	<0.1	0.11	<0.1	0.13	3.3	1.48	<0.1
Nitrogen, Ammonia, Total (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Palladium (ug/L)	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
pH	7.9	6.9	6.9	7.0	7.3	7.0	7.9	8.0	7.7	7.5	7.7	6.5	7.0	7.1	6.9	7.0
Phosphorus, Total (mg/L)	0.105	<0.1	<0.1	<0.1	<0.1	0.13	<0.1	<0.1	<0.1	0.14	<0.1	0.11	<0.1	<0.1	0.14	<0.1
Platinum (ug/L)	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Potassium, Total (mg/L)	2.5	2.0	2.0	0.8	5.2	2.1	8.0	9.1	6.8	5.7	4.3	0.8	1.9	4.0	3.0	1.5
Selenium, Total (ug/L)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Silver, Total (ug/L)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium, Total (mg/L)	4.35	2.25	2.5	1.45	12.1	4.85	46.4	53.1	39.9	64.7	23.5	2.35	5.8	26.7	14.6	2.15
Solids, Total Dissolved (mg/L)	111.5	79	75.5	57	204	104	537	423	371	460.5	220	54	78	221	136	67.5
Solids, Total Suspended (mg/L)	2	<1	1.85	6	2.5	7	5.5	8.15	6.5	6.5	1.15	1.5	10.5	1.85	3.65	8
Specific Conductance (umhos/cm)	231	122	107	49.5	358	191	934	760	656	845	399	55.1	117	407	243	83.6
Strontium, Total (ug/L)	152	71.6	60.6	19.9	97.7	55	246	195	200	222.5	117	19.2	31.8	217.5	127	46.3
Sulfate (mg/L)	20	10.1	5.85	4.55	67.6	27.7	135	123	148	110.8	53.4	6.1	16.3	29.15	17.3	7.2
Thallium, Total (ug/L)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Titanium (ug/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	13	<10	<10	<10
Turbidity (NTU)	1.1	1.6	2.7	2	2.5	4	1.5	3	1.5	5.5	2.1	1.05	4	0.85	1.3	3
Zinc, Total (ug/L)	<10	<10	<10	11.1	<10	<10	<10	10.6	<10	12.7	<10	<10	<10	<10	13.6	<10

Table 23-2
Total Project Point Source Emissions
Full Mine Development (20 Years)

Pollutant	PTE - Uncontr. (lb/hr)	PTE Uncontr. (tpy)	PTE w/control (lb/hr) [1]	PTE w/control (tpy) [1]	Proj. Act. Emiss. (tpy) [2]
Criteria Polutants					
PM10	11327.21	49580.14	274.67	1170.01	447.61
SO2	25.00	41.12	18.99	14.76	4.00
H2SO4/SO3	273.39	1197.43	2.79	12.20	9.46
PM	11332.33	49602.59	274.82	1170.67	448.13
NOx	56.40	247.02	56.40	247.02	94.91
VOC	6.92	20.84	6.68	19.79	6.82
CO	10.83	47.42	10.83	47.42	14.65
Pb	1.0497	4.5978	0.0105	0.0459	0.0336
Toxic Air Pollutants					
Antimony	0.0508	0.2225	0.0011	0.0048	0.0016
Arsenic	0.1039	0.4550	0.0024	0.0105	0.0034
Beryllium	0.0058	0.0252	0.0001	0.0005	0.0002
Cadmium	0.0101	0.0443	0.0003	0.0014	0.0008
Chromium	1.6144	7.0711	0.0364	0.1593	0.0526
Cobalt	9.0851	39.7926	0.0972	0.4258	0.2895
Manganese	14.3534	62.8678	0.3319	1.4538	0.4621
Mercury	0.0003	0.0011	0.0002	0.0007	0.0006
Nickel	183.1466	802.1822	1.8682	8.1829	5.8327
Phosphorus	4.9704	21.7702	0.1149	0.5034	0.1600
Selenium	0.0549	0.2403	0.0013	0.0056	0.0018
Barium	3.7423	16.3912	0.0871	0.3815	0.1224
Boron	1.0706	4.6890	0.0114	0.0500	0.0341
Copper	247.0929	1082.2671	2.8622	12.5365	7.8746
Molybdenum	0.0542	0.2372	0.0012	0.0053	0.0022
Vanadium	1.7258	7.5589	0.0397	0.1739	0.0566
Zinc	20.0011	87.6047	0.2056	0.9005	0.6501
Tellurium	0.4814	2.1087	0.0103	0.0453	0.0155
Hafnium	0.0207	0.0905	0.0004	0.0019	0.0007
POM	0.0015	0.0064	0.0015	0.0064	0.0009
2-Methylnaphthalene	2.51E-06	1.10E-05	2.51E-06	1.10E-05	1.10E-05
3-Methylchloranthrene	9.43E-08	4.13E-07	9.43E-08	4.13E-07	4.13E-07
7,12-Dimethylbenz(a)anthracene	8.38E-07	3.67E-06	8.38E-07	3.67E-06	3.67E-06
Acenaphthene	6.31E-06	2.76E-05	6.31E-06	2.76E-05	3.13E-06
Acenaphthylene	2.22E-05	9.74E-05	2.22E-05	9.74E-05	1.01E-05
Anthracene	1.65E-05	7.22E-05	1.65E-05	7.22E-05	7.72E-06
Benz(a)anthracene	1.48E-05	6.48E-05	1.48E-05	6.48E-05	6.85E-06
Benzo(a)pyrene	8.85E-07	3.88E-06	8.85E-07	3.88E-06	6.36E-07
Benzo(b)fluoranthene	5.28E-07	2.31E-06	5.28E-07	2.31E-06	6.03E-07

Benzo(g,h,i)perylene	4.34E-06	1.90E-05	4.34E-06	1.90E-05	2.15E-06
Benzo(k)fluoranthene	7.72E-07	3.38E-06	7.72E-07	3.38E-06	7.10E-07
Chrysene	3.18E-06	1.39E-05	3.18E-06	1.39E-05	1.77E-06
Dibenzo(a,h)anthracene	2.61E-06	1.14E-05	2.61E-06	1.14E-05	1.39E-06
Fluoranthene	6.69E-05	2.93E-04	6.69E-05	2.93E-04	3.05E-05
Fluorene	2.56E-04	1.12E-03	2.56E-04	1.12E-03	1.13E-04
Ideno(1,2,3-cd)pyrene	1.73E-06	7.60E-06	1.73E-06	7.60E-06	1.13E-06
Phenanthrene	2.59E-04	1.13E-03	2.59E-04	1.13E-03	1.20E-04
Pyrene	4.23E-05	1.85E-04	4.23E-05	1.85E-04	2.06E-05
Benzene	0.0084	0.0367	0.0084	0.0367	0.0045
Cumene	0.1532	0.1572	0.1532	0.1572	0.1354
Trimethylbenzene	1.2143	1.5970	1.2143	1.5970	1.3758
Dichlorobenzene	0.0001	0.0006	0.0001	0.0006	0.0006
Formaldehyde	0.0182	0.0796	0.0182	0.0796	0.0389
Hexane	0.1886	0.8259	0.1886	0.8259	0.8259
Toluene	0.0039	0.0172	0.0039	0.0172	0.0031
Naphthalene	0.0008	0.0035	0.0008	0.0035	0.0006
Xylene	0.1114	0.0896	0.1114	0.0896	0.0689
MIBC	0.0745	0.2596	0.0745	0.2596	0.2013
Isopropyl Alc.	1.0872	0.1329	1.0872	0.1329	0.1031
C8-C12 Isoalkanols	0.0063	0.0000	0.0063	0.0000	0.0000
HF	0.0416	0.1823	0.0004	0.0018	0.0014
HCl	56.3573	228.1750	4.9493	3.0081	2.3324
H2S	0.1079	0.4725	0.0295	0.1290	0.1001
CS2	1.6198	7.0947	0.5993	2.6250	2.0354
Crystalline Silica	0.0022	0.0098	0.0022	0.0098	0.0076
Fluorides (as F)	2.0209	8.8516	0.0435	0.1903	0.0650
Acetaldehyde	0.0067	0.0294	0.0067	0.0294	0.0029
Acrolein	0.0004	0.0018	0.0004	0.0018	0.0002
1,3-Butadiene	0.0002	0.0007	0.0002	0.0007	0.0001
Total HAP	272.96	1175.97	8.51	17.68	12.29
Green House Gasses					
CO2	45492	199256	45492	199256	162622
N2O	0.23	1.01	0.23	1.01	1.01
CH4	0.24	1.06	0.24	1.06	1.06

Notes:

[1] Assumes existing control equipment for crushing plant and control equipment included in process design as well as intended measures to control fugitive dust. Control levels may be increased to meet BACT and/or MACT requirements.

[2] Assumes crushing and hydrometallurgical plants process projected high end daily ore output from mine, 32,000 tpd. Also assumes 10% utilization for diesel mine dewatering pumps.

Table 23-3
Total Project Point and Fugitive Source Emissions
Full Mine Development (20 Years)

Pollutant	PTE - Uncontr. (lb/hr)	PTE Uncontr. (tpy)	PTE w/control (lb/hr) [1]	PTE w/control (tpy) [1]	Proj. Act. Emiss. (tpy) [2]
Criteria Polutants					
PM10	15326.33	54577.23	1949.89	3625.20	2902.01
SO2	27.20	41.14	21.19	14.78	4.01
H2SO4/SO3	273.39	1197.43	2.79	12.20	9.46
PM	26603.85	67279.25	6544.70	9175.44	8451.20
NOx	56.40	247.02	56.40	247.02	94.91
VOC	6.92	20.84	6.68	19.79	6.82
CO	10.83	47.42	10.83	47.42	14.65
Pb	1.0501	4.9616	0.0108	0.4097	0.3975
Toxic Air Pollutants					
Antimony	0.0512	0.2241	0.0015	0.0064	0.0032
Arsenic	0.1048	0.5350	0.0033	0.0905	0.0834
Beryllium	0.0058	0.0255	0.0002	0.0008	0.0004
Cadmium	0.0102	0.0446	0.0004	0.0018	0.0012
Chromium	1.6278	7.4226	0.0497	0.5107	0.4040
Cobalt	9.0919	39.9170	0.1040	0.5502	0.4139
Manganese	14.4717	64.7089	0.4502	3.2949	2.3032
Mercury	0.0003	0.0011	0.0002	0.0007	0.0006
Nickel	183.2173	802.9738	1.9389	8.9745	6.6243
Phosphorus	5.0227	22.7269	0.1672	1.4600	1.1166
Selenium	0.0556	0.2434	0.0020	0.0087	0.0049
Barium	3.7648	16.6882	0.1096	0.6785	0.4194
Boron	1.0716	4.7503	0.0124	0.1112	0.0953
Copper	247.3256	1083.8030	3.0949	14.0725	9.4106
Molybdenum	0.0545	0.2387	0.0016	0.0068	0.0037
Vanadium	1.7371	7.8071	0.0510	0.4220	0.3048
Zinc	20.0108	88.1652	0.2153	1.4610	1.2106
Tellurium	0.4850	2.1646	0.0139	0.1013	0.0714
Hafnium	0.0208	0.0927	0.0005	0.0041	0.0028
POM	0.0015	0.0064	0.0015	0.0064	0.0009
2-Methylnaphthalene	2.51E-06	1.10E-05	2.51E-06	1.10E-05	1.10E-05
3-Methylchloranthrene	9.43E-08	4.13E-07	9.43E-08	4.13E-07	4.13E-07
7,12-Dimethylbenz(a)anthracene	8.38E-07	3.67E-06	8.38E-07	3.67E-06	3.67E-06
Acenaphthene	6.31E-06	2.76E-05	6.31E-06	2.76E-05	3.13E-06
Acenaphthylene	2.22E-05	9.74E-05	2.22E-05	9.74E-05	1.01E-05
Anthracene	1.65E-05	7.22E-05	1.65E-05	7.22E-05	7.72E-06
Benz(a)anthracene	1.48E-05	6.48E-05	1.48E-05	6.48E-05	6.85E-06
Benzo(a)pyrene	8.85E-07	3.88E-06	8.85E-07	3.88E-06	6.36E-07
Benzo(b)fluoranthene	5.28E-07	2.31E-06	5.28E-07	2.31E-06	6.03E-07

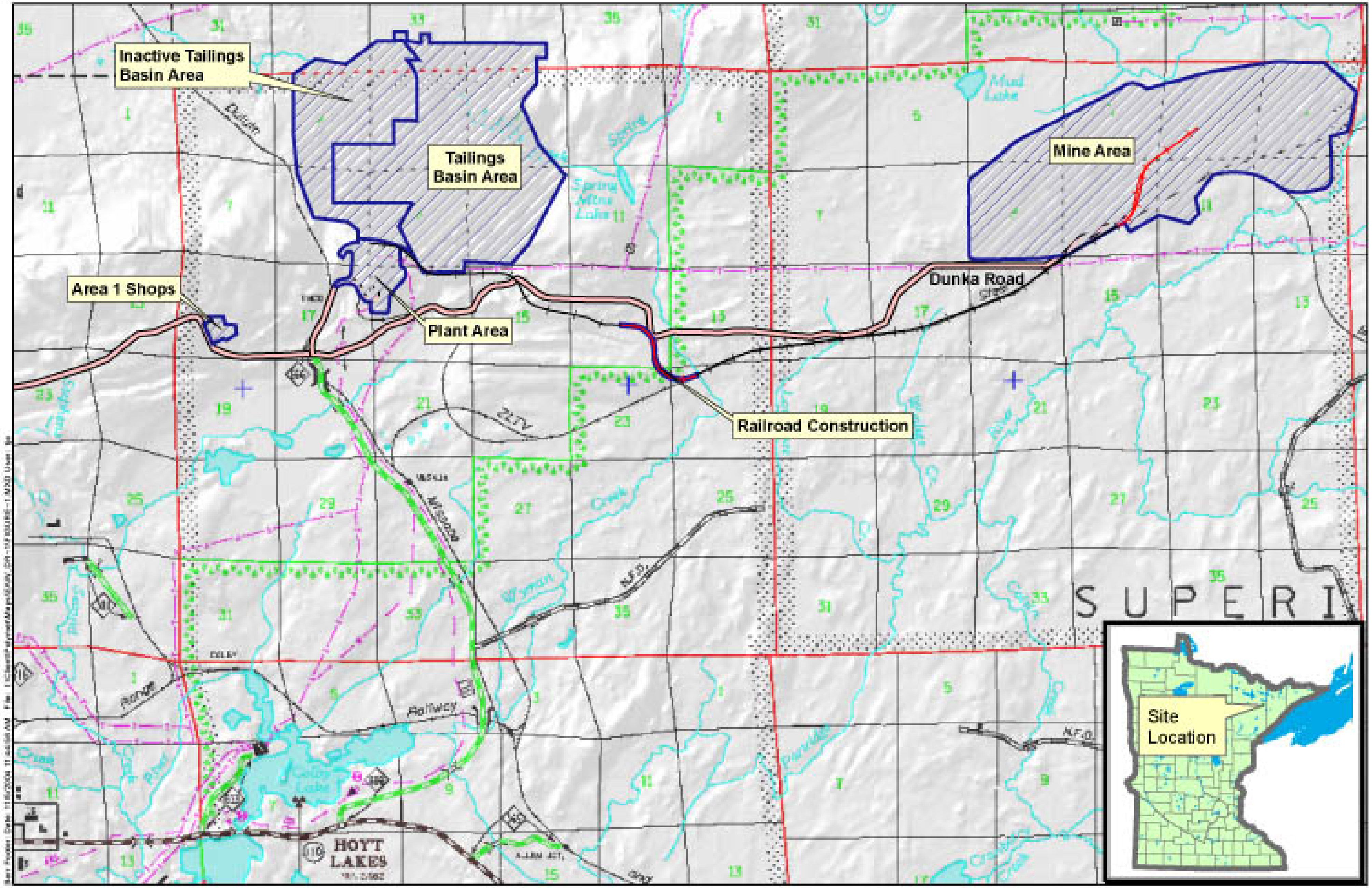
Benzo(g,h,i)perylene	4.34E-06	1.90E-05	4.34E-06	1.90E-05	2.15E-06
Benzo(k)fluoranthene	7.72E-07	3.38E-06	7.72E-07	3.38E-06	7.10E-07
Chrysene	3.18E-06	1.39E-05	3.18E-06	1.39E-05	1.77E-06
Dibenzo(a,h)anthracene	2.61E-06	1.14E-05	2.61E-06	1.14E-05	1.39E-06
Fluoranthene	6.69E-05	2.93E-04	6.69E-05	2.93E-04	3.05E-05
Fluorene	2.56E-04	1.12E-03	2.56E-04	1.12E-03	1.13E-04
Ideno(1,2,3-cd)pyrene	1.73E-06	7.60E-06	1.73E-06	7.60E-06	1.13E-06
Phenanthrene	2.59E-04	1.13E-03	2.59E-04	1.13E-03	1.20E-04
Pyrene	4.23E-05	1.85E-04	4.23E-05	1.85E-04	2.06E-05
Benzene	0.0084	0.0367	0.0084	0.0367	0.0045
Cumene	0.1532	0.1572	0.1532	0.1572	0.1354
Trimethylbenzene	1.2143	1.5970	1.2143	1.5970	1.3758
Dichlorobenzene	0.0001	0.0006	0.0001	0.0006	0.0006
Formaldehyde	0.0182	0.0796	0.0182	0.0796	0.0389
Hexane	0.1886	0.8259	0.1886	0.8259	0.8259
Toluene	0.0039	0.0172	0.0039	0.0172	0.0031
Naphthalene	0.0008	0.0035	0.0008	0.0035	0.0006
Xylene	0.1114	0.0896	0.1114	0.0896	0.0689
MIBC	0.0745	0.2596	0.0745	0.2596	0.2013
Isopropyl Alc.	1.0872	0.1329	1.0872	0.1329	0.1031
C8-C12 Isoalkanols	0.0063	0.0000	0.0063	0.0000	0.0000
HF	0.0416	0.1823	0.0004	0.0018	0.0014
HCl	56.3573	228.1750	4.9493	3.0081	2.3324
H2S	0.1079	0.4725	0.0295	0.1290	0.1001
CS2	1.6198	7.0947	0.5993	2.6250	2.0354
Crystalline Silica	0.0367	0.1608	0.0367	0.1608	0.1247
Fluorides (as F)	2.0339	8.9085	0.0564	0.2472	0.1218
Acetaldehyde	0.0067	0.0294	0.0067	0.0294	0.0029
Acrolein	0.0004	0.0018	0.0004	0.0018	0.0002
1,3-Butadiene	0.0002	0.0007	0.0002	0.0007	0.0001
Total HAP	273.22	1180.49	8.77	22.19	16.80
Green House Gasses					
CO2	45492	199256	45492	199256	162622
N2O	0.23	1.01	0.23	1.01	1.01
CH4	0.24	1.06	0.24	1.06	1.06

Notes:

[1] Assumes existing control equipment for crushing plant and control equipment included in process design as well as intended measures to control fugitive dust. Control levels may be increased to meet BACT and/or MACT requirements.

[2] Assumes crushing and hydrometallurgical plants process projected high end daily ore output from mine, 32,000 tpd. Also assumes 10% utilization for diesel mine dewatering pumps.

Scoping Environmental Assessment Worksheet: Figures



Project Boundaries

Railroads

Existing

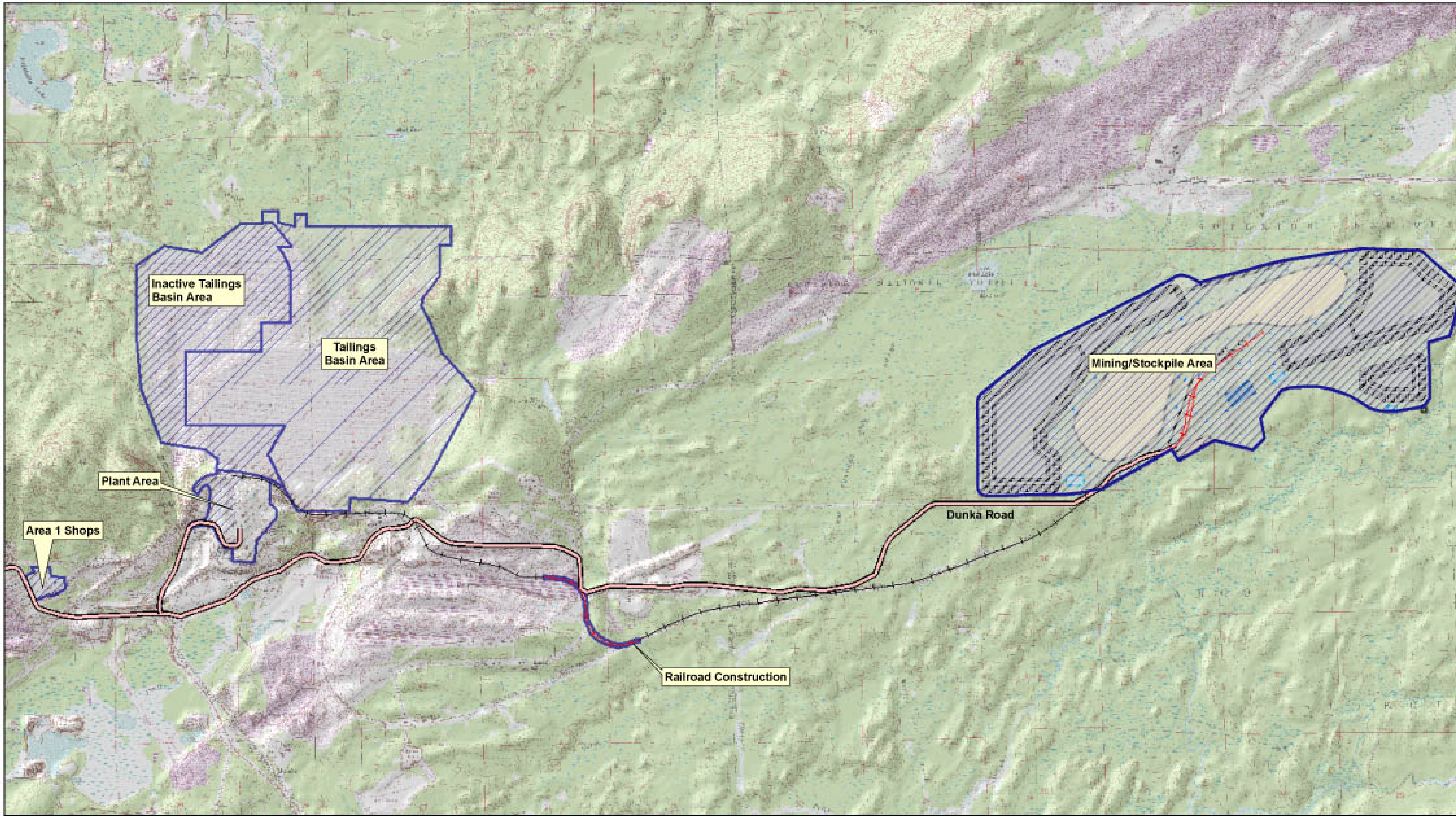
Proposed

Access Roads

0 0.5 1 2 Miles

Basemap from MnDOT

Figure 5-1
PROJECT LOCATION ON COUNTY MAP



Legend

- Project Boundaries
- Access Roads

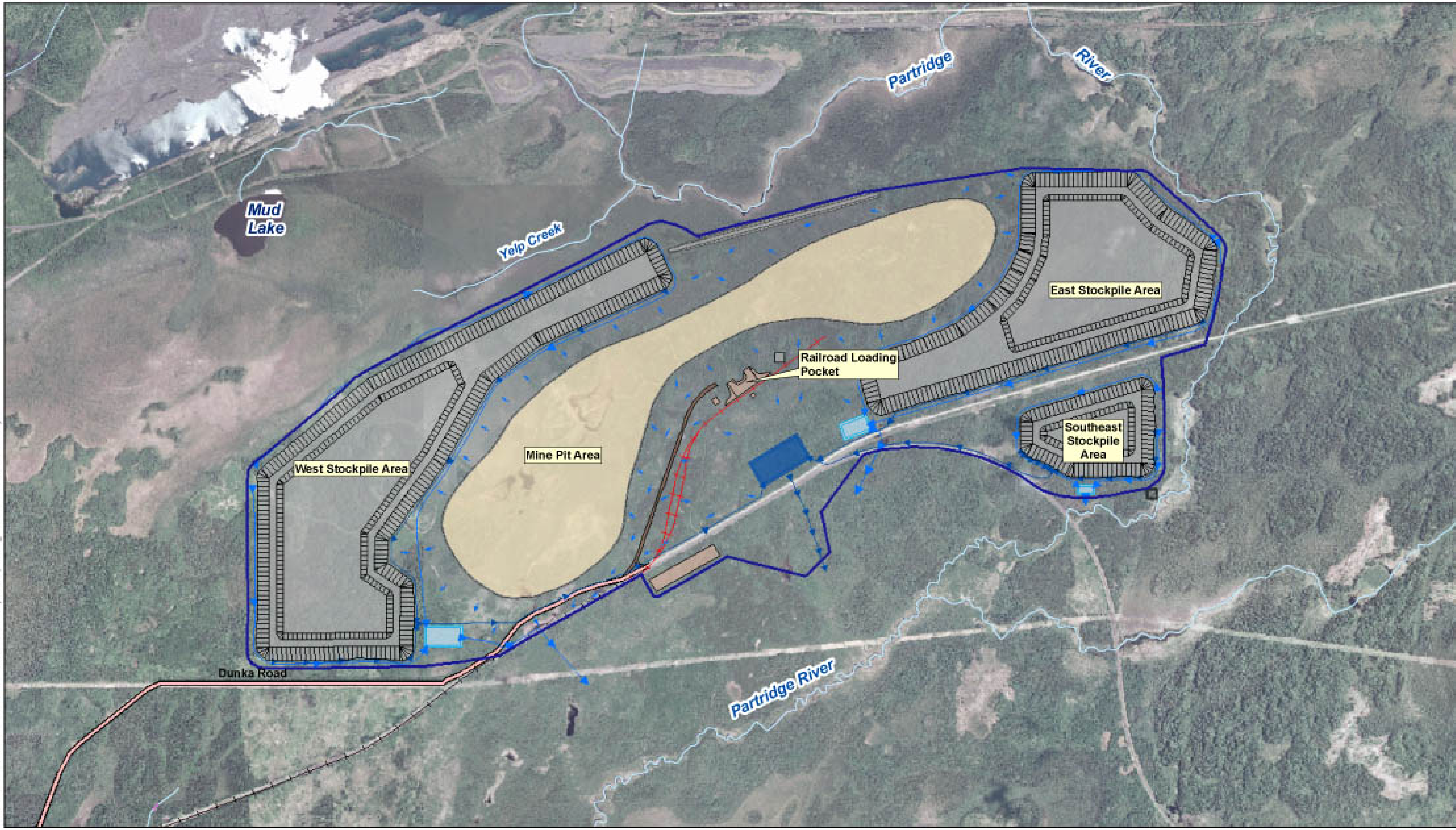
Railroads

- Existing
- Proposed

0 2,000 4,000 8,000 Feet

Allen, Isaac Lake, Babbitt, Aurora, Babbitt SW, and Embarrass
7.5 Minute USGS Quadrangles

Figure 5-2
PROJECT LOCATION ON USGS MAP



Railroads

- Existing
- Proposed
- Project Boundary
- Non-Reactive Runoff Flow Path
- Reactive Runoff Flow Path

- Stockpiles
- D-logging camp
- Mine Infrastructure
- Mine Pit
- Road
- Non-Reactive Runoff Pond
- Reactive Runoff Pond

N

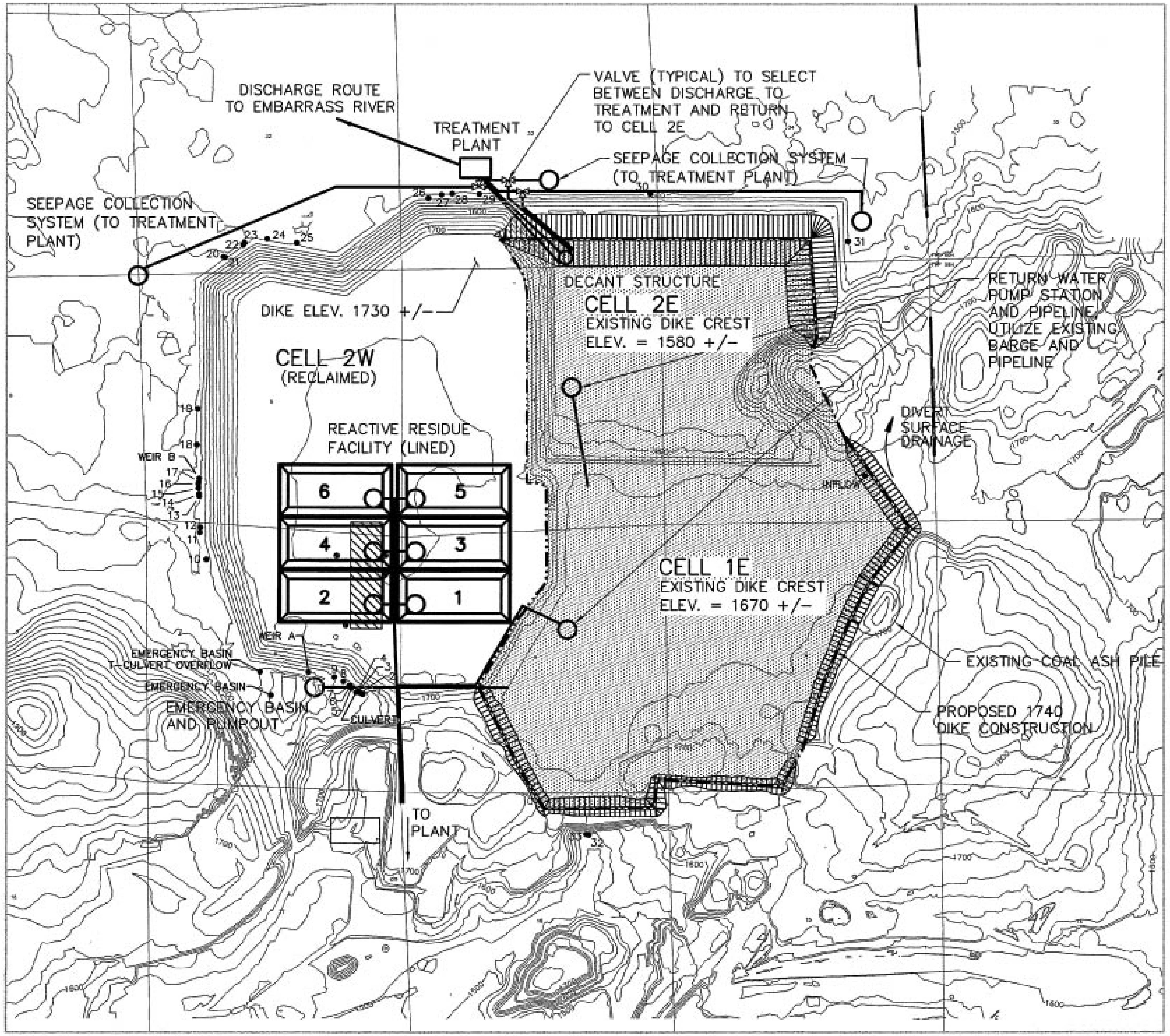
0 2,000 4,000 Feet

2003 FSA Aerial Photo

Figure 5-3
MINE AND STOCKPILES
SITE PLAN

Barr Footer: Date: 11/5/2004 2:57:30 PM File: I:\Client\Polymet\Maps\EAW_DR~1\F10B8~1.MXD User: tja

Figure 5-4
PLANT SITE LAYOUT



N

0 2000 4000
SCALE IN FEET

LEGEND

- EDGE OF BASIN – NO DIKE
- CENTERLINE OF PROPOSED DIKE
- HORNFELS ZONE
- FLOTATION TAILINGS DISPOSAL AREA
- SEEP LOCATION
- MONITORING WELL

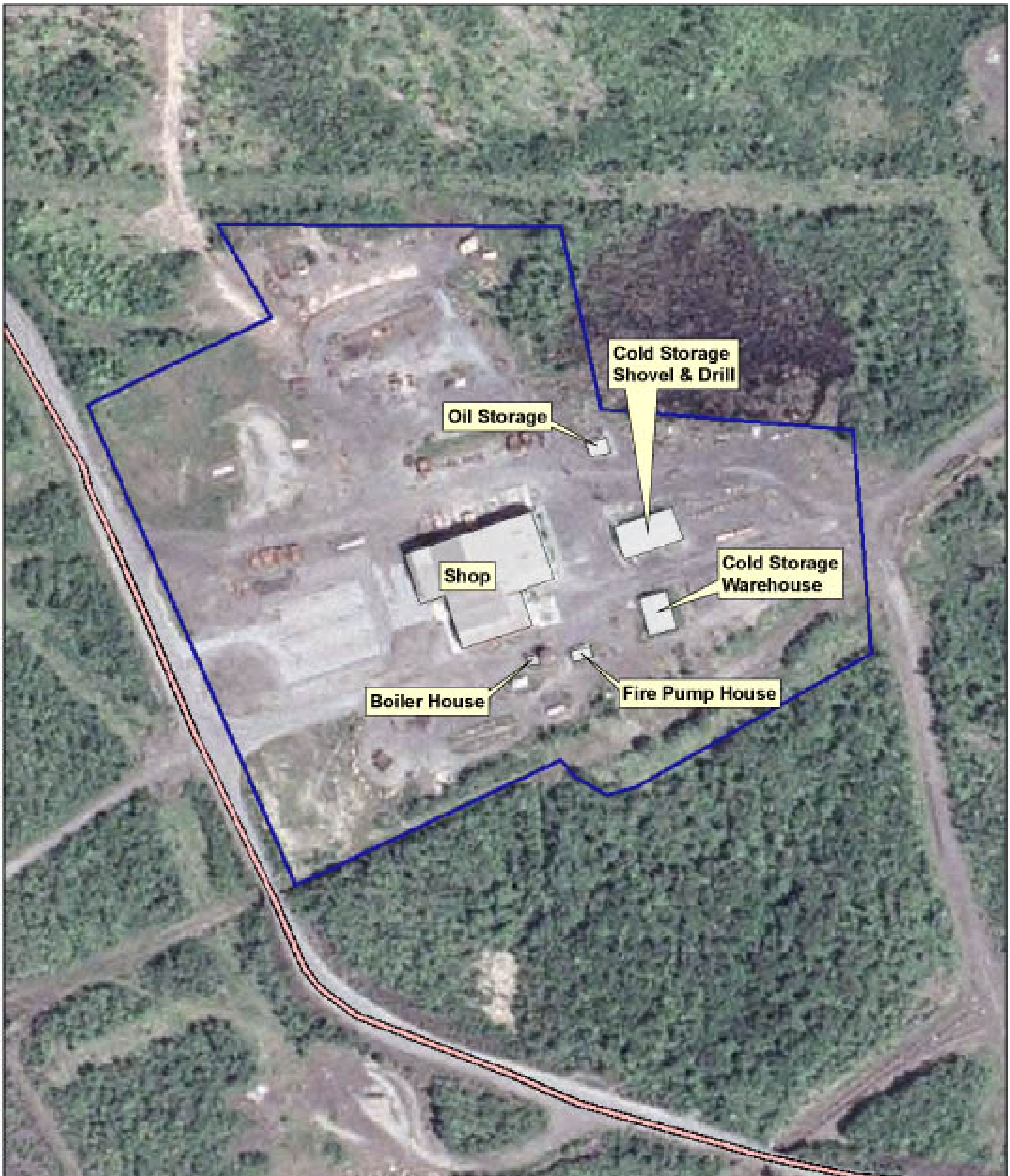
NOTES:

1. EXISTING DIKE ELEVATIONS AS OF 2004.
2. FINAL LOCATION OF TREATMENT PLANT, PUMP STATIONS, AND HYDROMET RESIDUE FACILITY TO BE DETERMINED IN FINAL DESIGN.

Figure 5–5

TAILINGS BASIN MODIFICATIONS
PolyMet Mining, Inc.

Xrefs in Drawing – M:\cad\2369862\20461_1.DWG
PTS M:\CAD\2369862\20471_1.DWG Plot at 1 12/10/2004 15:59:39



2003 FSA Aerial Photo

Legend

Area 1 Shops Area Boundary

Access Roads

0 150 300 600 Feet

Figure 5-6
AREA 1 SHOPS

2003 FSA Aerial Photo

Legend

Railroad Modifcations Area

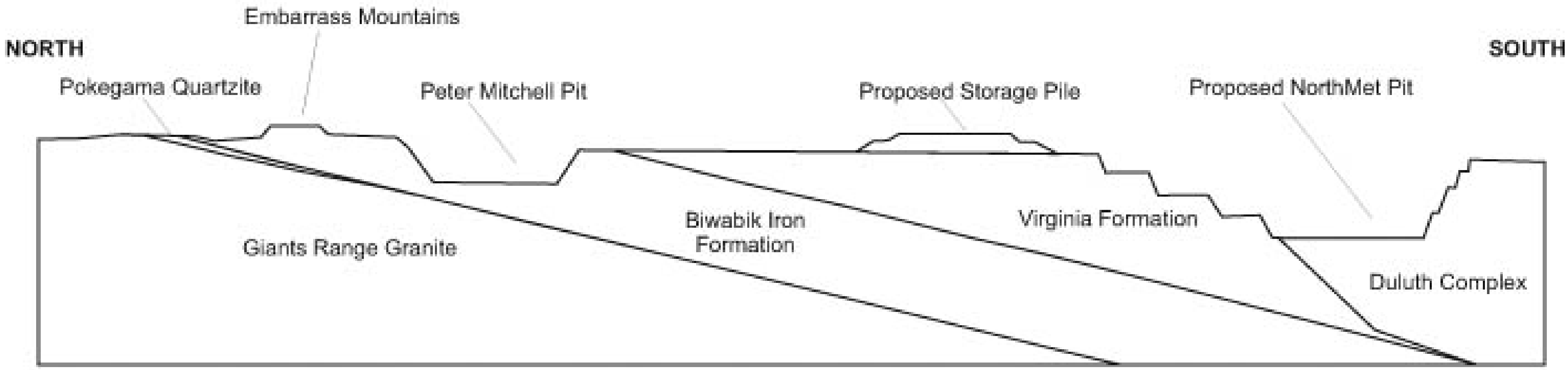
Proposed Railroad

0 200 400 800 Feet

Figure 5-7
RAILROAD MODIFICATIONS

P:\23\69\862\WO 007-4 MDNR Protected Waters Permit\Geo_X-Sec.CDR CDP 11-12-04

Schematic Cross Section From Northshore Mining Peter Mitchell Pit to Proposed NorthMet Pit



Not to Scale

Figure 6-1

PIT CROSS SECTION
PolyMet EAW

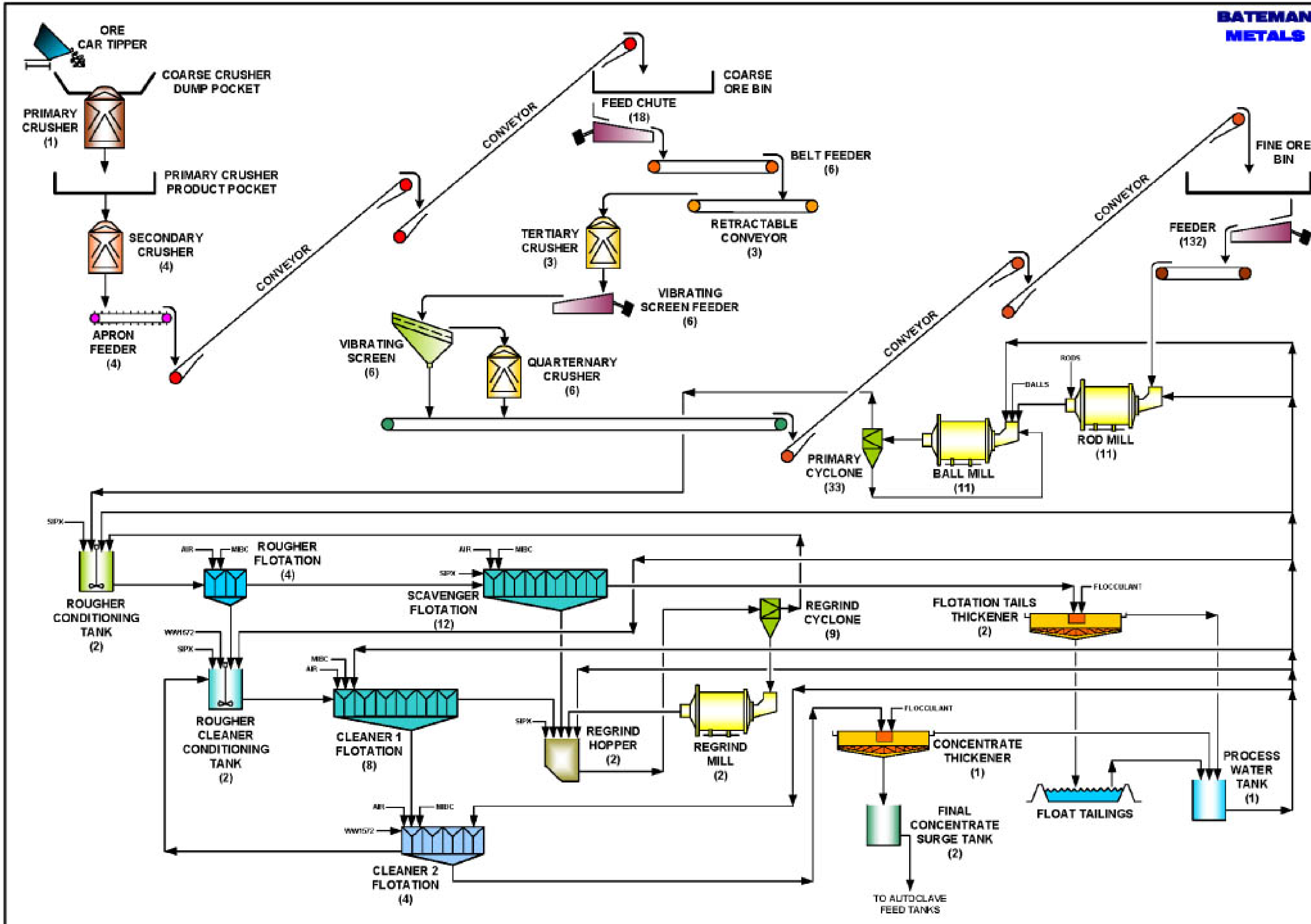


Figure 6-2
COMMINUTION AND FLOTATION SCHEMATIC DIAGRAM

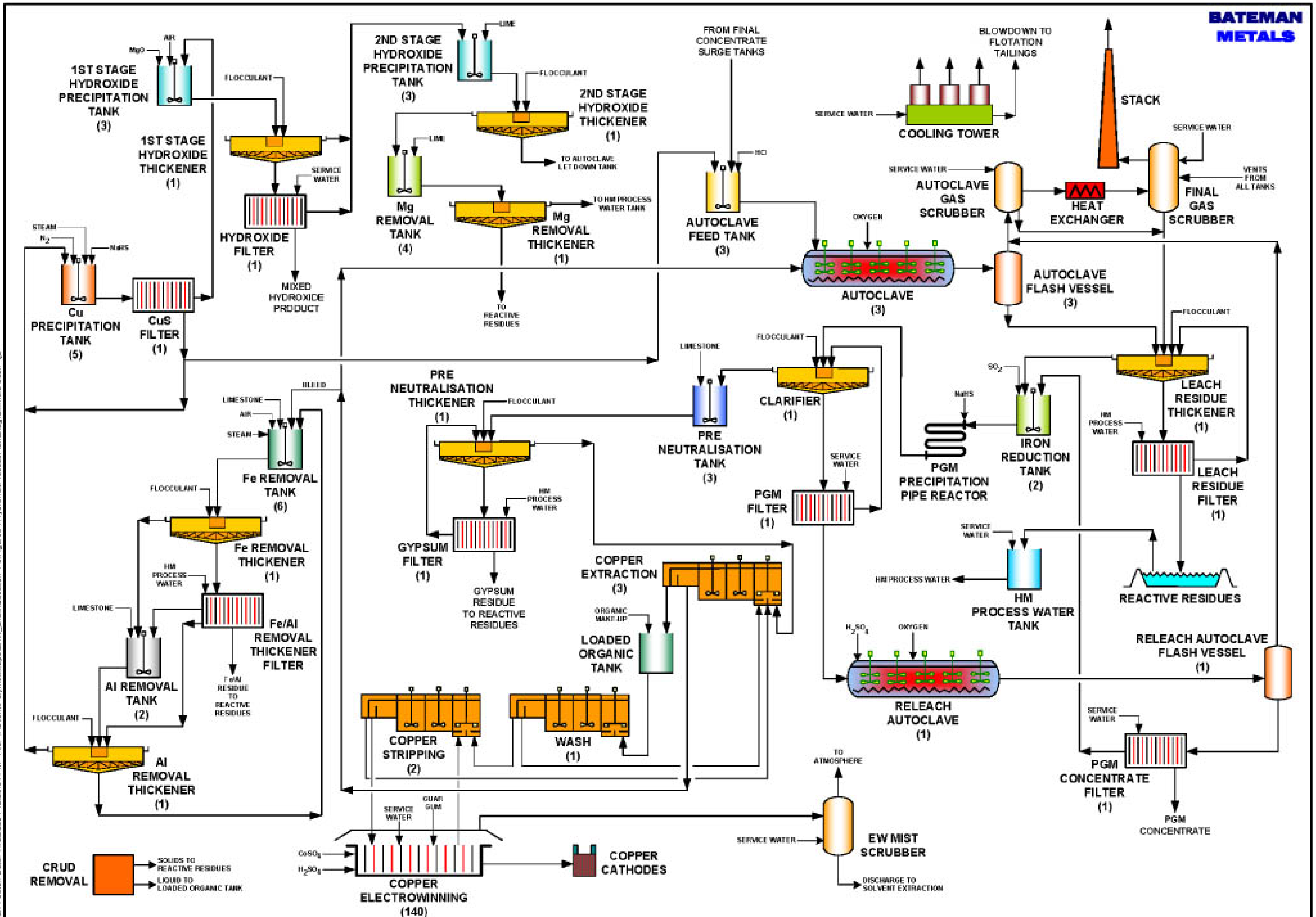


Figure 6-3
HYDROMET PROCESS PLANT SCHEMATIC DIAGRAM

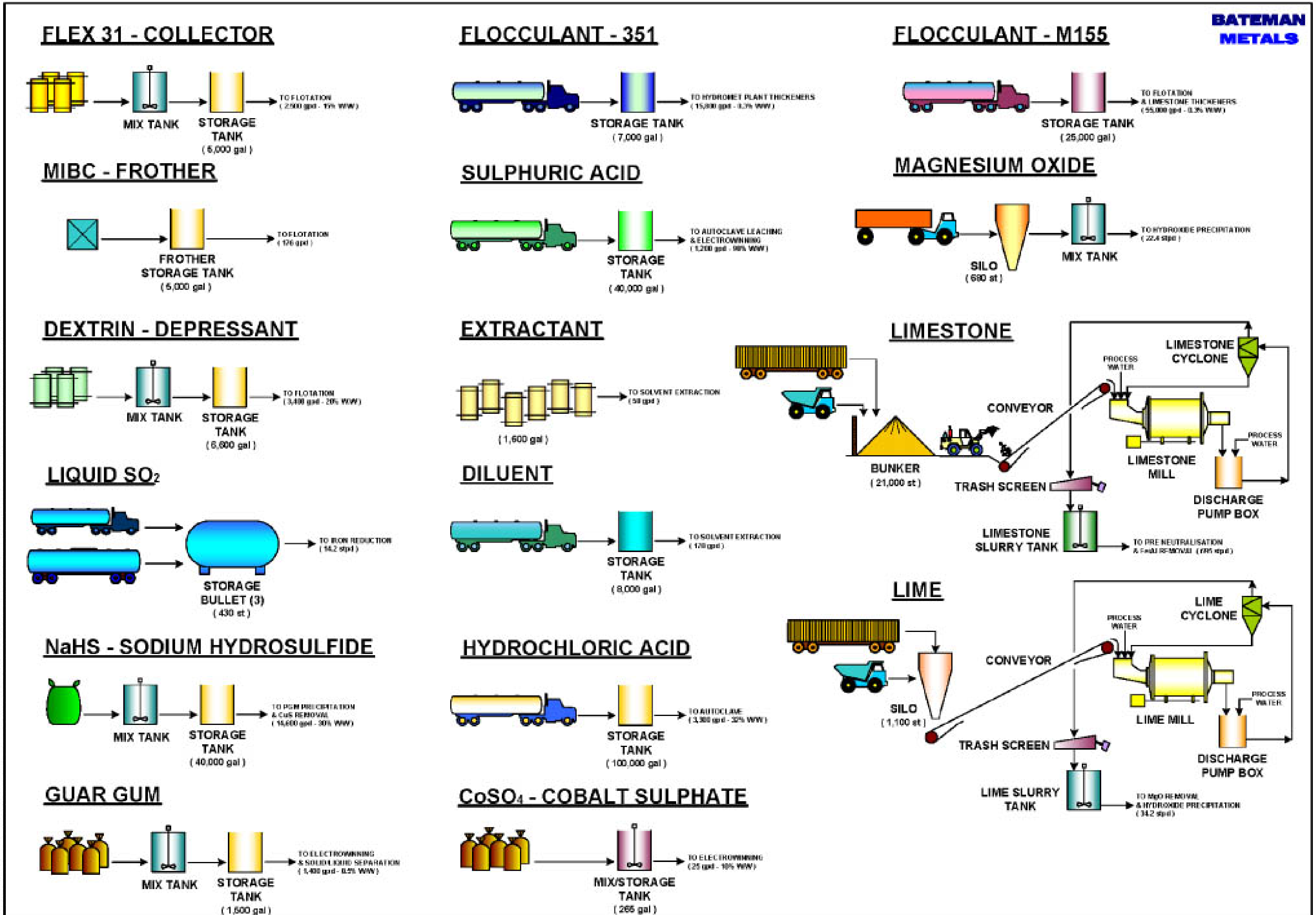
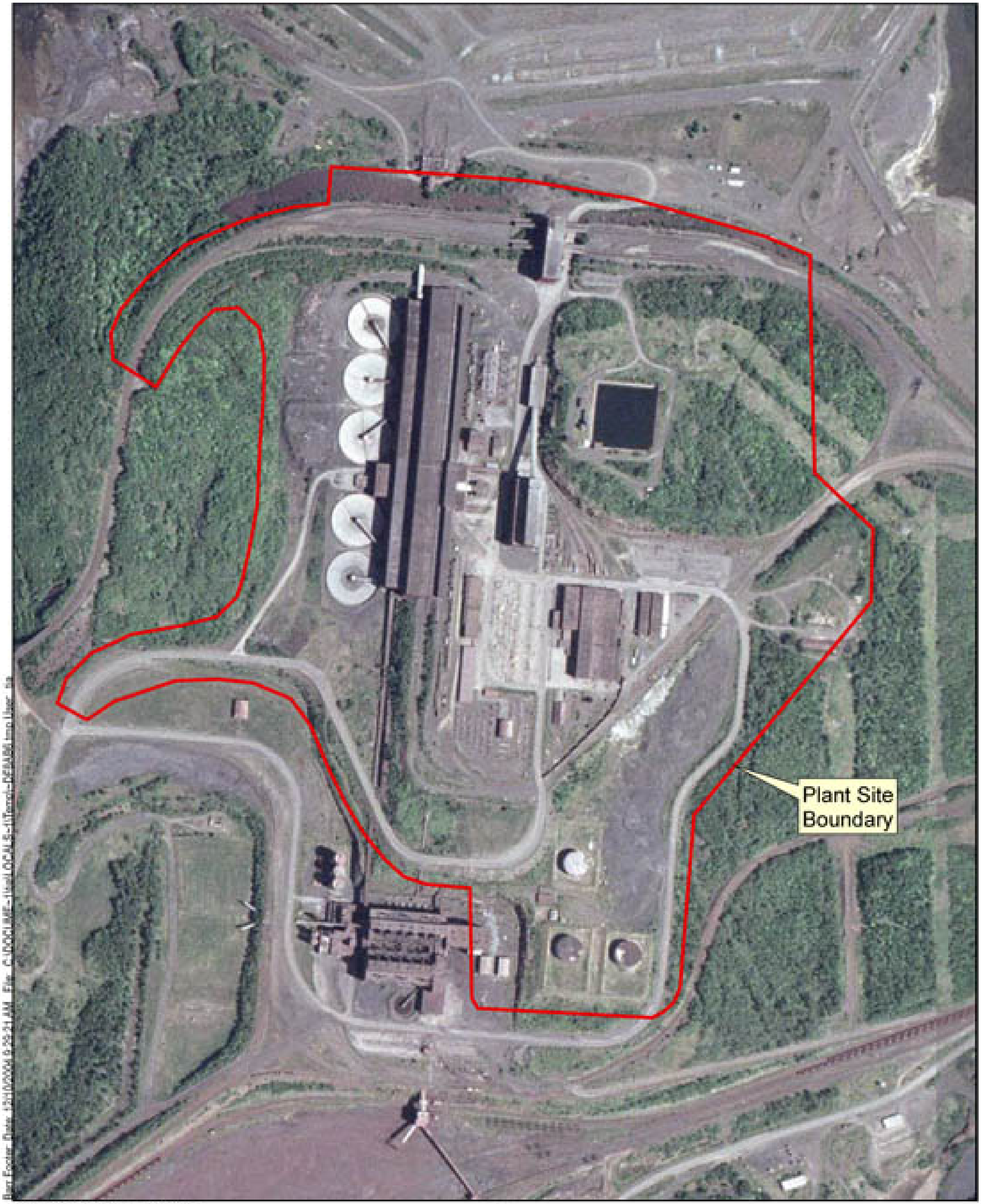


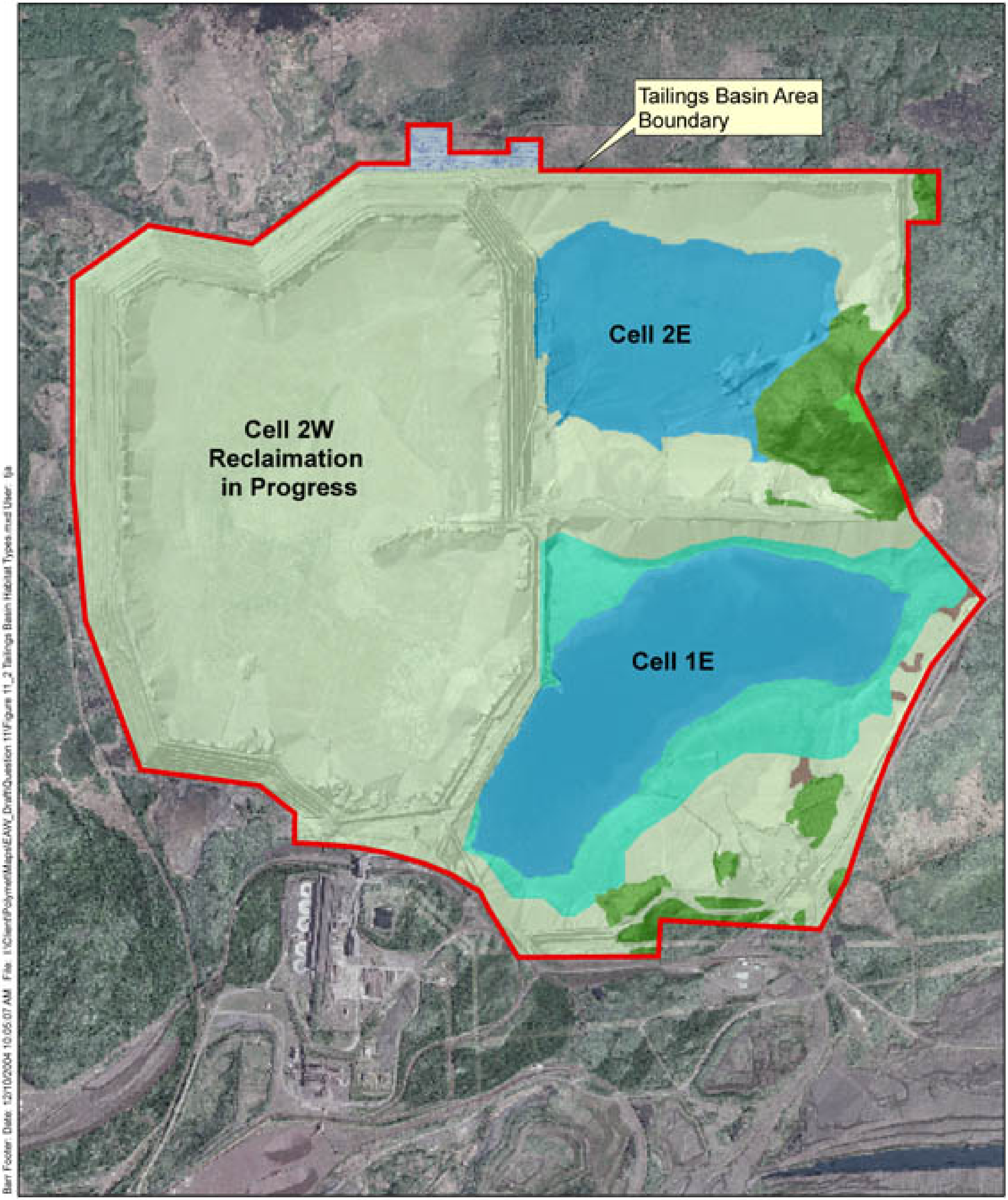
Figure 6-4
PROCESS
CONSUMABLES
SCHEMATIC DIAGRAM



2003 FSA Aerial Photo

600 300 0 600 Feet

Figure 11-1
AERIAL PHOTO OF PLANT SITE

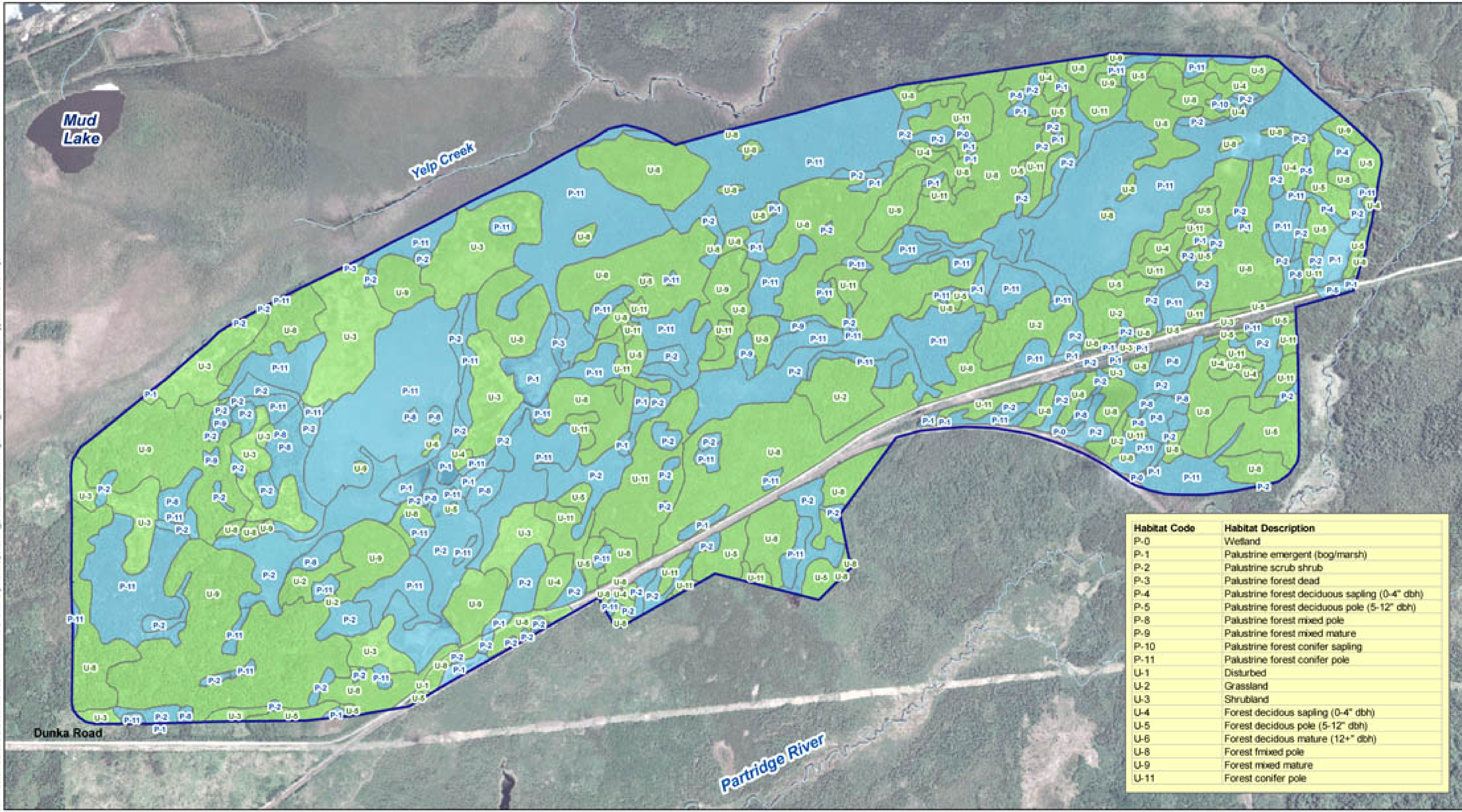


Habitat

- Brush
- Disturbed
- Grassland
- Tailings Basin Lowland
- Tailings Basin Open Water
- Tailings Basin Upland
- Wetland
- Wooded/Forest

0 1,000 2,000 4,000 Feet

Figure 11-2
Existing Habitat
Tailings Basin



Habitat Code	Habitat Description
P-0	Wetland
P-1	Palustrine emergent (bog/marsh)
P-2	Palustrine scrub shrub
P-3	Palustrine forest dead
P-4	Palustrine forest deciduous sapling (0-4" dbh)
P-5	Palustrine forest deciduous pole (5-12" dbh)
P-8	Palustrine forest mixed pole
P-9	Palustrine forest mixed mature
P-10	Palustrine forest conifer sapling
P-11	Palustrine forest conifer pole
U-1	Disturbed
U-2	Grassland
U-3	Shrubland
U-4	Forest decidous sapling (0-4" dbh)
U-5	Forest decidous pole (5-12" dbh)
U-6	Forest decidous mature (12+" dbh)
U-8	Forest fmixed pole
U-9	Forest mixed mature
U-11	Forest conifer pole

Project Boundary

Existing Habitat

Upland

Wetland

0 750 1,500 3,000 Feet

2003 FSA Aerial Photo

Figure 11-3
EXISTING HABITAT
MINE AREA

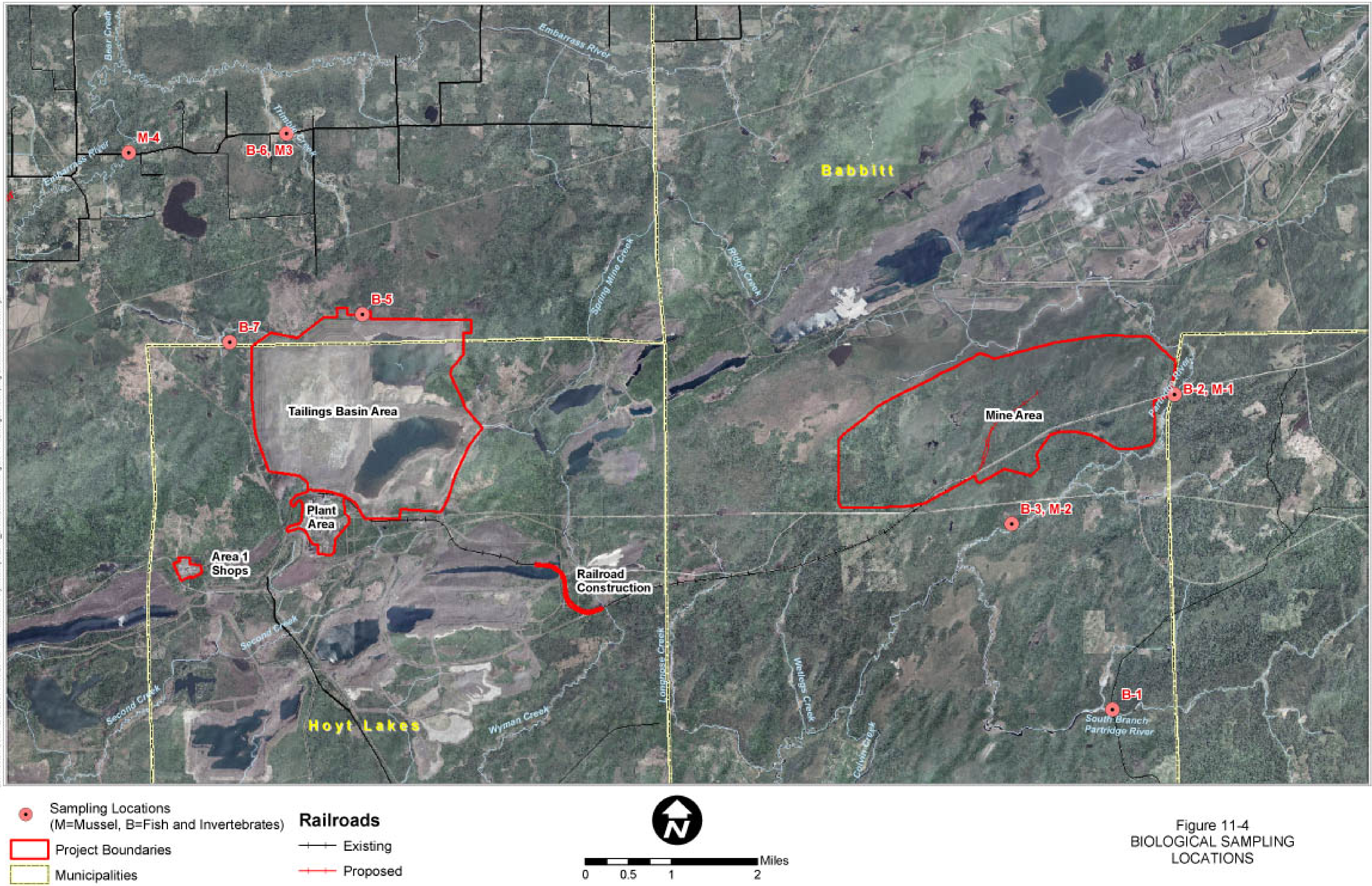
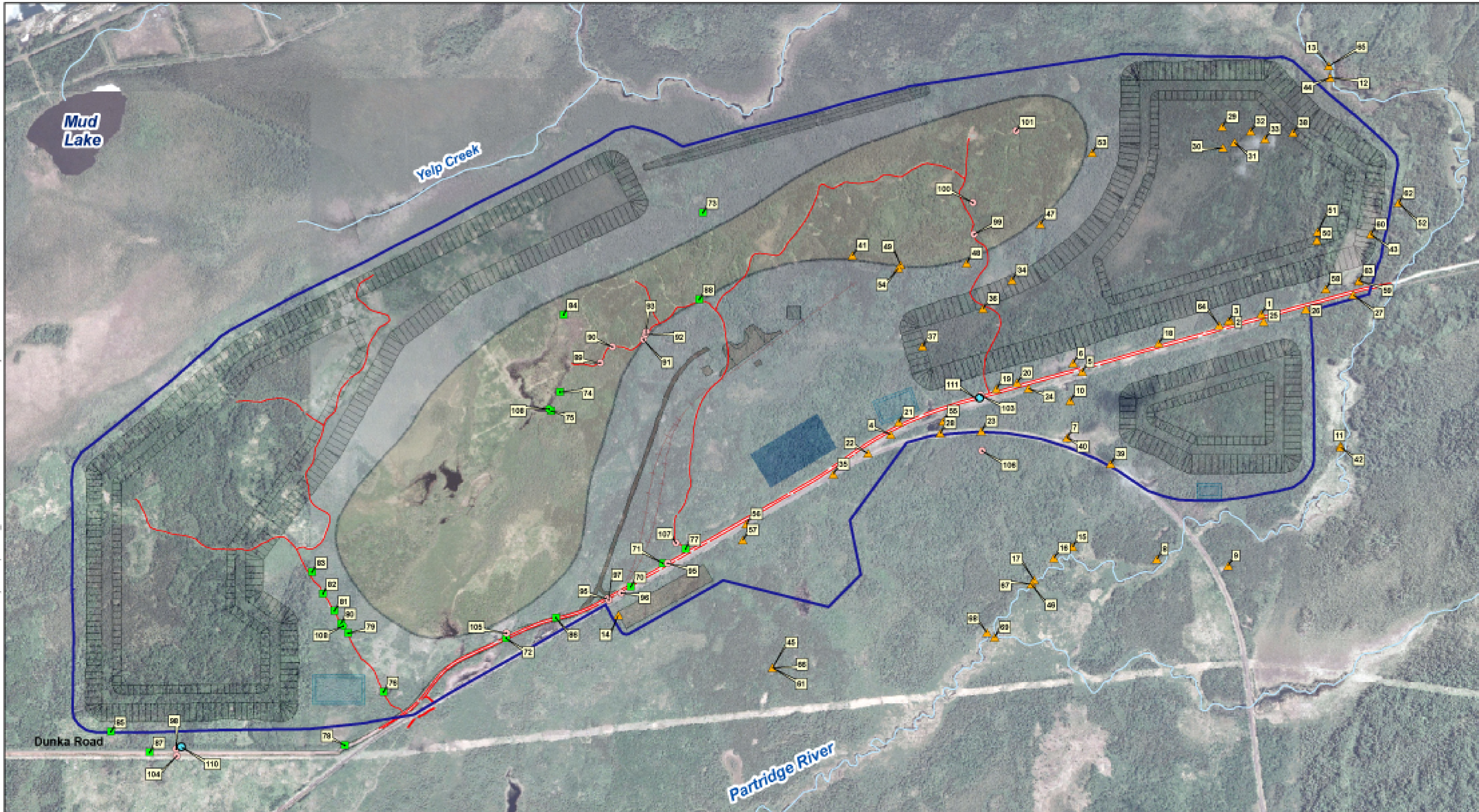


Figure 11-4
BIOLOGICAL SAMPLING LOCATIONS



Rare Species Locations (by Botanist)

- Cindy Johnson-Groh
- Deborah Pomroy-Petry
- ENSR
- Foth & Van Dyke
- Gary Walton

Mine Area Features

- Stockpiles
- Infrastructure; Sideslope
- Mine Pit
- Road
- Non-Reactive Pond
- Reactive Pond

- Project Boundary
- Existing Roads/Trails
- Wetland

N

0 750 1,500 3,000 Feet

2003 FSA Aerial Photo

Figure 11-5
RARE PLANT SPECIES

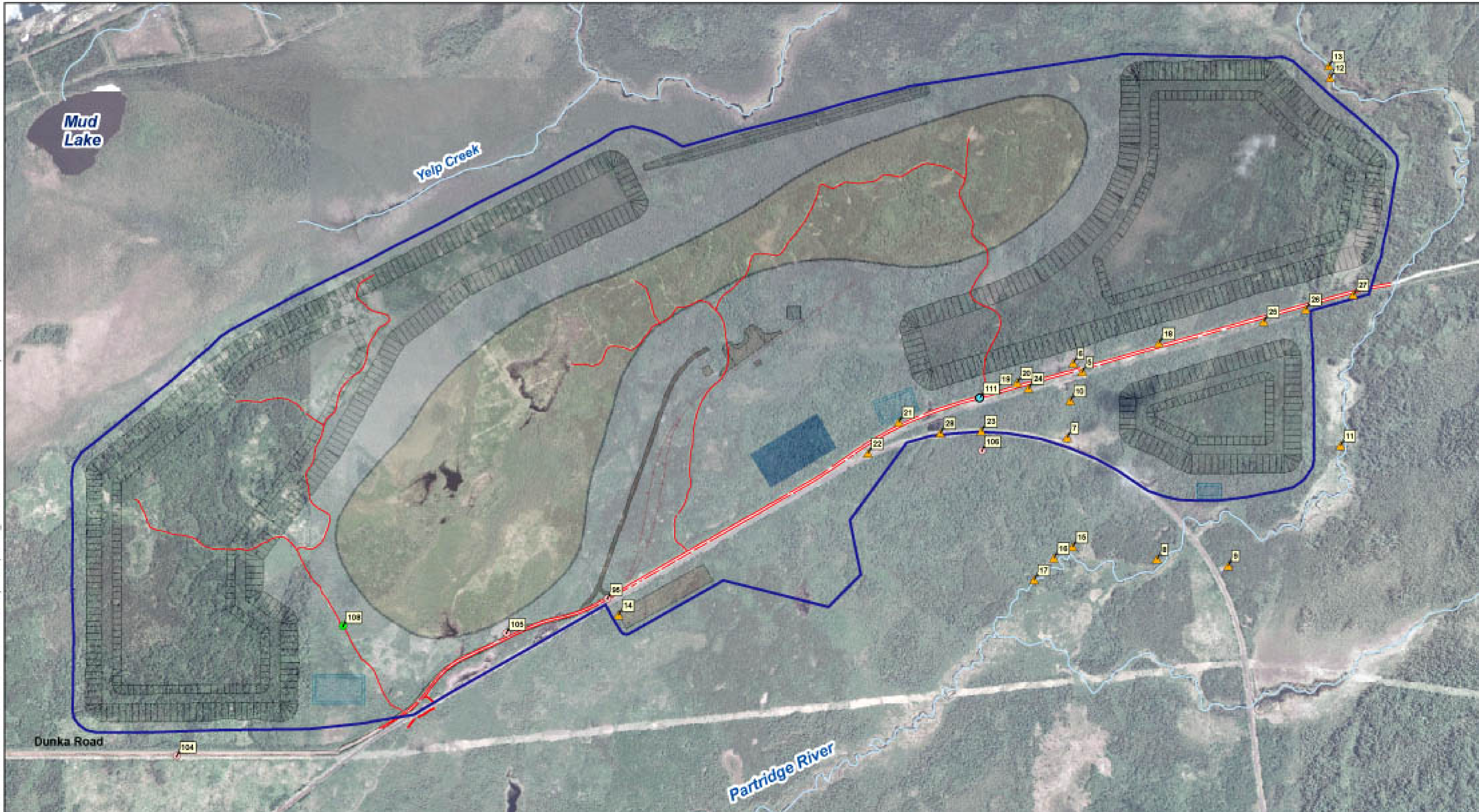


Figure 11-6
ENDANGERED OR THREATENED PLANT SPECIES

Barr Footer: Date: 12/2/2004 3:52:04 PM File: I:\Client\Polymet\Maps\EAW_DR~1\QUESTI~2\FIGURE~2.MXD User: tja

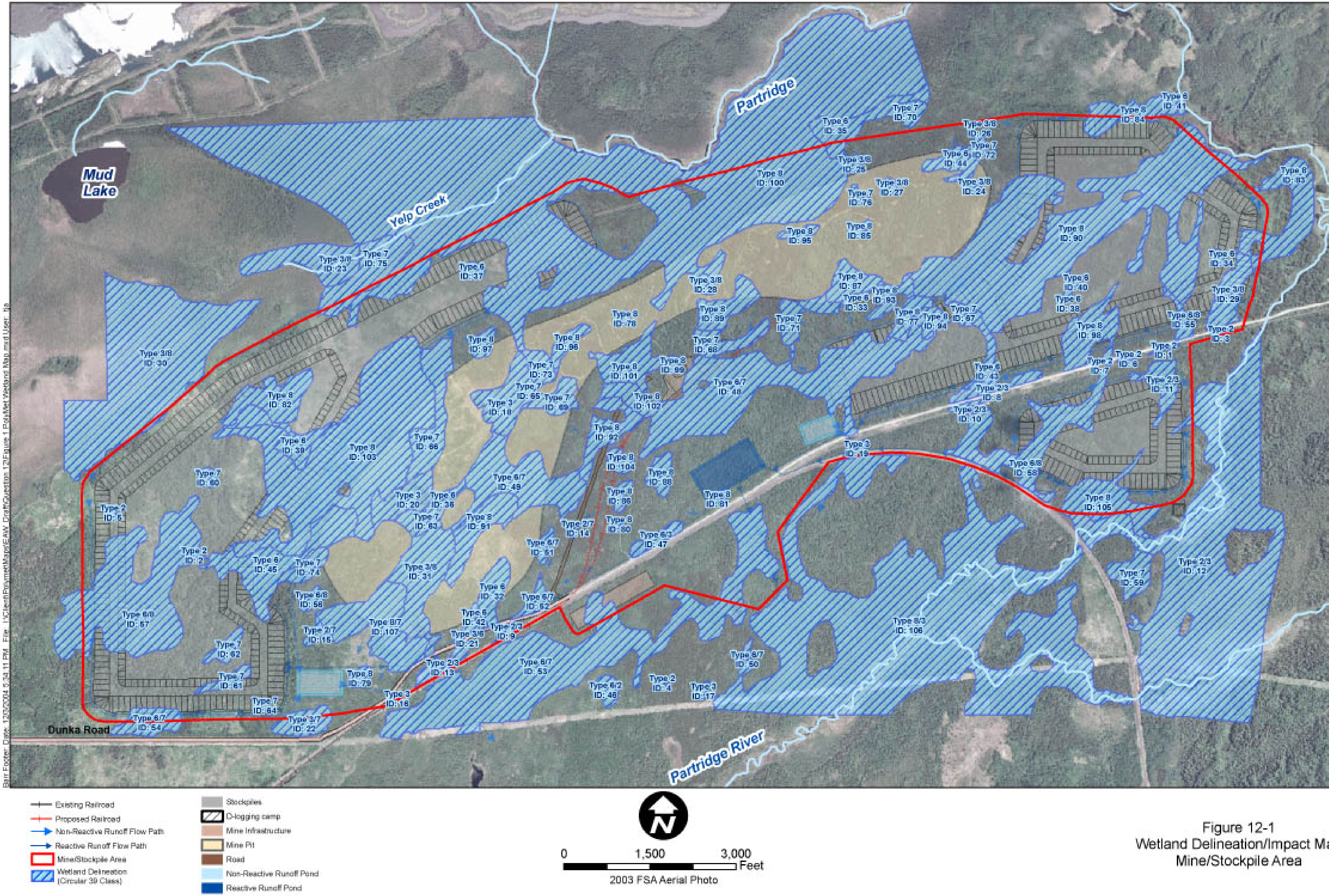


Figure 12-1
Wetland Delineation/Impact Map
Mine/Stockpile Area

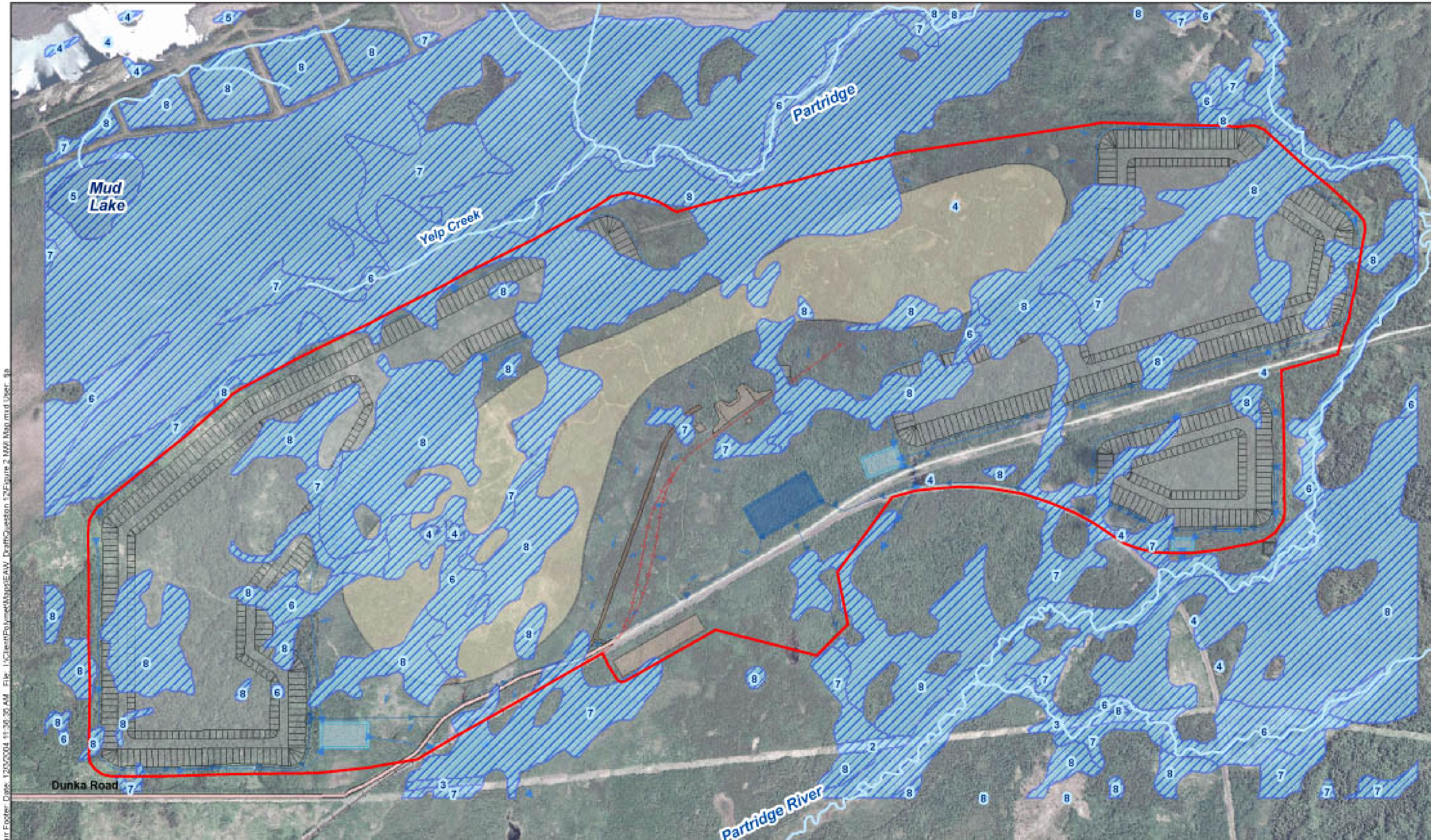


Figure 12-2
NWI Wetlands
Mine/Stockpile Area

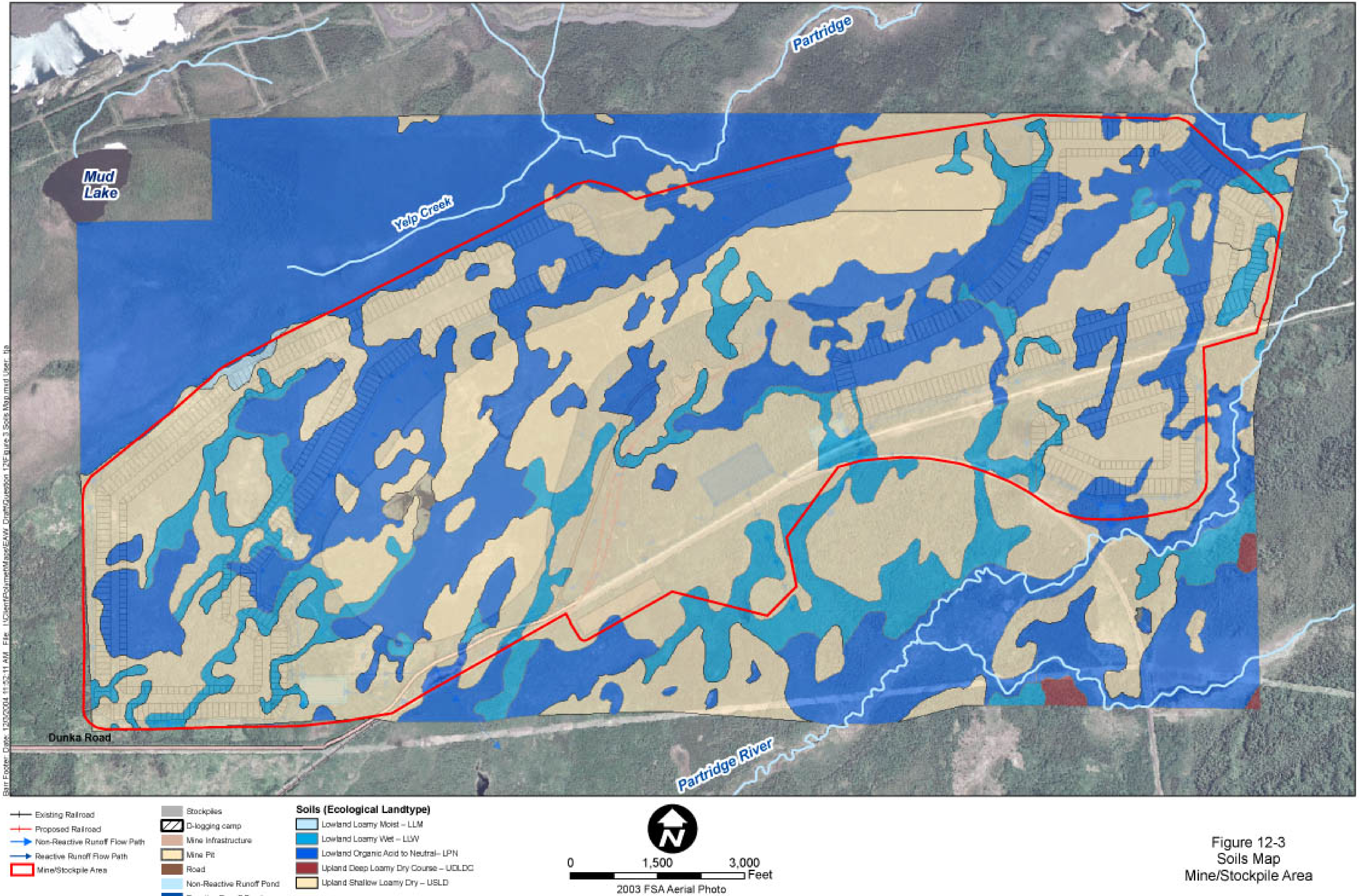
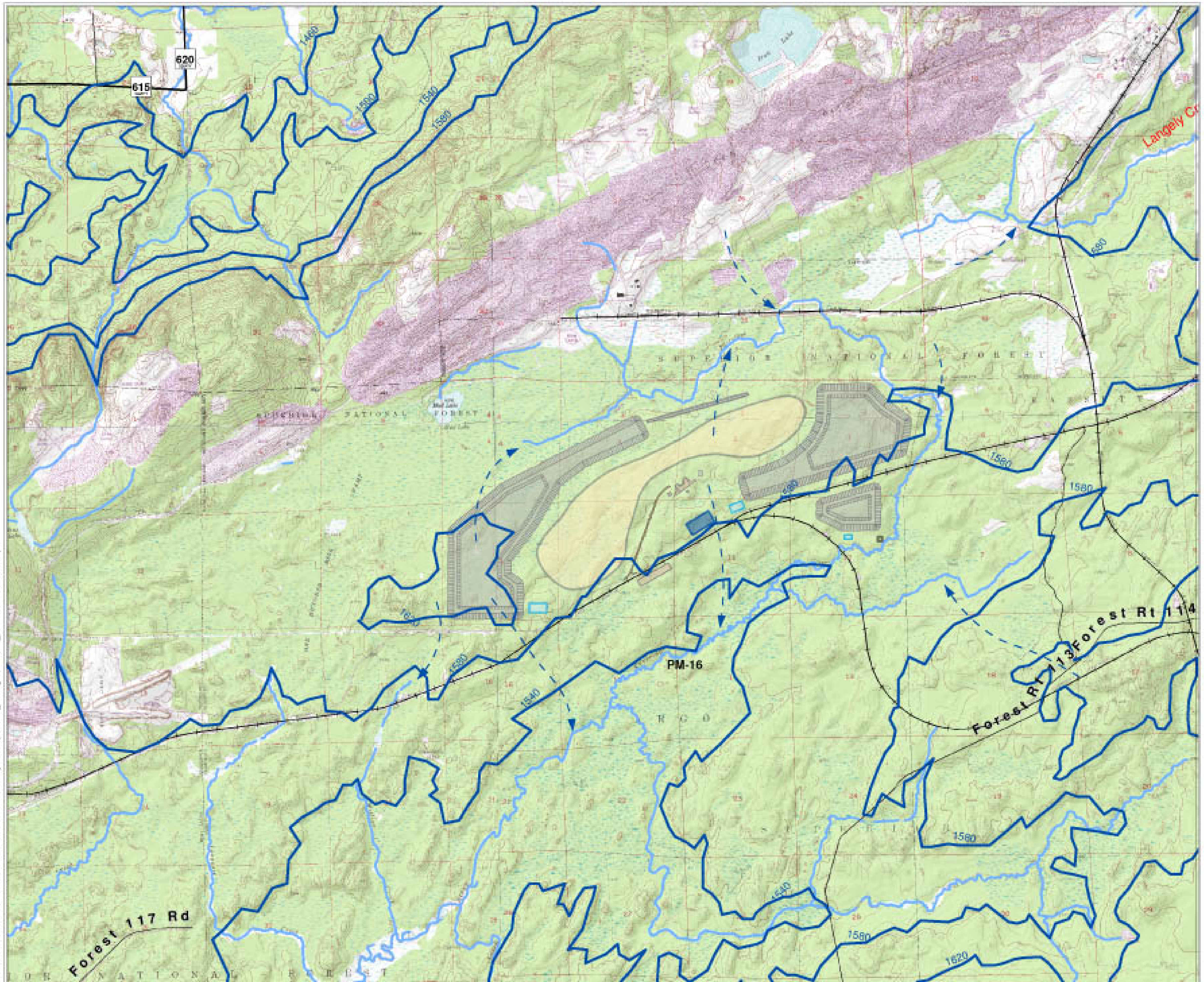


Figure 12-3
Soils Map
Mine/Stockpile Area



Legend

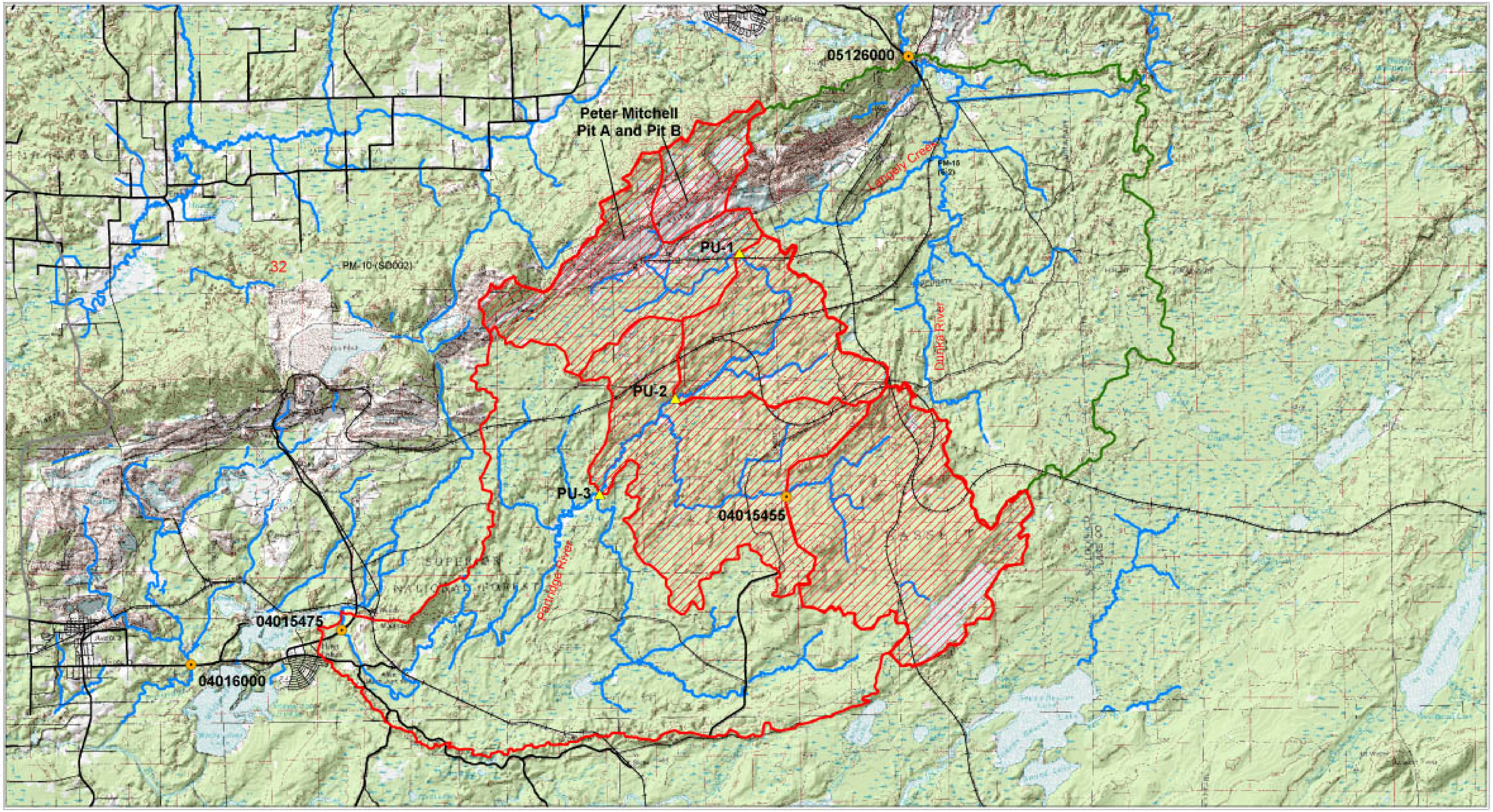
- Streams
- Water Table Contour (ft)
- Approximate Groundwater Flow Direction

Groundwater Elevation Data from :
Siegel, D.I. and D.W. Ericson, 1980. *Hydrology and Water Quality of the Copper-Nickel Study Region, Northeastern Minnesota.* U.S. Geological Survey Water-Resources Investigations Open File Report, USGS WRI 80-739.

0 1,250 2,500 5,000 7,500 10,000 Feet

Allen, Babbitt, Babbitt SW, and Isaac Lake 7.5 Minute USGS Quadrangles

Figure 13-1
Groundwater Contours
Near Mine Site



USGS Gaging Station

Ungaged Stream Site

Dunka River Watershed

Partridge River Watershed

Partridge River Sub-Watershed

0 0.5 1 2 3 4 5 6 7 Miles

Figure 17-1
SUBWATERSHEDS NEAR
THE MINE SITE

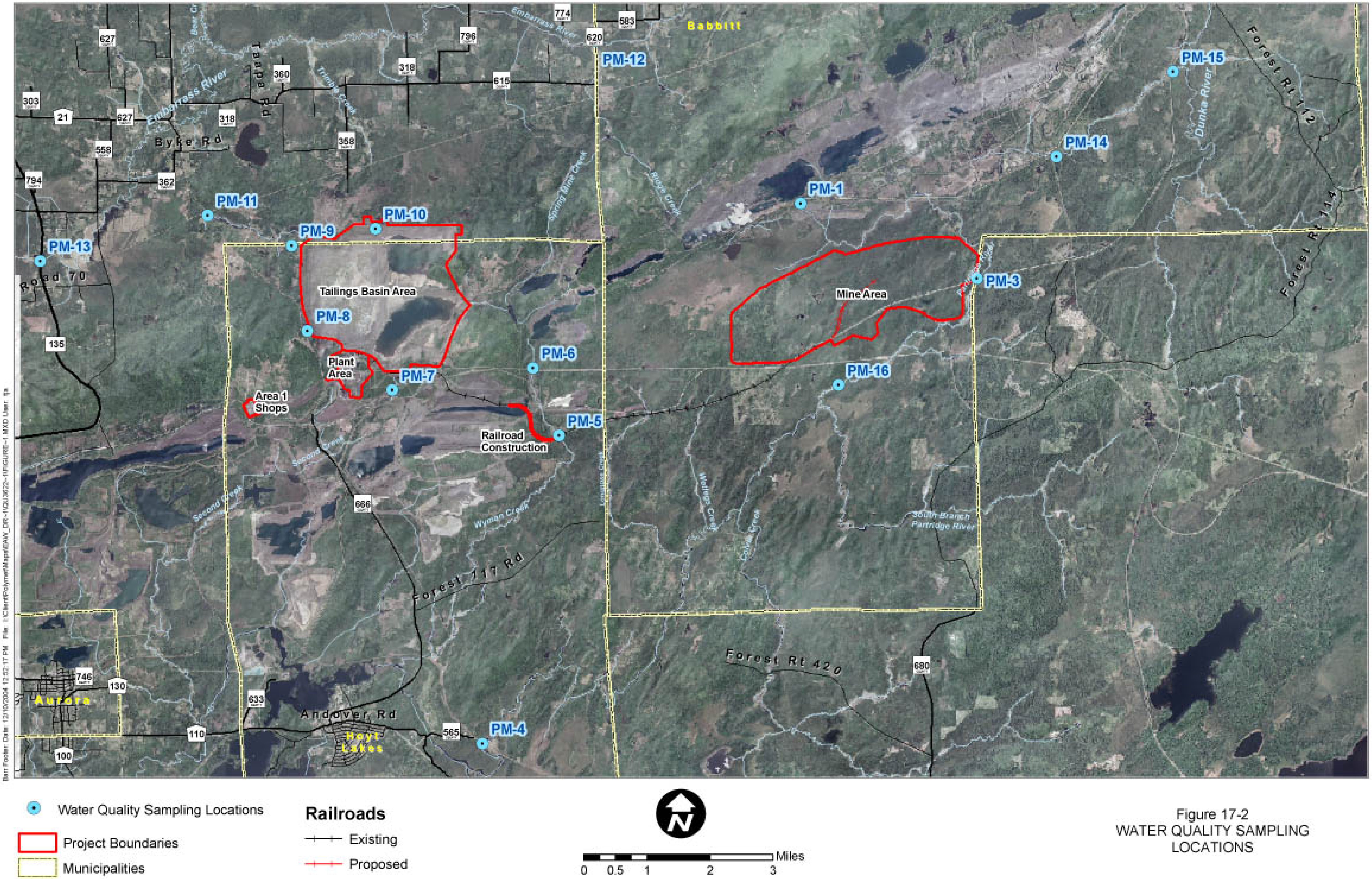


Figure 17-2
WATER QUALITY SAMPLING LOCATIONS

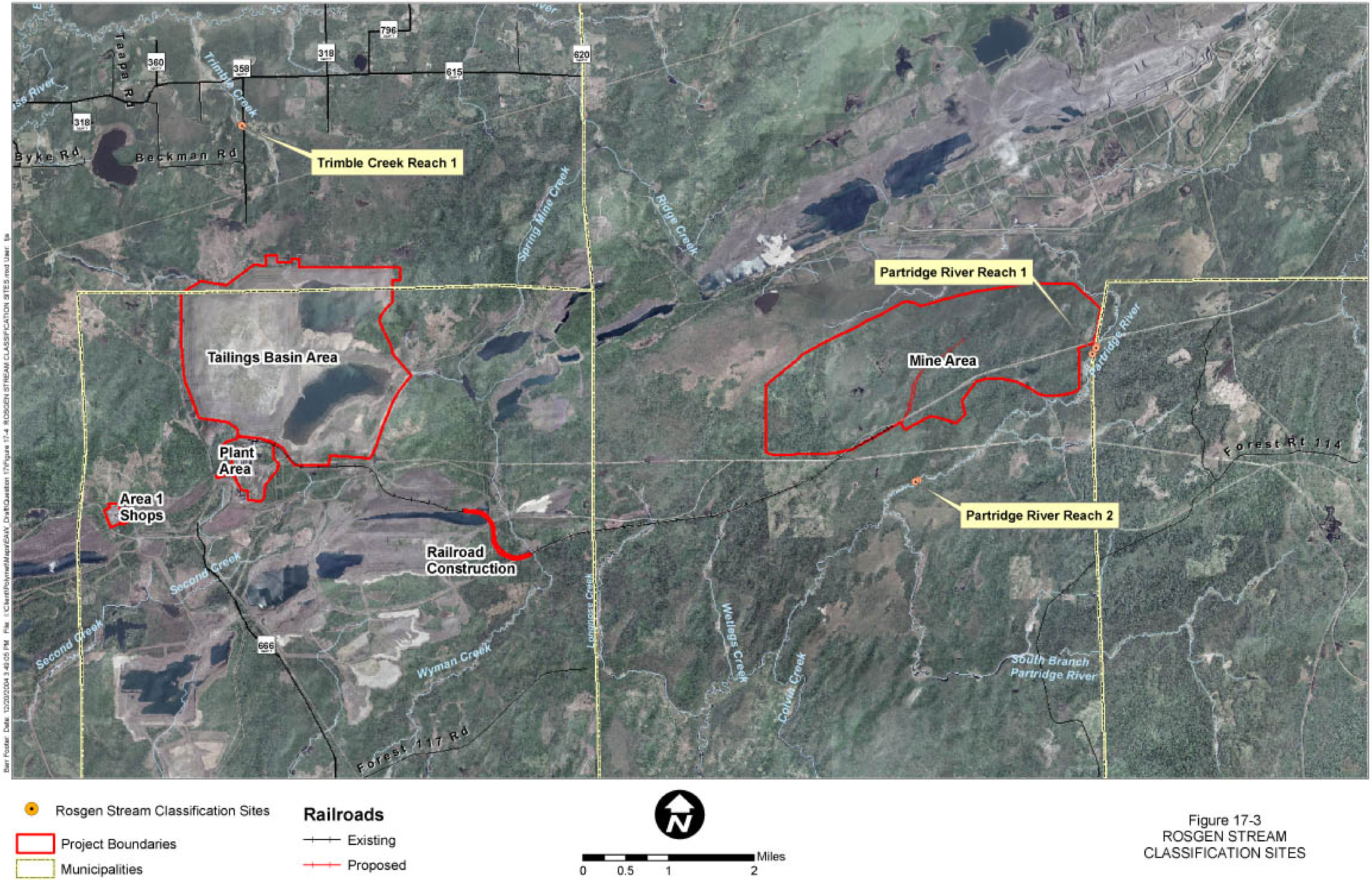
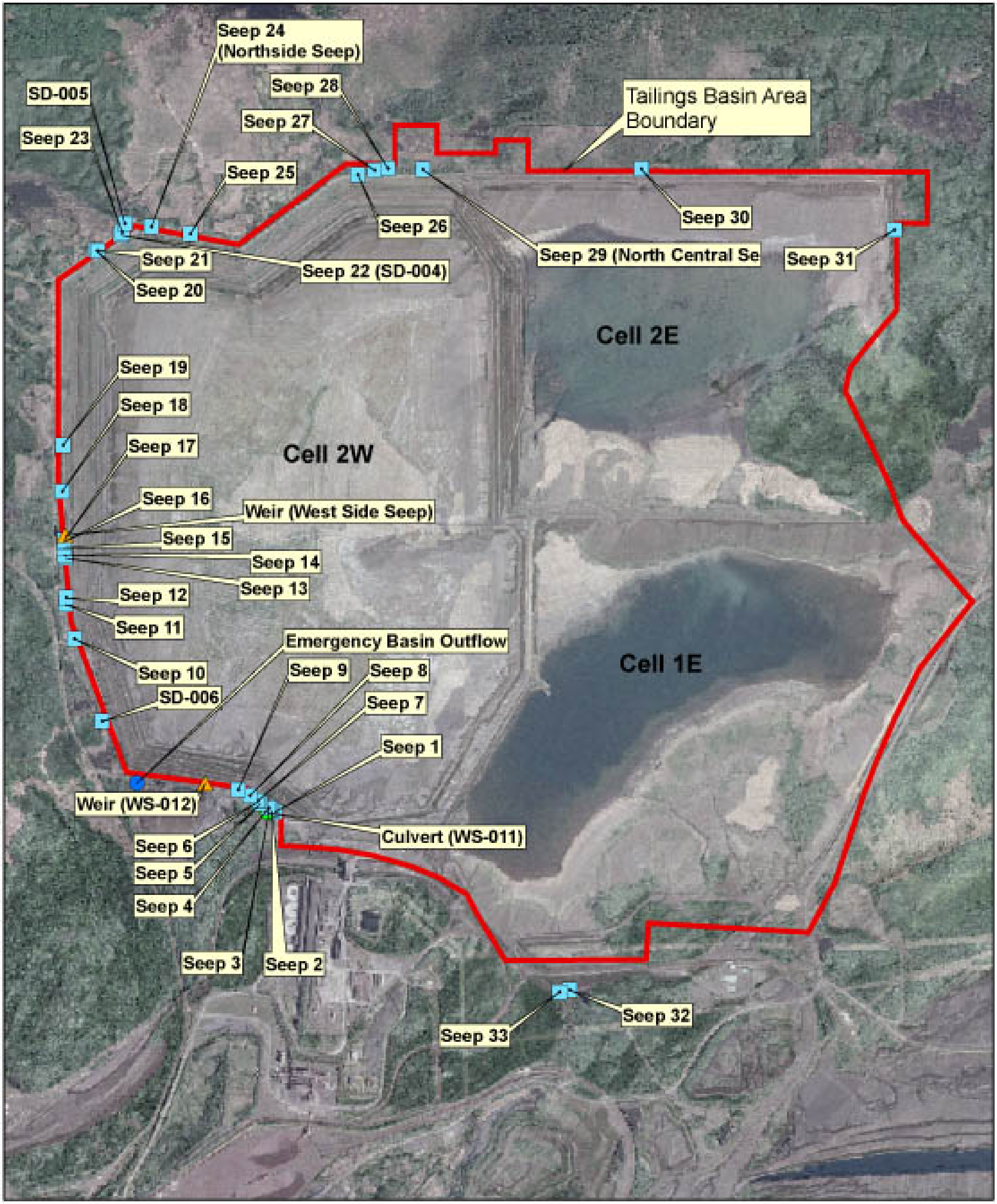


Figure 17-3
ROSGEN STREAM
CLASSIFICATION SITES



Seeps

- Culvert (WS-011)
- Emergency Basin Outflow
- Seeps
- Weirs

0 1,000 2,000 4,000 Feet

2003 FSA Aerial Photo

Figure 18-1
Seep Locations
Tailings Basin

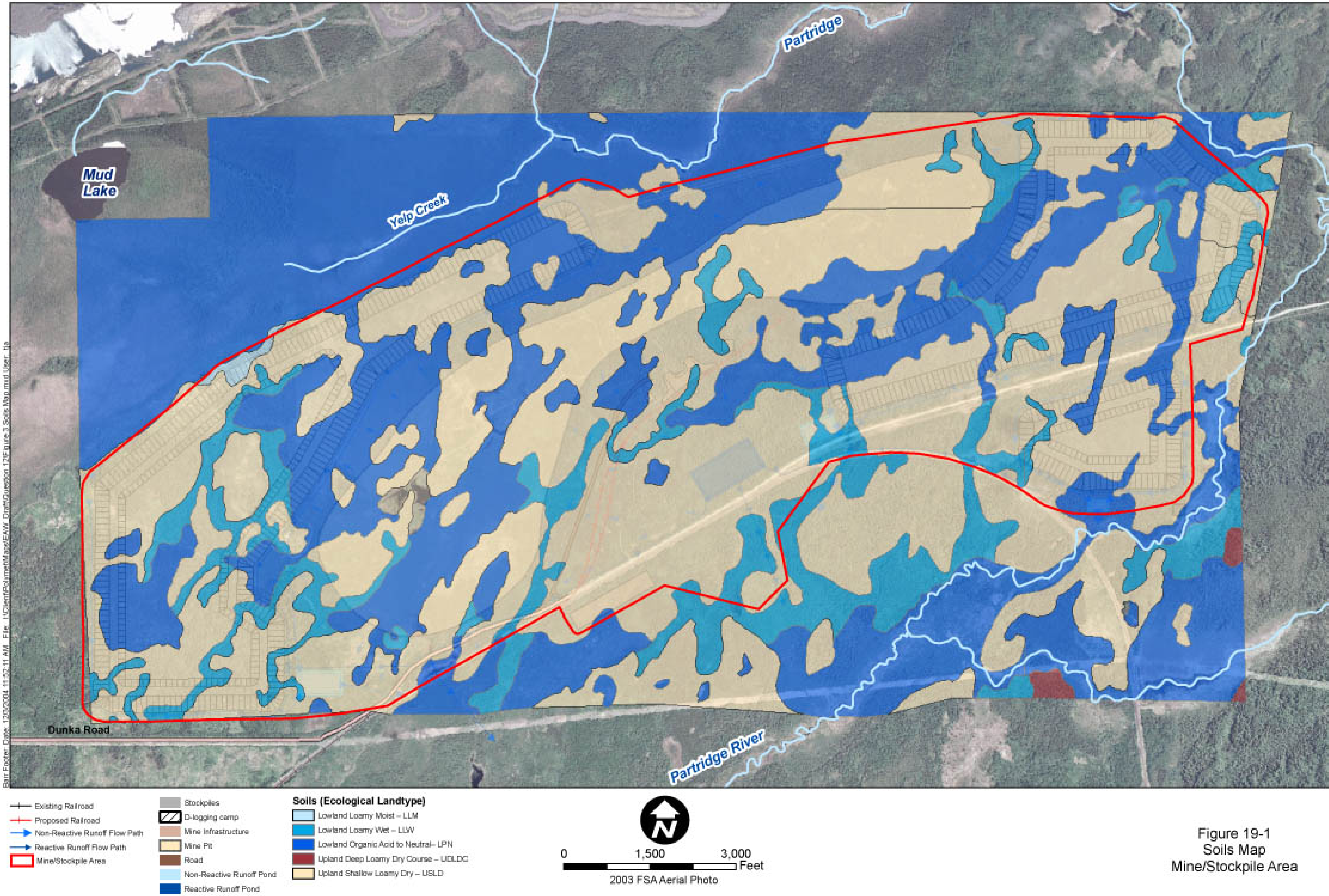
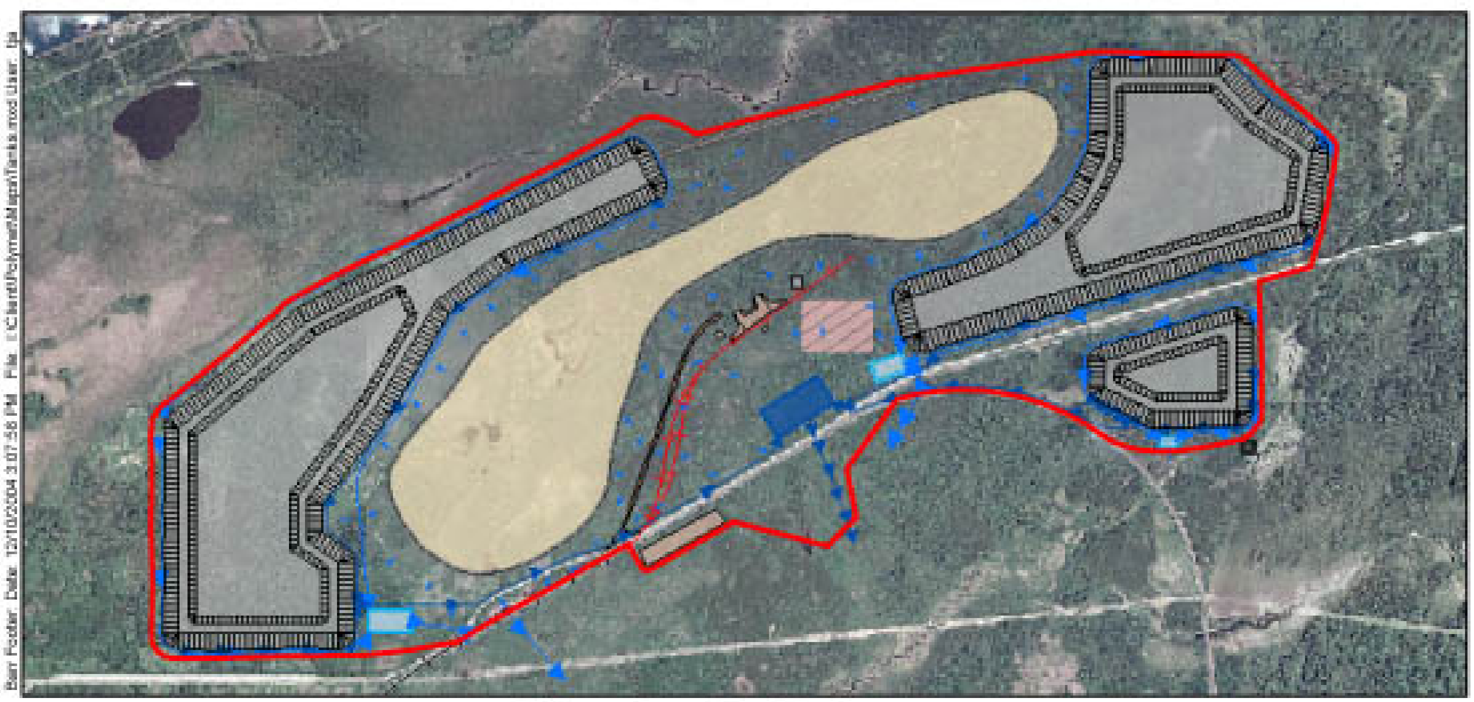


Figure 19-1
Soils Map
Mine/Stockpile Area

Area 1 Shops

Plant Area



Mine/Stockpile Area

Project Areas

General Tank Locations

Figure 20-1
GENERAL LOCATION OF TANKS
AREA 1 SHOPS, PLANT AREA
AND MINE/STOCKPILE AREA

Scoping Environmental Assessment Worksheet: Appendix A

APPENDIX A – ORE PROCESSING DETAIL

The following is a detailed description of the proposed ore processing steps.

CRUSHING

Coarse Crushing

The objective of the Coarse Crushing area is to reduce ore in two stages to a size suitable for further size reduction in Fine Crushing.

Operating approximately 17 hours a day, the coarse crushing circuit comprises Primary and Secondary Crushers that deliver crushed ore at a P_{80} of 3.4 in to the Coarse Ore Bins in the Fine Crushing building.

Trains deliver ore from the open pit to the Coarse Crusher Dump Pocket. A remotely controlled jack empties each ore car sequentially into the Primary Crusher (60"gyratory) that is capable of crushing ore at an average rate of 1852 short tons/hr, with peak loadings up to 2150 short ton/hr.

The Primary Crusher discharges into a Primary Crusher Product Pocket from which crushed ore is withdrawn under gravity into four parallel Secondary Crushers (36" gyratory) that operate in a choke fed mode.

A conveyor train (1A/2A), is fed by Apron Feeders under each Secondary Crusher. The 2A conveyor delivers coarse ore to the Coarse Ore Bin via tripper.

The Coarse Ore Bin has a live capacity of approximately 4 hours and supplies feed to Fine Crushing.

Emission control is provided by a separate collection system within the Coarse Crushing building. The emission controls consist of a single dry bag house for the Primary and Secondary Crushers. The material collected is slurried and added to the milling circuit as Ball Mill Feed.

Fine Crushing

The objective of the Fine Crushing area is to further reduce the coarse crushed product in two stages of reduction to a size suitable for feed to Milling. There are three Fine Crushing Trains.

Coarse ore is withdrawn from the Coarse Ore Bin to one of three Fine Crushing Trains. Each train consists of a Tertiary Crushers (7' Standard cone), two Vibrating Screens and Two Quaternary Crushers (7' Shorthead cone). For each train, a set of six feeders discharges to three conveyors (two Cross Conveyors and one Retract Conveyor) that in turn discharge into each Tertiary Crusher. The Retract Conveyor that feeds the Tertiary Crusher is retractable to allow for crusher maintenance. Each Retract Conveyor is fitted with a metal detector to prevent tramp metal from entering the Tertiary Crushers.

The discharge product of each Tertiary Crusher then passes via vibrating feeder to two screens per crusher, six in total. The oversize material from each screen discharges to a matched Quaternary Crusher operating in open circuit on the screen oversize. The screen undersize material passes directly to a conveyor below the fine crushing circuit that collects all screen undersize and Quaternary Crusher products. The final crushed product conveyor 3A discharges to a second conveyor 4A or 4B that transfers the crushed product to the Fine Ore Bins where conveyor 4A or 4B discharges to conveyors 5N or 5S. A tripper on each conveyor 5N and 5S distributes the crushed ore across the Fine Ore Bin. A transfer point at the discharge of conveyor 3A allows crushed ore to be distributed to conveyors 4A or 4B that in turn allows the crushed ore to be distributed to the Fine Ore Bins ahead of the North and South Milling Trains.

The Fine Ore Bin has a live capacity of approximately 13 hours and feeds eleven groups of 12 vibrating feeders, one group for each of eleven Milling Trains. Each group of 12 feeders then discharges to a single Rod Mill Feed Conveyor. Not all of the feeders are required to run to supply the required milling feed rate to each Rod Mill. Each Rod Mill Feed Conveyor is fitted with a weightometer that is used to adjust the vibrating feeders for controlled delivery of crushed fine ore to the Rod Mills.

Emission control is provided by wet venturi scrubbers on each Fine Crushing Train plus the conveyor transfer points Fine Crushing Building. The material collected is added to the milling circuit as Ball Mill Feed.

MILLING

The objective of the Milling area is to liberate the sulfide minerals contained in the ore through the milling process. Once liberated, the base metal sulfide minerals are amenable to separation and upgrade by froth flotation.

The milling circuit comprises eleven parallel trains of Rod/Ball Mills, which each take an equal proportion of the overall plant feed.

Each Rod Mill is fed at an average rate of 135 short tons/hr on an annualized basis with a crushed product with a P_{80} of 0.4 in and produces a milled product with a nominal P_{80} of 0.03 in. Short-term throughputs may rise to a maximum of 156 short tons/hr.

Each Rod Mill operates in open circuit and delivers a ground product to the feed end of a matched down stream Ball Mill. The Ball Mill operates in closed circuit with a bank of Primary Cyclones, with a circulating load of 350%; and the Primary Cyclone Overflow produced from this circuit is suitable for subsequent flotation.

Grinding media in the form of rods and balls is added to each mill to sustain a load of 35% and 40% by volume respectively to maintain the mill power draw. Additionally, water is added at sufficient rate to each mill feed to maintain the mill density of each mill at about 70 - 75% solids by weight. Grinding media is added periodically to the Ball Mill via a port on the mill feed chute. Rods are added to each Rod Mill using a dedicated rail mounted rod charger that can be located in front of each Rod Mill as required to charge rods through the rod mill discharge feed trunnion.

A Ball Mill Discharge Pump Box (not shown on Figure 6-6) receives ball mill discharge product with a P_{80} of 0.00787 in (65mesh), and dilution water to generate slurry of approximately 63% solids by weight. The resultant slurry is pumped by the duty Primary Cyclone Feed Pump (not shown on Figure 6-6) to a bank of three 26-in diameter Primary Cyclones. The overflow from this cyclone bank from each mill is combined in a launder and then divided into two streams of approximately equal volume, which report under gravity to the Rougher Conditioning Tank in each of two parallel Flotation Trains.

The Primary Cyclone Underflow is combined with the respective Rod Mill Discharge and flows under gravity to the feed spout of the associated Ball Mill.

FLOTATION

The objective of the Flotation area is to recover a bulk sulfide product containing the majority of the base and precious metals, rejecting largely siliceous tailings. Flotation of the sulfide minerals is achieved using a simple collector/frother combination. The frother is an organic compound that allows the formation of small bubbles when air is blown into the flotation cell. The collector is an organic chemical containing the xanthate ion, which is a long-chain hydrocarbon. One end of the ion is polar and will adhere selectively to sulfide minerals. The other end is non-polar and will adhere to the bubbles. This results in the sulfide minerals being selectively floated to the top of the tank.

Two Flotation Trains are provided, each matched to sets of Rod/Ball Mill Trains; in one set five trains are operating, in the other set six.

The Rougher Conditioning Tank Discharge flows under gravity to two Rougher Flotation Cells in each train, the residence time of the Rougher Flotation Cell is 7 minutes at an operating density of 30% by weight solids and at a design feed flow rate.

The collector will be a commercial preparation (Flex 31) of sodium isopropyl xanthate (SIPX). Methyl isobutyl carbonate (MIBC) will be used as the frother at addition rates as required to achieve the target flotation recoveries. Dextrin (a simple starch) is also added as a silicate depressant in the cleaner flotation circuit.

The Rougher Flotation Concentrate from each set of Rougher Flotation Cells is pumped to the cleaner circuit and combined in a single Rougher Cleaner Conditioning Tank for each cleaner flotation circuit. Additional frother, collector and depressant are added before the slurry flows by gravity to Cleaner 1 Flotation. The Rougher Flotation Tailings from each train flows under gravity to six Scavenger Flotation Cells.

Scavenger Flotation operates at a 30% by weight pulp density with a residence time of 20 minutes, and the resulting Scavenger Flotation Concentrate from Scavenger Flotation flows under gravity to a dedicated regrind milling circuit. Scavenger Flotation Concentrates are combined in each Regrind Hopper where they are combined with Cleaner 1 Flotation Tailings and Regrind Mill Discharge. The Scavenger Flotation Tailings from each train, at a flow rate of 838t/hr solids and a density of 40% by weight flow under gravity to a dedicated high rate Flotation Tails Thickener for each Flotation Train. With the aid of flocculant, the Flotation Tails Thickeners produce a thickened underflow at 60% by weight solids, that is then pumped to the existing Flotation Tailings Basin. The composition of Flotation Tailings is discussed in response to Question 20.

Two stages of concentrate cleaning are provided. Overall, the cleaner flotation circuit has a residence time of 10 minutes at a design flow rate and density of 15t% by weight solids.

In each train, stage 1 cleaner flotation is conducted in four Cleaner 1 Flotation Cells and the resultant Cleaner 1 Flotation Concentrate is pumped to two Cleaner 2 Flotation Cells. The final Cleaner 2 Flotation Concentrate stream from each train is then pumped to a single Concentrate Thickener at an average flow rate of 37.8 short tons/hr solids on an annualized basis with a solids density of approximately 12% by weight. The Cleaner 1 Flotation Tailings are directed to the Regrind Hopper and Cleaner 2 Flotation Tailings are recycled back to the Rougher Cleaner Conditioning Tank.

The Concentrate Thickener produces a thickened concentrate underflow containing approximately 65% by weight solids, which is pumped by Concentrate Thickener Underflow Pumps (not shown on figure 6-6) to the one of two Final Concentrate Surge Tanks, which provide surge capacity between the concentrate production circuits and the concentrate leaching circuits. The Final Concentrate Surge Tanks provide approximately twelve hours of surge capacity ahead of the Autoclave Leach area.

Each regrind mill classification circuit comprises a Regrind Cyclone and Regrind Mill to ensure Scavenger Flotation Concentrate and Cleaner 1 Flotation Tailings from each train are ground to a suitable size to allow higher final concentrate grades to be achieved in the subsequent cleaning circuits. The combined streams in each Regrind Hopper are pumped to the Regrind Cyclone from which overflow recycles back to the Rougher Conditioning Tank and underflow discharges to the Regrind Mill.

All pumps in the flotation circuit are organized with a duty and standby pump arrangement, and water spray is added to the concentrate launders to prevent sanding and assist the flow of concentrate into the Regrind Hopper.

Table 6-14 shows the assumed compositions of flotation concentrate and tailings based on the available metallurgical test work.

Table 6-14
Target Flotation Products

	Assays (wt%)					Distribution (%)				
Stream	Cu %	Ni %	Au ppm	Pt ppm	Pd ppm	Cu	Ni	Au	Pt	Pd
Feed	0.39	0.11	0.14	0.09	0.3	100	100	100	100	100
Concentrate	13.5	3.11	1.48	2.33	9.99	94.8	70.1	66.5	71.7	83.8
Tailings	0.02	0.037	0.02	0.02	0.06	5.2	29.9	33.5	28.3	16.2

AUTOCLAVE LEACH

The objective of the Autoclave Leach area is to convert the metal sulfides in the flotation concentrate into a soluble form for as a preliminary step to further processing.

The metal values of the copper, nickel and cobalt sulfides, PGMs and pyrrhotite (iron sulfide) contained in the flotation concentrate are thereby liberated. Conversion of the metal sulfide species into soluble metal species is achieved by the use of high temperature, high pressure leaching conditions in an acidic liquor in three Autoclaves, which is injected with oxygen gas, supplied from an 882 short tons or 1,763,678 lbs per day maximum capacity cryogenic oxygen plant, to oxidize the sulfides. The nominal oxygen consumption of the primary autoclaves is expected to be 781 short tons/hr.

The Autoclave Feed Tank for each Autoclave receives flotation concentrate and copper sulfide precipitate recycled from the downstream processing. The combined product is then pumped to the Autoclave. Hydrochloric acid is added to the Autoclave Feed Tank to maintain 10,000 ppm chloride concentration in the leach solution to enable leaching of the PGM's in the Autoclave. Raffinate (the barren solution remaining after removal of the copper) from Copper Solvent Extraction is also recycled to the Autoclave. The Autoclave Feed Tank slurry and raffinate are pumped by separate pumping systems to each of the three Autoclaves operating in parallel. Raffinate is added to each Autoclave at a rate designed to maintain Autoclave operation at 437°F; temperature control is maintained by adjusting the flow of copper raffinate relative to the flotation concentrate.

Each Autoclave is made up of five agitated compartments with the dividing wall removed between compartment 1 and 2. The Autoclaves are constructed from carbon steel and are lined with a corrosion resistant membrane overlain with two layers of acid resistant bricks. Autoclave internals, agitators, baffles and cell dividers are all of titanium construction to resist corrosion by the acidic leach liquor.

Oxygen is fed to each Autoclave at a controlled rate to ensure complete oxidation of all of the sulfide sulfur in the autoclave feed.

The following reactions are expected to pass to completion in the Autoclave.

Chalcopyrite Dissolution

$4CuFeS_{2(s)} + 4H_2O_{(l)} + 17O_{2(g/aq)} \rightarrow CuSO_{4(aq)} + 2Fe_2O_{3(aq)} + 4H_2SO_{4(aq)}$

Cubanite Dissolution

$2CuFe_2S_{3(s)} + 4H_2O_{(l)} + 13O_{2(g/aq)} \rightarrow 2CuSO_{4(aq)} + 2Fe_2O_{3(aq)} + 4H_2SO_{4(aq)}$

Pentlandite Dissolution

$NiFeS_{2(s)} + 4O_{2(g/aq)} \rightarrow NiSO_{4(aq)} + FeSO_{4(aq)}$

Pyrhotite Dissolution

$2sFe_7S_{8(s)} + 2H_2O_{(l)} + 31O_{2(g/aq)} \rightarrow 14FeSO_{4(aq)} + 2H_2SO_{4(aq)}$

Linnaeite Dissolution

$2Co_3S_{4(s)} + 2H_2O_{(l)} + 15O_{2(g/aq)} \rightarrow 6CoSO_{4(aq)} + 2H_2SO_{4(aq)}$

Sphalerite Dissolution

$ZnS_{(s)} + 2O_{2(g/aq)} \rightarrow ZnSO_{4(aq)}$

Gold Dissolution
$4Au_{(s)} + O_{2(g/aq)} + 2H_2SO_{4(aq)} + 16NaCl_{(aq)} \rightarrow 4Na_3AuCl_{4(aq)} + 2Na_2SO_{4(aq)} + 2H_2O_{(l)}$

Palladium Dissolution
$2Pd_{(s)} + O_{2(g/aq)} + 2H_2SO_{4(aq)} + 8NaCl_{(aq)} \rightarrow 2Na_2PdCl_{4(aq)} + 2Na_2SO_{4(aq)} + 2H_2O_{(l)}$

Platinum Dissolution
$2Pt_{(s)} + O_{2(g/aq)} + 2H_2SO_{4(aq)} + 8NaCl_{(aq)} \rightarrow 4Na_2PtCl_{4(aq)} + 2Na_2SO_{4(aq)} + 2H_2O_{(l)}$

Rhodium Dissolution
$4Rh_{(s)} + O_{2(g/aq)} + 2H_2SO_{4(aq)} + 24NaCl_{(aq)} \rightarrow 4Na_3RhCl_{6(aq)} + 6Na_2SO_{4(aq)} + 6H_2O_{(l)}$
Ferrous Oxidation
$2aFe(OH)_{3(aq)} + 3H_2SO_{4(aq)} \rightarrow Fe_2(SO_4)_{3(aq)} + 6H_2O_{(l)}$

Jarosite Precipitation
$Na_2SO_{4(aq)} + 3Fe_2(SO_4)_{3(aq)} + 12H_2O_{(l)} \rightarrow 2NaFe_3(SO_4)_2(OH)_{6(s)} + 6H_2SO_{4(aq)}$

The generation of acid from the oxidation of major sulfide minerals results in partial leaching of the silicate, hydroxide and carbonate minerals present in the flotation concentrate. The leaching process also generates substantial heat, which will subsequently be converted to steam in each Autoclave Flash Vessel and used in winter to heat the Process Plant buildings. Leached slurry exiting the Autoclaves is brought to atmospheric pressure using a dedicated Autoclave Flash Vessel for each Autoclave, which allows the removal of excess heat through the release of steam from the slurry.

A dedicated Autoclave Gas Scrubber is provided for each Autoclave Flash Vessel to deliver an initial scrub of the excess flash vessel gas streams to remove the majority of the entrained solids and process liquor in the vapor phase exiting the Autoclave Flash Vessel. This is achieved using raw water sprays to remove the entrained salts, solids and acid from the gas flow. The majority of the steam is deliberately not condensed in this first scrub stage. Scrubbed steam then passes through a Heat Exchanger to recover heat by condensing the steam. The hot water produced by this indirect heat exchange process is then used as required for building heating; any remaining hot water not required is cooled in a Cooling Tower and recycled to the Heat Exchanger. Any steam not condensed in the indirect heat recovery process then passes to a Final Gas Scrubber before discharge to atmosphere. The material scrubbed from the gas stream reports to the Leach Residue Thickener as a slurry.

PLATINUM GROUP METALS (PGM) PRECIPITATION

PGM Concentration

The objective of the PGM Precipitation area is to recover PGMs and Gold -- from the pregnant leach liquor using sodium hydrosulfide (NaHS) as a precipitant. This circuit produces a mixed PGM sulfide precipitate with a relatively large proportion (to the precipitated PGM's) of co-precipitated base metal sulfides.

The PGM precipitate is then repulped treated by a selective base metal leach. This removes base metals and produces a PGM concentrate of higher purity for shipment to an off-site refinery. Prior to NaHS addition to precipitate the PGM's and base metals, sulfur dioxide is introduced to the process slurry to reduce all of the contained ferric ions to ferrous ions in order to minimize side reactions of the NaHS precipitant with the dissolved iron values.

Discharge from each of three Autoclave Flash Vessels flows by gravity to matched Autoclave Let Down Tanks (not shown on Figure 6-7) where the slurry is further cooled to 185°F via recycling of cooled leach slurry. The Let Down Tank Discharge is then pumped to the Leach Residue Thickener through a Shell and Tube Heat Exchanger (not shown on Figure 6-7), which is supplied with non-contact cooling water from a Cooling Tower to further reduce the slurry temperature to 140°F. The heated water exiting the Heat Exchanger is recycled back to the Cooling Tower.

Air is drawn into the base of the Cooling Tower counter currently to the hot water sprayed into the top of the towers. Cooling of the heated water exiting the Heat Exchangers is effected by evaporation of water to the counter current air stream. Cooled water exiting the Cooling Tower is collected in a common sump where makeup water is added, in addition to an anti bacterial reagent to maintain a safe working environment.

The cooled discharge from all three Autoclave Flash Vessels is then pumped to the Leach Residue Thickener. The contained solids are then settled with the aid of flocculant; the thickener produces a dewatered underflow containing 40% by weight solids. The underflow is then pumped to the Leach Residue Surge Tank (not shown on Figure 6-7), which has a retention time of 8 hours, thus providing surge capacity between the Leach Residue Filter and thickener. The Leach Residue Filter separates the barren autoclave residue solids from the process liquor containing the metal values of interest. Residual entrained metal values are recovered by washing the leach residue with HM Process Water to recover the remaining dissolved metal values.

A Leach Residue Filter Cake of 75% solids is produced by the filter. The cake is discharged to the Residue Re-pulp Tank (not shown on Figure 6-7) where the cake is repulped and then pumped for disposal in the lined Reactive Residue facility. Wash liquor and primary filtrate from the Leach Residue Filter are recycled back to the Leach Residue Thickener.

The Leach Residue Thickener overflows at a flow rate of 1427 gpm and gravitates to the Thickener Overflow Tank (not shown on Figure 6-7) from which it is pumped at a controlled rate to the Iron Reduction Tank.

Iron Reduction

In the Iron Reduction Tank, ferric sulfate is almost completely reduced to ferrous sulfate using 0.07t/hr sulfur dioxide gas sparged into the tank.

$$Fe_2(SO_4)_{3(aq)} + SO_{2(g)} + 2\ H_2O_{(l)} \rightarrow 2\ FeSO_{4(aq)} + 2\ H_2SO_{4(aq)}$$

The Iron Removal Tank is covered and kept under a negative pressure to minimize fugitive gaseous SO_2 emissions from the tank. The offgas from the tank passes to the Final Gas Scrubber where the sulfur dioxide is recovered to a liquor stream.

The discharge from the Iron Reduction Tank is pumped directly to the PGM Precipitation Pipe Reactor where 1.4t/hr sodium hydrosulfide (NaHS) is added and metal and metal sulfide precipitation occurs via the following reactions.

$Na_3AuCl_{4(aq)} + NaHS_{(aq)} \rightarrow 2Au_{(s)} + 7NaCl_{(aq)} + HCl_{(aq)} + S_{(s)}$

$Na_2PdCl_{4(aq)} + NaHS_{(aq)} \rightarrow sPd_{(s)} + 3NaCl_{(aq)} + HCl_{(aq)} + S_{(s)}$

$Na_2PtCl_{4(aq)} + NaHS_{(aq)} \rightarrow sPt_{(s)} + 3NaCl_{(aq)} + HCl_{(aq)} + S_{(s)}$

$Na_3RhCl_{6(aq)} + 3NaHS_{(aq)} \rightarrow 2sRh_{(s)} + 9NaCl_{(aq)} + 3HCl_{(aq)} + 3S_{(s)}$

$2FeSO_{4(aq)} + 2NaHS_{(aq)} \rightarrow 2FeS_{(s)} + Na_2SO_{4(aq)} + H_2SO_{4(aq)}$

$2NiSO_{4(aq)} + 2NaHS_{(aq)} \rightarrow 2NiS_{(s)} + Na_2SO_{4(aq)} + H_2SO_{4(aq)}$

$2CoSO_{4(aq)} + 2NaHS_{(aq)} \rightarrow 2CoS_{(s)} + Na_2SO_{4(aq)} + H_2SO_{4(aq)}$

$2CuSO_{4(aq)} + 2NaHS_{(aq)} + \rightarrow 2CuS_{(s)} + Na_2SO_{4(aq)} + H_2SO_{4(aq)}$

The PGM Precipitation Pipe Reactor discharges slurry at an average flow rate of 1294 gpm, comprising the process liquor mixed PGM sulfide precipitates with some base metal impurity. This slurry is directed to the Clarifier and with aid of flocculant an underflow of 80% solids is achieved.

The Clarifier Underflow is then pumped to the PGM Precipitate Surge Tank (not shown on Figure 6-7), which has a retention time of 8 hours, thus providing surge capacity between the PGM Filter and Clarifier. The PGM Filter separates the PGM precipitate solids from the process liquor containing the metal values of interest. Residual entrained metal values are recovered by washing the PGM precipitate with Service Water and recycling to the Clarifier.

A PGM Precipitate Filter Cake of 80% solids is produced by the filter. The cake is discharged to the Releach Autoclave Feed Tank (not shown on Figure 6-7) where the cake is repulped to achieve 60% by weight solids and then fed to the Releach Autoclave.

The Clarifier Overflow, 441t/hr, contains the remaining base metals that are then recovered in downstream process stages, the copper by solvent extraction and the nickel and cobalt by precipitation.

PGM Releach

The Releach Autoclave removes base metal sulfides from the PGM precipitate. The Releach Autoclave operates at a temperature of 239°F with a design residence time of 120 minutes, at a pressure of approximately 102 psi to preferentially leach base metal sulfides. Oxygen gas is injected into the autoclave and additional sulfuric acid is added to the autoclave feed to maintain 5000 ppm H_2SO_4 in the Autoclave Discharge. There is also a small net generation of heat from the dissolution of base metal sulfides.

Leached slurry (containing base metals) exiting the Releach Autoclave is brought to atmospheric pressure through the Releach Autoclave Flash Vessel, which allows the removal of excess heat through the release of steam. The autoclave vent and flash steam flows are small and so these flows are combined with a number of other offgas streams and passed through the autoclave gas scrubbing systems (two stages of gas cleaning and one of heat recovery as described above). The two offgas lines from the Releach Autoclave will be tied into the autoclave gas scrubbing systems in such a manner as to allow the Releach Autoclave to remain operational when a primary autoclave is offline for maintenance.

The Releach Autoclave Flash Vessel underflow then discharges to a Releach Autoclave Let Down Tank (not shown on Figure 6-7) where it is further cooled to 140°F by cooling coils located within the tank. Cooling water is supplied as required to maintain the target temperature. The letdown tank has a residence time of 8 hours to provide surge capacity between the releach circuit and the PGM Concentrate Filter. Cooling water is supplied from the Cooling Tower to the letdown tank at 86°F and returned at 113°F.

The cooled slurry, 12.6 short tons/hr and 0.4% by weight solids, is then pumped to the PGM Concentrate Filter to produce a PGM Concentrate Filter Cake of 80% solids, which is washed in the filter with Service Water. The PGM Concentrate is a final product for sale to a refinery. The wash filtrate liquor is recycled to the Iron Reduction Tank.

PRE NEUTRALIZATION

The aim of the Pre Neutralization area is to remove acid from the copper extraction circuit feed using limestone to precipitate acid as gypsum, thus reducing the process liquor stream acidity to a value appropriate for copper solvent extraction, avoiding parallel copper and iron precipitation.

The feed to the pre neutralization circuit is a liquor stream of 390 short tons/hr of overflow from the Clarifier following PGM precipitation with NaSH. The Clarifier Overflow is pumped to a Pre Neutralization Tank that is followed by three Gypsum Removal Tanks (not shown on Figure 6-7). Each tank is agitated and baffled.

All of the reaction tanks in this area, comprising the Pre Neutralization Tank and the three Gypsum Removal Tanks are covered and kept under a negative pressure to minimize fugitive emissions from the tanks. The offgas streams from the tanks, which are predominantly CO_2 evolved by the reaction of limestone and acid, are combined and pass to the Final Gas Scrubber.

Limestone slurry is added in part to the Pre Neutralization Tank along with recycled gypsum slurry, from the underflow of the Pre Neutralization Thickener, to seed gypsum precipitation.

The following neutralization/precipitation reactions occur in the pre neutralization circuit:

$$CaCO_{3(s)} + H_2SO_{4(aq)} \rightarrow CaSO_{4\,(s)} + CO_{2(g)}$$

$$CaCO_{3(s)} + 2HCl_{(aq)} + Na_2SO_{4(aq)} \rightarrow CaSO_{4(aq)} + 2NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$$

$$CaSO_{4(aq)} + 2H_2O_{(l)} \rightarrow CaSO_4.2H_2O_{(s)}$$

The neutralized slurry from the gypsum precipitation circuit is pumped by the duty Transfer Pump (not shown on Figure 6-7) to the Pre Neutralization Thickener. The Pre Neutralization Thickener produces a dewatered underflow containing 40% by weight solids that is predominantly gypsum.

Approx 70% of the underflow is recycled to the Pre Neutralization Tank for gypsum seeding and the remainder is pumped to the Gypsum Filter press to separate gypsum residue. A final Gypsum Filter Cake of 60% by weight solids is produced, which is then washed with HM Process Water, and then repulped and pumped to the Reactive Residue Facility. Wash water filtrate is recycled back to the Pre Neutralization Thickener.

The overflow from the Pre Neutralization Thickener is sent to the Copper Solvent Extraction (SX) area.

COPPER SOLVENT EXTRACTION (SX)

Overview

Copper is selectively removed from the process liquor stream by the process of solvent extraction. In turn, the copper is removed from the solvent by a strip liquor solution at a suitable copper concentration for the subsequent Copper Electrowinning area.

The copper recovery process takes place in three extraction stages and two strip stages, with a single wash stage in between to remove entrained aqueous phase liquor from the loaded (copper-containing) organic phase prior to stripping. The solvent extraction plant operates in closed circuit with the electrowinning plant, acid from the latter circuit is used to strip the extracted copper in the two stripping stages.

Copper Extraction

Pre Neutralization Thickener Overflow gravitates to a Copper Extraction Feed Tank (not shown on Figure 6-7). The thickener overflow is then pumped to the copper extraction circuit for copper recovery through the SX Feed Cooler (not shown on Figure 6-7) which cools the copper process liquor stream from ~140 °F to 104°F. The SX Feed Cooler is a plate and frame heat exchanger supplied with cooled water from the Cooling Tower. The cooled process liquor stream is then retained in a PLS Tank (not shown on Figure 6-7) ahead of the SX circuit; the PLS Tank has a four hour residence time at design process liquor stream flows.

From the PLS Tank, liquor is pumped to the copper solvent extraction stages, at a rate approx 2,100 gpm and 14,000 ppm copper. Each extraction stage includes two mixer tanks providing a total of 3 minutes retention time during which the organic and aqueous phases are intimately mixed. During mixing, the extraction of copper occurs into the organic phase according to:

$$Cu^{+2}_{(aq)} + 2R\text{-}H_{(org)} \rightarrow CuR_{2(org)} + 2H^{+}_{(aq)}$$

The organic phase solvent consists of a commercial chelating agent (to assist in dissolution and precipitation) mixed in a high-flashpoint hydrocarbon. Further description of reagents is given in response to Question 20.

The aqueous / organic mixture flows from the second mixer tank into a Reverse Flow Settler, where the two phases are allowed to separate. “Picket fences” located at the top of each settler distribute the flow across the width of the settler. The two phases are collected in separate launders at the end of the settler. The aqueous and organic streams flow counter current through the SX extraction circuit. Process liquor stream enters the first extraction stage and flows sequentially through the other two stages. Raffinate (the aqueous solution remaining after extraction of the copper) leaves the last stage at 1780 gpm and gravitates to the Raffinate Holding Tank (not shown on Figure 6-7). The duty Raffinate Pump (not shown on Figure 6-7) is used to pump the raffinate in part to the initial concentrate leach Autoclave Cooling Water Tank (not shown on Figure 6-7), at approximately 75% of the total raffinate flow, with the remainder pumped to a bleed circuit, for nickel and cobalt recovery.

Stripped organic from the first stage of copper stripping gravitates to the last extraction stage and flows counter to the organic stream through the second and first extraction stages. Loaded organic from the first extraction stage gravitates to a Loaded Organic Tank which feeds a coalesceor wash stage to remove entrained aqueous to reduce carry-over of entrained aqueous solution. The loaded organic is then pumped to the first strip stage. Spent electrolyte from the copper tankhouse is used to strip the loaded organic in two stages. Loaded electrolyte leaving the second stage strip settler flows by gravity to the Electrolyte Filter Feed Tank (not shown on Figure 6-7).

Copper Stripping Stages

Contacting the loaded organic stream with highly acidic aqueous spent electrolyte (containing about 180,000 ppm sulfuric acid) during the strip mixing reverses the copper loading reaction thus consuming acid and increasing the copper content of the electrolyte stream while simultaneously depleting the organic phase of copper. During mixing the stripping of copper occurs in exchange for acidity from the spent electrolyte, thus regenerating the organic for further copper extraction.

$$CuR_{2(org)} + 2H^{+}_{(aq)} \rightarrow Cu^{+2}_{(aq)} + 2R\text{-}H_{(org)}$$

The barren organic is recycled to the extraction circuit. Following stripping, the loaded electrolyte passes to Copper Electrowinning (EW) where the copper is recovered as metal from the solution. The copper-loaded electrolyte is referred to as “advance electrolyte”.

Stripping of the loaded organic is carried out by counter-current flow in two mixer/settler stages. The aqueous phase, consisting of spent electrolyte is pumped to the first stage primary mix tank and then flows by gravity through to the second stage. As the quantity of spent electrolyte is considerably smaller than the organic input, the stripping stages operate with a large internal electrolyte recycle to maintain an organic/aqueous ratio of 1:1 internal to the settler. Concentrated sulfuric acid is added as required to compensate for that lost in the EW bleed. The stripped organic is transferred from the second stage settler directly to the third extraction stage.

Advance electrolyte is discharged from the second stage settler by gravity to the Electrolyte Filter Feed Tank (not shown on Figure 6-7) and pumped to a coalescing filter with anthracite/garnet dual media. The filter traps organic droplets and any solids remaining entrained in the electrolyte. Periodically the filter is drained and backwashed with water. The resultant liquor is then held in a storage tank and bled at a controlled rate to the Raffinate Tank (not shown on Figure 6-7). Loss of organic (entrained and dissolved) will be between 10 and 50 ppm in the aqueous stream leaving the stripping circuit. From the Electrolyte Filter (not shown on Figure 6-7), clean advance electrolyte is discharged into the Advance Electrolyte Tank (not shown on Figure 6-7), providing about one hour of surge between the Electrolyte Filter and the electrowinning circuit.

"Crud" is a colloquial term used in the industry to describe the result of contamination of the organic/aqueous reagents by dust, silica and even insects. Crud formation at the organic/aqueous interfaces in the settlers inhibits solvent extraction and contributes to organic loss. Crud is removed from the settlers by decanting, drainage and routinely by use of a portable, air operated crud pump.

Crud is pumped to a Crud/Spillage Holding Tank (not shown on Figure 6-7) to allow crud to be accumulated and then treated on a batch basis. From the Crud/Spillage Holding Tank (not shown on Figure 6-7), the crud is pumped to the Organic Recovery Tank (not shown in Figure 6-7). This tank is fitted with several off-takes at different depths. In general, fairly clear aqueous solution can be drained from the bottom of the tank while a clean organic layer should form on the surface. However, a mixed layer, consisting mostly of frothy crud, will remain in the transition layer in the middle of the tank and may require filtration to recover the remaining organic.

The clean organic material from the top of the Crud/Spillage Holding Tank (not shown on Figure 6-7) reports to the Loaded Organic Tank while the aqueous solution and transitional phase material from the bottom and middle of the tank report to a small filter press. To enable filtration of the crud, a pre-coat/filtration medium (clay) is added to a Clay Makeup Tank (not shown on Figure 6-7) by hand and gravitates to the Crud Spillage/Holding Tank (not shown on Figure 6-7) prior to being mixed with the other constituents before pumping to a small filter press. The filter cake containing unwanted solids and residual organic material is discarded to the Reactive Residue Facility, while filtrate is delivered to the Loaded Organic Tank.

COPPER ELECTROWINNING (EW)

From the Filtered Electrolyte Tanks (not shown on Figure 6-7) in the Copper SX area, copper-rich advance electrolyte solution is pumped to the Electrolyte Re-circulating Tank (not shown on Figure 6-7) in which the advance electrolyte is mixed with spent electrolyte recycle from electrowinning, water make-up, spillage (if free of solids), as well as plating agents (guar gum). Cobalt sulfate is also added to maintain the required concentration of 100ppm cobalt in the electrolyte.

From the Electrolyte Re-circulation Tank (not shown on Figure 6-7) the combined electrolyte flow is pumped through strainers to remove tramp material before being distributed to the electrowinning cells. Tramp will be only minor trash that will be cleaned out and properly disposed annually. A duty/standby transformer rectifier arrangement provides the cell electrical supply.

A ventilation system comprising covers for each electrowinning cell and an associated EW Mist Scrubber will be provided for the electrowinning cells. This system collects gases vented from the electrowinning cells and then scrubs the off-gas to remove entrained acid mist before venting to atmosphere. The EW Mist Scrubber water discharges back to the Pre Neutralization Thickener.

Copper is plated onto stainless steel cathode blanks over a cycle of approximately seven days. When the full copper deposit has plated, an overhead crane is used to remove one third of the cathodes from each cell in sequence. The cathodes are then water washed to remove the copper-bearing electrolyte, and immediately stripped in an automatic stripping machine. Wash liquor is recycled to the SX circuit to recover the contained copper. Stripped cathodes are bundled sampled and weighed in the stripping machine and the bundles of cathodes are then removed by forklift to a laydown area prior to shipping.

Spent electrolyte leaving the production cells gravitates to the Electrolyte Re-circulation Tank (not shown on Figure 6-7). The majority of the electrolyte is re-circulated to the electrowinning cells but sufficient spent electrolyte is recycled back to stripping to balance the advance electrolyte flow entering electrowinning from stripping. Spent electrolyte passes through strainers before being pumped through a plate heat exchanger using cooling water to maintain the spent electrolyte temperature below approximately 104°F. Tramp will be only minor trash that will be cleaned out and properly disposed annually.

A small amount of electrolyte is bled out of the SX/EW circuit back to the solvent extraction circuit in order to prevent iron and impurity build-up in the electrolytic circuit.

A plating agent (guar gum) is made up in an agitated tank and pumped to the circuit using a dosing pump at an addition rate proportional to cathode production. There are two spillage pumps in the circuit, each of which pumps back to the Electrolyte Re-Circulation Tank (not shown on Figure 6-7).

BLEED STREAM PURIFICATION

Iron/Aluminum Removal

A stream comprising 25% of the primary raffinate flow from Copper Extraction is removed as a bleed stream. The bleed stream is first treated to remove iron and aluminum and subsequently remove nickel and cobalt, and finally to precipitate magnesium before the remaining solution is recycled to the process. The first stage of the bleed circuit involves neutralization of excess acid and precipitation of iron.

The bleed stream, 470 gpm, at 104°F and ~20,000 ppm H_2SO_4, is pre-heated with steam in the Preheat Tank (not shown on Figure 6-7) to increase the stream temperature to 176°F. The Preheat Tank discharge is then pumped to a series of five cascaded Iron (Fe) Removal Tanks into which air, O_2 and limestone slurry are added.

All of the reaction tanks in this area, comprising the Preheat Tank, and the five Iron (Fe) Removal Tanks are covered and kept under a negative pressure to minimize fugitive emissions from the tanks. The offgas from the tanks is combined and passes to the Final Gas.

The underflow from the Aluminum (Al) Removal Thickener, the next downstream purification stage, is also recycled to the head of the Iron (Fe) Removal Tanks in order to combine the aluminum and iron residues for separation in a single filter step. The main reactions occurring in this circuit are listed below:

Acid Neutralization:

$$CaCO_{3(s)} + H_2SO_{4(aq)} + H_2O_{(l)} \rightarrow CaSO_4.2H_2O_{(s)} + CO_{2(g)}$$

Iron Oxidation:

$$2FeSO_{4(aq)} + H_2SO_{4(aq)} + 1/2O_{2(aq)} \rightarrow Fe_2(SO_4)_{3(aq)} + H_2O_{(l)}$$

Iron Precipitation:

$$Fe_2(SO_4)_{3(aq)} + 3CaCO_{3(s)} + 9H_2O_{(l)} \rightarrow 2Fe(OH)_{3(s)} + 3CaSO_4.2H_2O_{(s)} + 3CO_{2(g)}$$

Slurry gravity overflows from the fifth Iron (Fe) Removal Tank to a high rate Iron (Fe) Removal Thickener where flocculant is added to aid solids settling. The thickener feed stream enters the thickener with a solids density of approximately 8% by weight. The thickener produces a thickener underflow stream at 55% by weight solids, which is pumped by Iron Removal Thickener Underflow Pumps (not shown on Figure 6-7) to the Iron/Aluminum (Fe/Al) Removal Filter Surge Tank (not shown on Figurer 6-7). The combined Iron/Aluminum (Fe/Al) Removal Filter is fed from the Iron/Aluminum (Fe/Al) Removal Filter Surge Tank (not shown on Figure 6-7). The surge tank has a residence time of 8 hours to allow for online filter maintenance.

A final Fe/Al Removal Filter Cake of 80% by weight solids is produced, which is then washed with HM Process Water, to remove soluble metal values and the washed cake is then repulped and pumped to the Reactive Residue Facility. Wash water filtrate is divided and recycled to both the Aluminum (Al) Removal Tanks and Aluminum (Al) Removal Thickener.

Iron (Fe) Removal Thickener Overflow, containing only ppm levels of iron, is directed to two Aluminum (Al) Removal Tanks to which limestone is added. The pH is further raised to ensure aluminum precipitation but to minimize co-precipitation of copper, nickel, cobalt and zinc via the following reactions:

$CuSO_4 + 2aH_2O = sCu(OH)_2 + aH_2SO_4$

$NiSO_4 + 2aH_2O = sNi(OH)_2 + aH_2SO_4$

$ZnSO_4 + 2aH_2O = sZn(OH)_2 + aH_2SO_4$

$CoSO_4 + 2aH_2O = sCo(OH)_2 + aH_2SO_4$

$Al_2(SO_4)_3 + 6aH_2O = 2sAl(OH)_3 + 3aH_2SO_4$

$H_2SO_4 + sCaCO_3 = aCaSO_4 + aH_2O + gCO_2$

$2aHCl + sCaCO_3 = aCaCl_2 + aH_2O + gCO_2$

$CaCl_2 + aNa_2SO_4 = aNaCl + aCaSO$

$CaSO_4 + 2aH_2O = sCaSO_4.2H_2O$

The slurry from the Aluminum (Al) Removal Tanks, 555 gpm at 0.9% solids, is combined with wash water filtrate from the Iron/Aluminum (Fe/Al) Removal Filter and directed to the Aluminum (Al) Removal Thickener. With the aid of flocculant an underflow of 50% by weight solids is achieved and recycled back to the first Iron (Fe) Removal Tank, via a Re-pulp Tank (not shown on Figure 6-7). The Aluminum (Al) Removal Thickener Overflow, at a flow rate of 533 gpm and ~140°F, contains approximately 700 ppm Cu, 500 ppm Co, 1,000 ppm Zn, and 10,000 ppm Ni that is first treated to recover the contained copper separately prior to the subsequent Co/Ni recovery stage.

Copper Removal

The objective of the copper removal stage is to remove soluble copper from the process liquor stream before nickel and cobalt precipitation. This is achieved by precipitating the copper as a copper sulfide. Sodium Hydrosulfide (NaHS) is used to precipitate the copper sulfide along with sulfides of minor amounts of other heavy metals present.

The overflow from the Aluminum (Al) Removal Thickener gravitates to the Aluminum Overflow Tank (not shown on Figure 6-7), which provides surge capacity between the Aluminum (Al) Removal Thickener and the copper removal circuit. The liquor is pumped to a Preheating Tank (not shown on Figure 6-7) where steam is directly sparged into the tank to increase the stream temperature to 158 °F. The stream then gravitates to a De-aeration Tank (not shown on Figure 6-7) where nitrogen is introduced to remove any dissolved oxygen from the solution prior to NaHS addition. The overflow from the De-aeration Tank then gravitates to the Copper Precipitation Tanks where NaHS is introduced on a staged basis as required by the reaction extents.

The following precipitation reactions occur:

$$2CuSO_{4(aq)} + 2NaHS_{(aq)} \rightarrow 2CuS_{(s)} + Na_2SO_{4(aq)} + H_2SO_{4(aq)}$$

$$6CuS_{(s)} + 2CuSO_{4(aq)} + 2H_2O \rightarrow 4Cu_2S_{(s)} + 2S_{(s)} + 2H_2SO_{4(aq)} + O_{2(g)}$$

$$2NaHS_{(aq)} + 2ZnSO_{4(aq)} \rightarrow 2ZnS_{(s)} + Na_2SO_{4(aq)} + H_2SO_{4(aq)}$$

$$2NaHS_{(aq)} + 2CoSO_{4(aq)} \rightarrow 2CoS_{(s)} + Na_2SO_{4(aq)} + H_2SO_{4(aq)}$$

$$2NaHS_{(aq)} + 2NiSO_{4(aq)} \rightarrow 2NiS_{(s)} + Na_2SO_{4(aq)} + H_2SO_{4(aq)}$$

All of the reaction tanks in this area, comprising the Preheating Tank, the De-aeration Tank, and the three Copper Precipitation Tanks are covered and kept under a negative pressure to minimize fugitive emissions from the tanks. The off-gas from the tanks is combined and passes to the Final Gas Scrubber.

The Copper (Cu) Precipitation Tank Discharge gravitates to the CuS Filter Surge Tank (not shown on Figure 6-7) that provides buffer storage between the copper removal circuit and the subsequent CuS Filter. The precipitated solids are separated from the stream using a plate and frame CuS Filter that produces a filter cake of 80% solids containing a mixed sulfide precipitate. No washing of the solids occurs on the filter. The filter cake intermittently discharges from the filter into a hopper and is then conveyed into a re-pulp tank where the filter cake is repulped using Service Water to a density of 65% solids. A proportion of the slurry, ~75%, is recycled to the Copper (Cu) Precipitation Tank to provide a seed for the precipitation of sulfides, while the remaining 25% is recycled back to the Autoclave Feed Tank, to releach and recover the contained metals, predominantly copper. The CuS Filter Filtrate is collected in a Filtrate Tank (not shown on Figure 6-7).

The CuS Filter Filtrate contains minimal copper levels and is pumped to the final purification area, which involves Hydroxide Precipitation of remaining heavy metals.

HYDROXIDE PRECIPITATION

Hydroxide Product Precipitation

The objective of Hydroxide Precipitation is to remove remaining heavy metal species from solution in two hydroxide precipitation stages. The first stage utilizes magnesium oxide slurry (30%) and air to precipitate a mixed Ni/Zn/Co/Mg hydroxide, which is separated from the process slurry in a filter press as a saleable mixed hydroxide product for off-site refining. In the second stage precipitation, lime is added to further raise the pH in order to precipitate the majority of the remaining heavy metal hydroxides for recycle back to the post autoclave leach slurry via the Autoclave Let Down Tank.

Filtrate from the CuS Filter is pumped at a controlled rate from the Filtrate Tank (not shown on Figure 6-7) to the first of a series of three 1st Stage Hydroxide Precipitation Tanks. Air is sparged to these tanks and staged addition of magnesium oxide is provided to facilitate precipitation of a range of metal hydroxides.

The major reactions include:

$$4FeSO_{4(aq)} + O_{2(g)} + 2H_2SO_{4(aq)} \rightarrow 2Fe_2(SO_4)_{3(aq)} + 2H_2O_{(l)}$$

$$NiSO_{4(aq)} + Mg(OH)_{2(s)} \rightarrow Ni(OH)_{2(s)} + MgSO_{4(aq)}$$

$$CoSO_{4(aq)} + Mg(OH)_{2(s)} \rightarrow Co(OH)_{2(s)} + MgSO_{4(aq)}$$

$$ZnSO_{4(aq)} + Mg(OH)_{2(s)} \rightarrow Zn(OH)_{2(s)} + MgSO_{4(aq)}$$

$$H_2SO_{4(aq)} + Mg(OH)_{2(s)} \rightarrow 2H_2O_{(l)} + MgSO_{4(aq)}$$

$$2HCl_{(aq)} + Mg(OH)_{2(s)} \rightarrow 2H_2O_{(l)} + MgCl_{2(aq)}$$

The resulting discharge from the first stage of hydroxide precipitation, at a flow rate of approximately 552 gpm and 1.5% by weight solids, gravitates to the 1st Stage Hydroxide Thickener and, with the aid of flocculant, an underflow of 40% by weight solids is achieved containing the precipitated heavy metals. This underflow is pumped to a Hydroxide Filter Surge Tank (not shown on Figure 6-7) that has a residence time of 8 hours to allow for filter maintenance. The slurry is then pumped at a controlled rate from that tank into the Hydroxide Filter to produce a filter cake of 75% by weight solids. The filter cake is washed with Service Water to remove entrained process solution, and the filter wash water is reports to the 2nd Stage Hydroxide Precipitation Tank.

The final Mixed Hydroxide Product has an approximate composition of 80% $Ni(OH)_2$, 9% $Zn(OH)_2$, 4% $Co(OH)_2$, and 7% $Mg(OH)_2$. The filter cake is intermittently discharged into a hopper beneath the filter and is conveyed to a storage hopper ahead of a bagging plant that packages the filter cake for shipment to a refiner.

Second and Third Stage Hydroxide Precipitation

The 1st Stage Hydroxide Thickener Overflow is pumped to the first of three 2nd Stage Hydroxide Precipitation Tanks. Lime is added to these tanks to raise the pH to a higher level than achieved in the first stage precipitation process to ensure precipitation of all remaining heavy metal species resulting in a mixed hydroxide/gypsum precipitate. Discharge from the tanks gravitates to the 2nd Stage Hydroxide Thickener. Flocculent is added to settle the hydroxide precipitates and produce an underflow product at a density of 40% by weight solids. The underflow product is then recycled back to the Autoclave Let Down Tank (not shown on Figure 6-7) where the high acidity will ensure that the metals contained in the precipitate will be redissolved, and to aid cooling of the leach slurry to a temperature suitable for pumping.

The 2nd Stage Hydroxide Thickener Overflow is then pumped to a final purification stage in the Magnesium Precipitation area for the removal of remaining magnesium to allow the solution to be recycled to the process as HM Process Water.

MAGNESIUM PRECIPITATION

The objective of Magnesium Precipitation is to remove the majority of the remaining magnesium from the process stream exiting the Hydroxide Precipitation area to prevent magnesium build-up in the process liquors throughout the entire hydrometallurgical leach circuit, and to minimize the concentration of other metals present in the recycled process liquor to avoid impurity build-up in the process liquor.

The feed to this circuit is overflow from the 2nd Stage Hydroxide Thickener, at a flow rate of approx 553 gpm and 158°F, which then gravitates through a series of four cascaded Magnesium (Mg) Removal Tanks. Lime slurry is stage added to each reactor as required to facilitate magnesium precipitation via the following reaction:

$$MgSO_{4(aq)} + Ca(OH)_{2(s)} \rightarrow Mg(OH)_{2(s)} + CaSO_{4(aq)}$$

These reaction tanks will be covered due to the elevated temperature but as no gas evolution is expected the tanks will not be connected to the plant gas scrubbing system.

The resulting slurry exiting the Magnesium (Mg) Removal Tanks gravitates to the Mg Removal Thickener where, with the aid of flocculant, an underflow product of 50% by weight solids of magnesium hydroxide is produced. This underflow is then pumped to the Reactive Residues Facility. The thickener overflow gravitates to the Magnesium Removal Thickener Overflow Tank (not shown on Figure 6-7) and is pumped back to the HM Process Water Tank for reuse.

Scoping Environmental Assessment Worksheet: Draft Scoping Decision Document

NorthMet Mine and Ore Processing Facilities Project
Draft Scoping Decision

1.0 INTRODUCTION AND PURPOSE

1.1 BACKGROUND

The Minnesota Department of Natural Resources (DNR) in with co-operation of the United States Army Corps of Engineer (USACE) and the United States Forest Service (USFS) will prepare a joint state and federal Environmental Impact Statement (EIS) for the NorthMet Mine and Ore Processing Facilities Project (NorthMet) proposed by PolyMet Mining Corporation to extract copper, nickel, cobalt, and precious metals. The joint EIS will allow evaluation to the NorthMet project in accordance with the National Environmental Policy Act (NEPA; 42 U.S.C. §§ 4321-4347), and Minnesota Environmental Policy Act (MEPA; Minn. Stat. Ch. 116D). The NorthMet mine is proposed approximately 6 miles south of the town of Babbitt while the ore processing facility is proposed at a currently inactive taconite processing facility, formerly owned and operated by LTV and now owned by Cliffs Erie, located 5 miles north of the town of Hoyt Lakes, all of which is located in St. Louis County, Minnesota.

The proposed project includes open pit mining operations with ore hauled to the processing facility on a largely existing rail line owned by Cliffs Erie. Ore would be processed at a refurbished and modified taconite processing facility. The hydrometallurgical process of flotation and autoclave leach facilities would be used with refurbished crushing and grinding facilities to produce copper metal and precipitates of nickel, cobalt, palladium, platinum, and gold. Precipitates are proposed for shipment off-site to third party treatment. The flotation process will generate flotation tailings that are proposed for disposal on top of a portion of an existing taconite tailings disposal facility. The hydrometallurgical process would generate some waste residue that is proposed for disposal in lined cells on top of the existing taconite tailings adjacent to the area proposed for disposal of flotation tailings.

1.2 SELECTION OF APPROPRIATE ENVIRONMENTAL REVIEW DOCUMENT

The EIS is mandatory for this project pursuant to Minnesota Rules part 4410.2000 subpart 2; the rule directs that an EIS shall be prepared if the project meets or exceeds the thresholds of any of the EIS categories listed in part 4410.4000. Part 4410.4400 identifies metallic mineral mining and processing under subpart 8 as requiring preparation on an EIS. The EIS will meet applicable requirements of Minnesota Rules part 4410.0200 to 4410.7800 (MEQB Rules) that govern the Minnesota Environmental Review Program. The DNR is the responsible governmental unit (RGU) under MEPA. The DNR will engage the services of a consultant to assist in EIS preparation, however the DNR will retain responsibility for EIS content.

The USACE received an application from the PolyMet Corporation to discharge fill material in waters of the U.S., including wetlands to develop the NorthMet project. The USACE has determined that its action on the permit would be a major federal action that could significantly affect the quality of the human environment, requiring the preparation of a Federal EIS pursuant to the National Environmental Policy Act (NEPA) (42 U.S.C. §§ 4321-4347) and its implementing regulations (40 C.F.R. parts 1500-1508).

The USACE is serving as co-lead agency in preparation of the EIS with the DNR. Although the mine site for the NorthMet project is located on USFS land, there is an existing mineral lease for the deposit. The USFS has determined that they do not have a federal action if the NorthMet project is developed in compliance with the existing conditions of the lease. The USFS is serving as cooperating agency in the EIS preparation with the USACE and DNR.

1.3 PURPOSE AND NEED OF THE PROJECT

The primary purpose of the NorthMet mining operation is to provide copper, precious metal, and nickel-cobalt concentrates for sale to the world market. Over the project lifetime, PolyMet projects that the operation will produce approximately 3.2 million tons of copper, 860,000 tons of nickel, 9.3 million ounces of palladium, and 2.6 million ounces of platinum.

PolyMet anticipates that optimized mining and processing operations would involve extracting and processing 32,000 tons of NorthMet ore each day. All mining activities must be conducted and sequenced as efficiently and cost-effectively as possible. In this way, the production of copper and other metals can remain competitive, not only within the United States, but also in the worldwide metals market.

PolyMet would strive to operate the NorthMet project in a manner that is efficient and cost-effective, and that minimizes impacts to the environment. PolyMet projects that between 490 and 600 long-term jobs would be created in the Babbitt and Hoyt Lakes area, in addition to several hundred jobs during the one-year construction phase.

1.4 THE SCOPING PROCESS

The Draft Scoping Decision Document is a companion to the Scoping Environmental Assessment Worksheet (EAW) prepared for the project. The purpose of the Draft Scoping Decision Document is to identify those project alternatives and environmental impact issues that will be addressed in the EIS. The Draft Scoping Decision Document also presents a tentative schedule of the environmental review process.

Public review and comment on the Draft Scoping Decision Document will be conducted as prescribed MEQB rules part 4410.2100. After public review and comment the DNR and USACE will consider the comments received and develop a Final Scoping Decision Document. A notice of availability will be published in the EQB monitor for this document.

2.0 PROJECT ALTERNATIVES

The MEQB rules require that an EIS include at least one alternative of each of the following types, or provide an explanation of why no alternative is included in the EIS (*Guide to Minnesota Environmental Review Rules*, page 12): alternative sites, alternative technologies, modified designs or layouts, modified scale or magnitude, and alternatives incorporating reasonable mitigation measures identified through comments received during the EIS scoping and draft EIS comment periods. The alternative of no action shall be addressed

Minnesota Rules part 4410.2300, subpart G directs that an alternative may be excluded for the analysis in the EIS if "it would not meet the underlying need for or purpose of the project, it would likely not have any significant environmental benefit compared to the project as proposed, or another alternative, of any type, that will be analyzed in the EIS would likely have similar environmental benefits but substantially less adverse economic, employment, or sociological impacts." Selection or dismissal of alternatives will be documented in the EIS.

2.1 PROPOSED ALTERNATIVE

The EIS will describe the proposed project and the potential environmental and socioeconomic effects outlined in Section 3.0.

2.2 NO ACTION ALTERNATIVE

The EIS will describe the expected condition if the proposed project is not developed, with respect to the potential environmental and socioeconomic effects outlined in Section 3.0. This alternative will consider the processing of the same amounts of metals and precipitates at existing facilities due to consistent market demand of metals.

2.3 SITE ALTERNATIVES

The MEQB rules allow the RGU to exclude alternative sites if other sites do not have any significant environmental benefit compared to the project as proposed, or if other sites do not meet the underlying need and purpose of the project. The MEQB's Guide to Minnesota Environmental Review Rules lists a number of factors for the RGU to consider when deciding whether alternative sites would meet the underlying need for or purpose of the project.

The DNR and USACE do not propose to evaluate alternative mine pit or processing plant sites for this project. An alternative mine site would not meet the underlying need or purpose of the project. The mineralization of the desired elements within a geologic deposit dictates the location of the mine. An alternative processing plant site may not be feasible or achievable in the time frame of the project.

The EIS will evaluate the suitability and benefits of alternative tailings basin and waste rock stockpile locations. Although specific alternatives have not yet been identified the following options are under consideration.

<u>In-pit Waste Rock Disposal</u>– Sub-aqueous placement of reactive waste rock in an existing taconite mine pit. This alternative would evaluate placement of reactive waste rock in an aqueous environment that would retard oxidation of sulfide minerals and reduce the degree of associated water quality concerns. This alternative would also reduce the magnitude of long-term treatment of water contacting reactive rock. As part of this option, the use of various sub-aqueous cover

materials to further restrict oxygen transport to the rock will be evaluated. In addition to environmental impacts, the effect of land and mineral ownership of remaining reserves would be addressed, as well as other pertinent issues.

Off-site Waste Rock Disposal – If there is an excess of non-reactive rock, it might be possible to reduce the total amount of land disturbance and create limnological structure by stockpiling in the Northshore pit. An alternative site may not be feasible or achievable in the time frame of the project. This option will be discussed and a preliminary screening analysis may be conducted.

In-pit Tailings Disposal– Sub-aqueous placement of tailings in an existing taconite mine pit. This alternative is being considered to account for uncertainty about the reactivity of the tailings. The use of the existing tailings basin as currently proposed would likely be unsuitable if the waste characterization indicates that tailings are reactive or if the physical characteristics of the tailings are not suitable for dam construction. This alternative would evaluate placement of tailings in an aqueous environment that would retard oxidation of sulfide minerals and reduce the degree of associated water quality concerns. This alternative would also reduce the magnitude of long-term treatment of water contacting reactive tailings. As part of this option, the use of various sub-aqueous cover materials to further restrict oxygen transport to the tailings will be evaluated. The benefits of this alternative would be greatly diminished if waste characterization determines that the tailings are non-reactive. In addition to environmental impacts, the effect of land and mineral ownership of remaining reserves would need to be addressed, as well as other pertinent issues.

Off-site Tailings Basin– Development of a new tailings basin with an impermeable base to prevent water seepage into the surrounding environment. This alternative is being considered to account for uncertainty about the reactivity of the tailings. The use of the existing tailings basin as proposed would likely be unsuitable if the waste characterization indicates that tailings are reactive. This alternative would evaluate potential impacts associated with developing a new tailings basin. The benefits of this alternative would be greatly diminished if waste characterization determines that the tailings are non-reactive.

2.4 TECHNOLOGY ALTERNATIVES

2.4.1 Mining Technologies

The DNR and USACE do not propose to evaluate alternative mining technologies. The proposed project uses a conventional technology that has been used in other mining operations. The deposit is not suitable for underground mining. Other mining technologies applicable to the NorthMet deposit would likely have no significant environmental benefit over the proposed technologies.

2.4.2 Ore Processing

The DNR and USACE do not propose to evaluate alternative hydrometallurgical technologies. The proposed project uses a technology that does not include cyanide leach or other technologies that may have significant environmental effects. Although there are impacts that will need to be analyzed for the proposed hydrometallurgical process, other processing technologies would likely have no significant environmental benefit over the proposed technology.

2.5 MODIFIED DESIGNS OR LAYOUTS

There are several design components of the project that the DNR and USACE propose to evaluate by generation and consideration of Technical Design Evaluation Reports. The intent of using these reports is to evaluate various project design components. These reports could be used to optimize effectiveness, implementability, and cost of project design.

Project components that are proposed for Technical Design Evaluation Reports are:

Reactive residue facility -	Evaluation will focus on the suitability and benefits of facility design and location within the existing tailings basin, including size and number of cells.
Tailings basin geotechnical-	Evaluation will focus on stability, suitability, and benefits of various tailings dam designs. Alternatives will include upstream dam construction, downstream dam construction, suitability of flotation tailings for dam construction, and location of dams. The evaluation should also consider the mass and source of material needed for dam construction for various dam construction scenarios.
Wastewater treatment-	Evaluation will focus on different wastewater treatment technologies for the mine site and ore processing facility. Although specific alternatives for wastewater treatment have not been identified at this time, the wastewater treatment analysis will be used to develop types of treatment technologies that would be suitable given the wastewater characteristics that require treatment.
Air emission control-	Evaluation will focus on how available technology for control of emissions would impact other media (i.e. wastewater, solid waste generation, etc.).
Wetland mitigation-	Evaluation will focus various options to mitigate for wetland impacts. Potential options include wetland banks, off-site creation of wetlands, off-site protection of wetlands, off-site enhancement of wetlands, out-of-kind mitigation, and on-site mitigation as part of mineland reclamation.
Reactive waste segregation-	Evaluation will focus on feasibility and benefits of segregating reactive waste into degrees of reactivity and

	using different stockpiles or designs to manage the waste depending on the degree of reactivity of the waste.
Tailings basin modification-	Evaluation will focus on strategies to minimize seepage from the tailings basin.

The evaluation criteria for these reports would include effectiveness, implementability, and cost. The results of the reports will be summarized in the EIS. The ultimate design of project components would be determined by the permitting process.

2.5.1 Mine Pit

The DNR and USACE do propose to evaluate a modified design or layout for the mine.

<u>Mine Pit Backfill</u> – This alternative would evaluate the benefits and feasibility of placing waste rock into the mine pit. This could occur by sequencing of mining to allow placement of waste rock into a previously mined portion of the pit.

2.5.2 Waste Rock Stockpiles

The EIS will address alternative designs and layouts for waste rock stockpiles.

<u>Chemical Modification of Reactive Waste Rock Stockpiles</u> – This alternative will evaluate geochemical modification by incorporation of material into reactive waste rock stockpiles to reduce reactivity or treat reactive water within the stockpile.

2.5.3 Ore Transportation from Mine to Processing Plant

The DNR and USACE do not propose to evaluate alternative designs and layouts for ore transportation from the mine to the processing plant. The proposed project includes using existing railroads with construction of a railroad spur at the mine site and approximately one mile of new railroad to connect the railroad that serves the mine site to the railroad that serves the ore processing plant. Alternative designs and layouts would not likely provide significant environmental benefit over the proposed project.

2.5.4 Ore Processing Plant

The DNR and USACE do not propose to evaluate alternative designs and layouts for the ore processing plant. Alternative designs and layouts would not likely provide significant environmental benefit over the proposed project that makes use of an existing processing plant that would be refurbished and modified.

2.5.5 Wastewater

The EIS will consider the suitability and benefits of alternative designs and layouts for wastewater treatment. In addition to the Technical Design Evaluation Report described in section

2.5, there are several options for management of wastewater that need to be considered. Results from the waste characterization and wastewater treatability studies will be needed to determine the suitability of these alternatives. The following options have been identified:

- Pretreatment of mine site reactive runoff and discharge to Publicly Owned Treatment Works (POTW). The cities of Babbitt and Hoyt Lakes each have a POTW that could be considered.
- Pretreatment of tailings basin process water and discharge to the City of Hoyt Lakes POTW.
- Use of mine site reactive runoff as make-up water for processing plant with single wastewater treatment at the Processing Plant. This option could also include pretreatment and discharge to a POTW.

2.6 SCALE OR MAGNITUDE ALTERNATIVES

The DNR and USACE do not propose to evaluate alternative scale or magnitude of the project. The location and orientation of the NorthMet deposit combined with the infrastructure requirements to mine and process the ore are such that alternative scale/magnitude would likely not have significant environmental benefits compared to the proposed project.

2.7 INCORPORATION OF MITITGATION MEASURES IDENTIFIED THROUGH PUBLIC COMMENTS

The EIS will consider all mitigation measures suggested through public comment. Those mitigation measures that were identified but not carried forward for analysis will be discussed briefly as well as the reasons for their elimination.

3.0 EIS ISSUES

Issues have been identified and described in the Scoping EAW and are categorized below by significance and amount of additional analysis required in the EIS. Mitigation measures that could reasonably be applied to eliminate or minimize adverse environmental effects will be identified in the EIS.

3.1 *Topic has been adequately analyzed in the Scoping EAW. Topic is not relevant or so minor that it will not be addressed in the EIS. The Scoping EAW will be appended to the EIS for reference; the relevant EAW number is provided in parents () after each topic.*

Land Use (Item 9)
Water-related land use management district (Item 14)
Water surface Use (Item 15)
Geologic Hazards and Soil Conditions (Item 19a)
Traffic (Item 21)
Vehicle Related Air Emissions (Item 22)
Visibility (Item 26)

3.2 *Significant impacts are not expected but information beyond that in the Scoping EAW will be included in the EIS.*

3.2.1 Cover Types (Item 10)

The EIS will discuss potential impacts from changes in cover types as a function of time both during and after operation.

3.2.2 Fish and Wildlife Resources (Item 11a)

The EIS will discuss potential impacts to fish and wildlife habitats. This discussion will make use of existing studies that are appropriate for identification of the potential impact. Examples of studies that may be used include The Copper-Nickel Study Plots and previous work in the area completed by ENSR. The EIS will also discuss potential mitigation for impacts to fish and wildlife habitat.

3.2.3 Threatened and Endangered Species (Item 11b)

The EIS will evaluate potential impacts threatened and endangered species. Existing information will be evaluated and additional information collected if necessary to support state and federal regulatory requirements for threatened and endangered species. Potential mitigation strategies and alternatives will be evaluated to prevent and minimize any identified impacts.

3.2.4 Erosion and Sedimentation (Item 16)

If tailings from Cell 2W are needed for dam construction, information on the details of excavation activities, erosion prevention, and reclamation will be developed during EIS preparation.

3.2.5 Air Emissions (Item 23)

The EIS will include descriptions of air emissions sources, potential control technologies and any impacts to Class I and Class II areas.

A BACT analysis will by completed for PM_{10} and sulfuric acid mist. MACT analysis will be required for some sources after case by case determinations have been made.

The EIS will verify that this AERA truly represents worst case. This verification will include the following analysis:

Conduct source-specific air dispersion modeling of those units that could influence the final risk estimates, specifically focusing on the risk drivers from the AERA (crusher/grinding operations and Hydromet plant; nickel and nickel compounds, hydrogen chloride, NO2, manganese) and/or conduct a quantitative sensitivity analysis of the critical sources using the new design parameters (location, height, exit velocity, emission database) to determine if the overall risks calculated in this AERA are still conservative estimates.

The EIS will also contain a Class I and Class II increment analysis for air emissions from the project.

3.2.6 Odor and Noise (Item 24)

The EIS will include additional information on potential sources and verify PolyMet simulations and assumptions that were include in the EAW. Operational and structural mitigation to prevent potential impacts will also be discussed.

3.2.7 Archeology (Item 25)

The EIS will verify the location of Knot Camp to avoid disturbance. The historical significance of the Cliff's Erie plant site will be evaluated and mitigation proposed if warranted. The EIS will also provide additional information on areas of "unknown" potential for containing archeological resources. Any resources identified will be discussed and mitigation to prevent impacts will be proposed.

3.2.8 Compatibility with plans and land use regulations (Item 27)

The EIS will evaluate mineland reclamation strategies to develop those designs that are most compatible with surrounding land uses and local community goals.

3.2.9 Infrastructure (Item 28)

The EIS will include an evaluation of wastewater treatment alternatives that propose to use existing Hoyt Lakes or Babbitt POTWs. If any of these alternatives are deemed suitable for further evaluation, the EIS will include details about existing plant capacity and discuss options for increasing capacity and meeting pretreatment and NPDES permit conditions.

The EIS will also include additional detail on the electrical line and substation associated with the mine site. Potential impacts will be identified as well as mitigation of alternatives to prevent or minimize impacts.

3.2.10 Other – Asbestiform Fibers (Item 30)

Additional testing for asbestiform fibers is proposed to occur as part of the Pilot Plant Processing study, and the results of these tests will be included in the EIS. If the results of these tests are consistent with current understanding of the NorthMet deposit, no additional analysis or mitigation will be developed. Existing information about the cleavage fragments crystals related to risk of mesothelioma will be reviewed and summarized in the EIS.

3.3 *Potentially significant impacts may result; information beyond what was in the EAW will be included in the EIS.*

3.3.1 Physical Impacts on Water Resources (Item 12)

Avoidance, minimization and mitigation of the 1,257 acres of potential wetland impacts will be evaluated as part of the EIS. Indirect impacts to wetland function on ecological diversity from changes in hydrology and water chemistry will also be evaluated. The EIS will also discuss the suitability and feasibility of various wetland mitigation strategies. Additional detailed wetland delineations will be included for the first five years of proposed mining activity.

The EIS will include a watershed assessment of the upper Partridge River due to net hydrologic effects of Polymet's proposal. This watershed assessment will evaluate the changes in watershed discharge due to land surface changes (loss of wetlands, vegetation, and mine pit construction), as well as the direct hydrologic changes from mine pit dewatering and other mine site discharges. The response to Question 13 describes a hydrogeologic study that will be used to quantify the mine site discharges. A Level 1 Rosgen geomorphic survey will be conducted for the Partridge River, down to Colby Lake to identify any potentially geomorphilogical sensitive stream reaches. If the watershed assessment combined with the Level 1 Rosgen geomorphic survey indicates a potential for fluvial geomorphic impacts resulting from Polymet's proposal, there will be additional evaluation of the impact. If this additional evaluation determines that the changes in magnitude, timing, duration or rate of stream flow will cause significant adverse impacts, additional mitigation and monitoring will be developed.

3.3.2 Water Appropriations (Item 13)

Mine Site - The amount of water that must be discharged to dewater the mine pit is a significant issue that will be included in the EIS. In order to better estimate this amount of water the following information will be included in the EIS.

- Design and effectiveness of diking and trenching to prevent surface run-off into the pit.
- Estimates of direct precipitation into the mine pit
- Results of unconsolidated sediment hydrology study
- Results of phase I and phase II hydrogeology study of the NorthMet Deposit including potential water to enter the pit from the Virginia Formation.
- Development of a water balance model to estimate the quantity of water entering the pit from various sources with consideration of seasonal changes and pit size.

This information will be used to help design water treatment facilities and estimate changes in Partridge River streamflow as part of the watershed assessment described in response to Question 12. Hydrologic modeling will also be done to estimate the quantity and timing of outflow from the pit and runoff from stockpiles after mining. This information will be necessary to determine potential water treatment needs for reclamation. Because this water is likely to have come into contact with exposed ore or could be saline, it could be reactive and need appropriate treatment. The amount of water potentially needing treatment will be an important consideration in the EIS.

Processing Plant and Tailings Basin – The EIS will use the results of the pilot plant process and existing information on the LTV tailings basin to develop a water balance model for the processing plant and tailings basin. The EIS will provide additional information on water quantity from the processing plant and tailings basin, including the redesigned seepage collection system. The following information will be used in the water balance model:

- Water generated from the flotation tailings and from the hydrometallurgical processing
- Water collected at the base of the existing tailings basin

- Makeup water needed for the processing plant

Similar to the mine site this information will be used to discuss water quantity effects as well as to develop a better understanding of water treatment needs. Additional information will be presented on the proposed appropriation from Colby Lake.

3.3.3 Surface Water Runoff (Item 17)

The EIS will include surface water quantity and quality impacts as well as alternatives and mitigation to prevent or minimize impacts. Additional detail will be developed for surface water runoff systems that handle non-contact and non-reactive runoff as well as the quality and quantity of this water. Characterization of non-reactive runoff will also be estimated to ensure the suitability of treating this runoff source as non-contact runoff.

The EIS will include information on the quality and quantity of existing water bodies and any potential for changes to these parameters from all aspects of the mining project. Estimation of hydrologic and chemical balances in the Mine Site during normal operations and after closure and the potential effect of discharges on receiving water biota will need to be evaluated in the EIS (the hydrologic and chemical balances for the Tailings Basin and reactive runoff from reactive waste rock stockpiles are addressed in the Response to Question 18).

As part of the EIS, conservative estimates for the flow will be used to insure that any environmental impacts are minimized. (For example, the lowest reasonable estimate of 7Q10 will be used to insure that in stream water quality standards are met.)

3.3.3 Wastewater (Item 18)

Estimates of the quantity and quality of industrial wastewater generation from the mine site, processing plant and tailings basin will be included in the EIS. Predictions will be made as a function of time, during both the operating life of the project and after operations cease.

The following studies and information will be developed as part of the EIS to better understand potential wastewater impacts, and methods of prevention and mitigation as appropriate.

<u>Mine Site</u>

- Waste characterization study results
- Pilot Plant Process Testing
- Phase I and II Hydrogeological Evaluation
- Hydrogeological Investigation of Unconsolidated Surficial Deposits
- Effectiveness of mine site water management systems (including lining and capping systems for reactive waste rock stockpiles)
- Existing water quality data from other sources such as AMAX test shaft, Copper-Nickel Study, and other mining operations.
- Models to predict water quality
- Treatability studies for reactive runoff

    - Conceptual treatment design and tests capacity of design to meet expected water quality goals. Synthetic laboratory water, which has the expected chemical composition of seep and pond water, will be created for the test or water from existing stockpiles of Duluth Complex may be used.
    - A variety of treatment options will be evaluated. This may include both active and low maintenance treatment.

<u>Mine site open pit</u>

- Composition of the pit walls as a function of time
- Surface area of pit walls
- Models to predict water quality under various closure scenarios

<u>Plant-Tailings Basin</u>

- Tailings Basin/Plant Water and Water Quality Management Approach, including effectiveness of the tailings basin seepage collection system.
- Existing water quality data from tailings basin seepage
- Water quality impacts from emergency basin seepage and material discharged to the basin.
- Processing Plant and Tailings Basin Water Balance and Chemical Budget
    - Chemical budget, modeling of the Tailings Basin seep and pond chemistry requires the following inputs:
        - Model(s) will be run in conjunction with water balance and projected pond water chemistry.
        - Tailings characterization. From ongoing waste characterization studies for new Process Plant tailings.
        - Modeling and tailing leaching kinetics results delivered as part of the NPDES and permit to mine applications
        - Prediction of water quality in cells designed for hydrometallurgical residue
        - Interaction of water from Polymet operation with underlying taconite tailings

- Treatability Study for Seep Water and Water from the Ponds
    - Conceptual treatment design and tests capacity of design to meet expected water quality goals. Synthetic laboratory water, which has the expected chemical composition of seep and pond water, will be created for the test or water from existing stockpiles of Duluth Complex may be used.
    - A variety of treatment options will be evaluated. This may include both active and low maintenance treatment.

<u>Other Issues</u>

- Existing Environment of receiving waters
    - Biological monitoring (fish, mussels, and invertebrates)
    - Existing water quality parameters that do not meet standards
- Mercury

  - Ability to meet 1.3 ng/L water quality standard for discharge
  - Methylation of mercury due to increased sulfate concentrations

Sanitary wastewater treatment, which will be needed at the Plant and Mine Site, is a conventional technology and will not require significant study for the EIS

3.3.4 Solid Waste (Item 20)

The characterization, handling, and facility design of waste materials will be a significant issue addressed in the EIS. The three components of the project that will be the major focus of this discussion will be waste rock from the mine site, tailings from ore beneficiation process, and reactive residue from the hydrometallurgical processes. Below is a brief description of materials and issues that will be included in the EIS on each of these components:

<u>Mine site waste rock:</u>

- Amounts and composition of non-reactive waste rock, reactive waste rock, and lean ore as determined by the block model
- What chemical composition of waste rock will be the cutoff between non-reactive and reactive waste rock
- What sulfide levels will create acid mine drainage
- Are there other constituents of concern in this material
- Details and effectiveness of the Grade Control Program including details on blast hole sampling for waste rock management
- Details and alternatives for reactive waste rock stockpile design and siting
- Development of a mine waste management plan
- Determine the quantity and quality of drainage to be generated over time

<u>Ore beneficiation process tailings:</u>

- Characterization of tailings
- Suitability of disposal on existing unlined tailings basin
- Evaluation of alternatives for design, construction and siting
- Physical and chemical suitability of existing and new tailings for construction of tailings basin
- Determine the quantity and quality of drainage to be generated over time

<u>Hydrometallurgical processes reactive residue:</u>

- Characterization and quantities of residue
- Design of reactive residue facility
- Suitability of reactive residue facility on existing tailings basin Cell 2W
- Evaluation of alternatives for design, construction and siting
- Determine the quantity and quality of drainage to be generated over time.

Results from the Pilot Plant Processing study and the Waste Characterization Study will be used in conjunction with existing data to generate and characterize the above-described material. The Pilot Plant Processing study will generate tailings and reactive residue from a sample of the NorthMet Deposit of the proposed ore beneficiation and hydrometallurgical processes. The Waste Characterization study is a long term study that would continue after the completion of the EIS. This study makes use humidity cell test of the NorthMet Deposit and Tailings to determine the reactive or non-reactive nature of the materials. Initial data will be available for inclusion in the EIS. As part of the characterization study, PolyMet will conduct a complete chemical and mineralogical study of its waste. This information will be used to compare the predicted behavior of the Polymet material with other samples of Duluth Complex material for which long term data exists. Various methods to speed up potential reactions and comparisons with existing data may be used to determine the applicability of the initail results.

Identification, handling and facility design of other wastes will be included in the EIS.

3.3.5 Cumulative Effects (Item 29)

The EIS will evaluate cumulative effects using guidance from the Council on Environmental Quality handbook for considering cumulative effects under the National Environmental Policy Act (CEQ, 1997). The affected resources that are related to the cumulative effect issues will be used to determine the appropriate geographic and temporal scope to the analysis. The geographic and temporal scope will in turn be used to identify the specific past, present, and reasonably foreseeable future actions to be considered. The following list of cumulative effect issues are proposed for evaluation in the EIS:

- Hoyt Lakes Area Projects and Air Concentrations in Class II Areas
- Class I Areas PM10 Increment
- Ecosystem Acidification Resulting From Deposition of Air Pollutants
- Mercury Deposition and Bioaccumulation in Fish
- Visibility Impairment
- Loss Of Threatened And Endangered Plant Species
- Loss of Wetlands
- Loss or Fragmentation of Wildlife Habitat
- Streamflow and Lake Level Changes
- Water Quality Changes
- Economic Impacts
- Social Impacts

Additional detail about specific analysis of each of these issues is included in response to the Scoping EAW Question 29.

3.3.6 Other – Reclamation (Item 30)

The EIS will evaluate the proposal with consideration for compliance with DNR rules for mineland reclamation. Minnesota Rules for nonferrous metallic metal mining (Chapter 6132) describe the DNR’s policy for nonferrous mines, "…that mining be conducted in a manner that will reduce impacts to the extent practicable, mitigate unavoidable impacts, and ensure that the mining area is left in a condition that protects natural resources and minimizes to the extent practicable the need for maintenance." Alternative designs, layouts, and siting will also be evaluated to determine the most feasible reclamation strategy. The three criteria that will be used in this evaluation will be protection of natural resources, minimization of long-term maintenance, and eventual land use objectives.

As part of the permit to mine, a detailed financial assurance analysis will be conducted. This will include final closure and will also address premature shut down. An evaluation of reclamation costs and its effect on facility design, construction and closure will be discussed in the EIS.

4.0 IDENTIFICATION OF PHASED OR CONNECTED ACTIONS

There are no phased or connected actions associated with this project.

5.0 EIS SCHEDULE (TENTATIVE)

June 2005	Scoping EAW comment period (includes public meeting)
July 2005	Final Scoping Decision Document
December 2005	EIS Preparation Notice Published
June 2006	Draft EIS issued for public review (includes public meeting)
December 2006	Final EIS Issued
March 2007	EIS Adequacy Determined

6.0 SPECIAL STUDIES OR RESEARCH

6.1 Waste Characterization Study

Waste Characterization will be conducted on samples of waste rock material from the NorthMet Deposit and from sample tailings that will be generated from pilot plant testing of the NorthMet Deposit. Waste characterization is a long-term study that would continue after environmental review is complete and even into mining operation. Because the study is an ongoing process decisions need to be made as when information can be used to inform environmental review and permitting activities. The NorthMet Waste Characterization is proposed to generate initial information for use in the draft EIS.

Waste characterization has several components that are described generally below:

- Characterization of mass (amount of waste)
- Physical Characterization (particle size distribution)
- Bulk chemical characterization
- Characterization of mineralogy/petrology (composition)
- Dissolution testing (Humidity Cell Testing)

The results of this study are proposed to provide information about the reactive or non-reactive nature of waste rock and tailings [and degree of reactivity of reactive rock] that would be generated from NorthMet Mining Operations. This information can be used to develop plans and design systems that prevent impacts to natural resources.

6.2 Wastewater Treatability Studies

Results from the pilot plant testing and the waste characterization study will provide information on the quality of water that the mine and process will likely generate. Water balances will be used to estimate the quantity of water requiring treatment. With this information samples of water will be generated that simulate the wastewater that will require treatment. These samples will be subject to various wastewater treatment technologies. The water will be tested again to determine if the treatment technology was successful in generating water that can meet water quality standards. This information will be used to plan and design for wastewater treatment technologies or alternatives to prevent impacts to natural resources.

6.3 East Range Multi-Jurisdictional Community Readiness Assessment: Employment, Economic and Social Impacts

A quantitative assessment of cumulative employment and economic effects will be performed. Background information on employment and the economy of St. Louis County and the East Range will be summarized:

- Historical population trends by county and major population centers since 1970*
- Historical employment trends by county since 1970*
- Historical tax revenue trends by county since 1970*
- Summary of historical economic activity (major industries, major sources of employment) by county since 1970*
- Summary of population, employment, tax revenue and economic activity in 2002 (the baseline year)

  * *Approximate date. Actual historical data will be collected based on availability of primary sources and the economic/fiscal impact model used for the assessment.*

Impact analyses will be completed through input-output mathematical modeling to estimate employment impact, output impact and value added measures in terms of total (direct, indirect and induced) impacts for the construction period, operations period and closure period. Analyses will also assess impacts to State, Local and Federal taxes and royalties.

Appendix B
Final Scoping Decision Document

October 25, 2005
NorthMet Mine and Ore Processing Facilities Project
Final Scoping Decision

1.0 INTRODUCTION AND PURPOSE

1.1 BACKGROUND

The Minnesota Department of Natural Resources (DNR) in co-operation with the United States Army Corps of Engineer (USACE) and the United States Forest Service (USFS) will prepare a joint state and federal Environmental Impact Statement (EIS) for the NorthMet Mine and Ore Processing Facilities Project (NorthMet) proposed by PolyMet Mining Inc. (PolyMet) to extract copper, nickel, cobalt, and precious metals. The joint EIS will allow evaluation of the NorthMet project in accordance with the National Environmental Policy Act (NEPA; 42 U.S.C. §§ 4321-4347), and Minnesota Environmental Policy Act (MEPA; Minn. Stat. Ch. 116D). The NorthMet mine is proposed approximately 6 miles south of the town of Babbitt while the ore processing facility is proposed at a currently inactive taconite processing facility, formerly owned and operated by LTV Steel Mining Company (LTVSMC) and now owned by Cliffs Erie, located 5 miles north of the town of Hoyt Lakes, all of which are located in St. Louis County, Minnesota.

The proposed project includes open pit mining operations with ore hauled to the processing facility on a largely existing rail line owned by Cliffs Erie. Waste rock, lean ore, and deferred ore stockpiles from the mining operations are proposed near the mine pit. Stockpiles would be segregated into reactive and non-reactive stockpiles. Non-reactive stockpiles would be constructed and managed in a manner similar to those associated with taconite mining. These stockpiles would be designed and built to prevent sedimentation and erosion from stormwater runoff and provide beneficial use of these areas. Reactive stockpiles are proposed to be placed on engineered liner systems that capture any runoff and direct the runoff to a wastewater treatment system. Ore would be processed at a refurbished and modified taconite processing facility. The hydrometallurgical process of flotation and autoclave leach facilities would be used with refurbished crushing and grinding facilities to produce copper metal and precipitates of nickel, cobalt, palladium, platinum, and gold. Precipitates are proposed for shipment off-site to third party treatment. The flotation process will generate flotation tailings that are proposed for disposal on top of a portion of an existing taconite tailings disposal facility. The hydrometallurgical process would generate some waste residue that is proposed for disposal in lined cells on top of the existing taconite tailings adjacent to the area proposed for disposal of flotation tailings.

1.2 SELECTION OF APPROPRIATE ENVIRONMENTAL REVIEW DOCUMENT

The EIS is mandatory for this project pursuant to Minnesota Rules part 4410.2000, subpart 2; the rule directs that an EIS shall be prepared if the project meets or exceeds the thresholds of any of the EIS categories listed in part 4410.4400. Part 4410.4400 identifies metallic mineral mining and processing under subpart 8 as requiring preparation of an EIS. The EIS will meet applicable requirements of Minnesota Rules part 4410.0200 to 4410.7800 (MEQB Rules) that govern the

Minnesota Environmental Review Program. The DNR is the responsible governmental unit (RGU) under MEPA. The DNR will engage the services of a consultant to assist in EIS preparation, however the DNR will retain responsibility for EIS content.

The USACE received an application from PolyMet to discharge fill material in waters of the United States, including wetlands, to develop the NorthMet project. The USACE has determined that its action on the permit would be a major federal action that could significantly affect the quality of the human environment, requiring the preparation of a Federal EIS pursuant to the National Environmental Policy Act (NEPA) (42 U.S.C. §§ 4321-4347) and its implementing regulations (40 C.F.R. parts 1500-1508).

The USACE is serving as co-lead agency in preparation of the EIS with the DNR. Although the mine site for the NorthMet project is located on USFS land, there is an existing mineral lease for the deposit. The USFS has determined that they do not have a federal action if the NorthMet project is developed in compliance with the existing conditions of the lease. The USFS is serving as cooperating agency in the EIS preparation with the USACE and DNR.

1.3 PURPOSE AND NEED OF THE PROJECT

The purpose of the NorthMet mining and ore processing project is to produce copper metal, precious metal concentrates, and nickel-cobalt concentrates for sale to the world market by uninterrupted operation of the facility for the life of the mine.

1.4 THE SCOPING PROCESS

The Scoping Decision Document is a companion to the Scoping Environmental Assessment Worksheet (EAW) prepared for the project. The Scoping EAW and Draft Scoping Decision Document were noticed in the Environmental Quality Board Monitor on June 6, 2005. The USACE issued a Notice of Intent (NOI) to prepare an EIS on July 1, 2005. The DNR and the USACE issued press releases about the availability of the Scoping EAW, Draft Scoping Decision Document, and the public meeting to local area newspapers. A public meeting was held on June 29, 2005 at the Hoyt Lakes Arena in Hoyt Lakes, Minnesota. The public comment period ended July 6, 2005. A total of 29 comment letters/emails and two verbal comments were received. The DNR and the USACE considered all comments that were received. A Response to Public Comments document was developed to address the comments. The Draft Scoping Decision Document was revised based on the public and agency comments.

Public review and comment on the Draft Scoping Decision Document was conducted as prescribed in MEQB rules part 4410.2100. This Minnesota state process has included all procedural and substantive requirements to satisfy scoping for preparation of a federal EIS under NEPA.

2.0 <u>PROJECT ALTERNATIVES</u>

The MEQB rules require that an EIS include at least one alternative of each of the following types, or provide an explanation of why no alternative is included in the EIS (*Guide to*

Minnesota Environmental Review Rules, page 12): alternative sites, alternative technologies, modified designs or layouts, modified scale or magnitude, and alternatives incorporating reasonable mitigation measures identified through comments received during the EIS scoping and draft EIS comment periods. The alternative of no action shall be addressed

Minnesota Rules part 4410.2300, subpart G directs that an alternative may be excluded from the analysis in the EIS if "it would not meet the underlying need for or purpose of the project, it would likely not have any significant environmental benefit compared to the project as proposed, or another alternative, of any type, that will be analyzed in the EIS would likely have similar environmental benefits but substantially less adverse economic, employment, or sociological impacts." Selection or dismissal of alternatives will be documented in the EIS.

2.1 PROPOSED ALTERNATIVE

The EIS will describe the proposed project and the potential environmental and socioeconomic effects outlined in Section 3.0.

2.2 NO ACTION ALTERNATIVE

The EIS will describe the expected condition if the proposed project is not developed, with respect to the potential environmental and socioeconomic effects outlined in Section 3.0.

2.3 SITE ALTERNATIVES

The MEQB rules allow the RGU to exclude alternative sites if other sites do not have any significant environmental benefit compared to the project as proposed, or if other sites do not meet the underlying need and purpose of the project. The MEQB's Guide to Minnesota Environmental Review Rules lists a number of factors for the RGU to consider when deciding whether alternative sites would meet the underlying need for or purpose of the project.

The DNR and USACE will not evaluate alternative mine pit or processing plant sites for this project. An alternative mine site would not meet the underlying need or purpose of the project. The mineralization of the desired elements within a geologic deposit dictates the location of the mine. An alternative processing plant site would not likely have significant environmental benefits over using existing mining industry infrastructure.

The EIS will evaluate the suitability and benefits of alternative waste rock stockpile and tailings basin locations.

2.3.1 Waste Rock Disposal

<u>In-pit Reactive Waste Rock Disposal</u> – Sub-aqueous placement of reactive waste rock in an existing taconite mine pit. The LTVSMC Area 3 Pit shown in Figure 1 has been identified for evaluation of in-pit disposal of reactive waste rock based on hauling distance and information on hydrologic characteristics. This evaluation will make use of both available information and additional information that can be developed during the time period for EIS preparation. Detailed

site specific hydrological and chemical data and modeling may need to be developed that cannot be collected within the time period for preparation of this EIS. In that case the EIS would identify the data gaps and the impacts of these gaps for evaluation of this alternative. This alternative would evaluate placement of reactive waste rock in an aqueous environment that would retard oxidation of sulfide minerals and could reduce the degree of associated water quality concerns. This alternative could also reduce the magnitude of long-term treatment of water contacting reactive rock. As part of this option, the use of various sub-aqueous cover materials to further restrict oxygen transport to the rock will be evaluated. In addition to environmental impacts, the effect of land and mineral ownership of remaining reserves would be addressed, as well as other pertinent issues. Because land and mineral ownership issues could impact feasibility, they will be investigated first.

Off-site Non-reactive Waste Rock Disposal – If there is an excess of non-reactive rock, it might be possible to reduce the total amount of land disturbance by stockpiling in existing areas already disturbed by mining activity. LTVSMC Area 3 Pit will be evaluated for placement of non-reactive waste rock. Other disturbed areas around the Area 3 Pit and an existing railroad stockpile shown in Figure 1 will be evaluated for land disposal of non-reactive waste rock. In addition to environmental impacts, the effect of land and mineral ownership of remaining reserves would be addressed. Because land and mineral ownership issues could impact feasibility, they will be investigated first.

2.3.2 Tailing Disposal

In-pit Tailings Disposal – Sub-aqueous placement of tailings in existing taconite mine pits including LTVSMC's Area 2, Area 2W, Area 2WX, Area 3, Area 5S, and Area 5N identified in Figure 1. This evaluation will make use of available information and limited additional information that can be developed during the time period for EIS preparation. Detailed site specific hydrological and chemical data and modeling may need to be developed that cannot be collected within the time period for preparation of this EIS. In that case the EIS would identify the data gaps and the impacts of these gaps for evaluation of this alternative. This alternative would evaluate placement of tailings in an aqueous environment that would retard oxidation of sulfide minerals and could reduce the degree of associated water quality concerns. This alternative could also reduce the magnitude of long-term treatment of water contacting reactive tailings. As part of this option, the use of various sub-aqueous cover materials to further restrict oxygen transport to the tailings will be evaluated. The benefits of this alternative would be greatly diminished if waste characterization determines that the tailings are non-reactive. In addition to environmental impacts, the effect of land and mineral ownership of remaining reserves would need to be addressed. Because land and mineral ownership issues could impact feasibility, they will be investigated first.

2.4 TECHNOLOGY ALTERNATIVES

The DNR and USACE will not evaluate alternative hydrometallurgical technologies. The proposed project uses a technology that does not include cyanide leach or other technologies that may have significant environmental effects. Although there are impacts that will need to be analyzed for the proposed hydrometallurgical process, other processing technologies would likely have no significant environmental benefit over the proposed technology.

2.4.1 Mining Technologies

Underground Mining – This alternative will evaluate the feasibility and environmental impacts associated with using underground mining techniques to mine the NorthMet ore deposit. Although there may be environmental benefits associated with a smaller footprint from an underground mine, the cost of using underground mining techniques on the diffuse ore body may impact the feasibility of the project. If the cost of developing an underground mine were so high that the proposer could not develop the project, this alternative would not meet the purpose of the project. Due to this situation the economic feasibility will be evaluated by a third party contractor prior to any further assessment of this alternative. If the cost of underground mining is feasible at a lower economic return, the environmental impacts will be assessed to determine if there would be significant environmental benefits.

2.5 MODIFIED DESIGNS OR LAYOUTS

The DNR and USACE will not evaluate alternative designs and layouts for ore transportation from the mine to the processing plant. The proposed project includes using existing railroads with construction of a railroad spur at the mine site and approximately one mile of new railroad to connect the railroad that serves the mine site to the railroad that serves the ore processing plant. Alternative designs and layouts would not likely provide significant environmental benefit over the proposed project.

The DNR and USACE will not evaluate alternative designs and layouts for the ore processing plant. Alternative designs and layouts would not likely provide significant environmental benefit over the proposed project that makes use of an existing processing plant that would be refurbished and modified.

2.5.1 Technical Design Evaluation Reports

There are several design components of the project that the DNR and USACE will evaluate by generation and consideration of technical design evaluation reports. The intent of using these reports is to evaluate various project design components. These reports will be used to evaluate effectiveness, implementability, and cost of various project design components. Many of these reports will provide detail on the proposed action that will be used for evaluation of environmental impacts. A scope of work for each of these reports is included in Attachment A. The following technical design evaluation reports will be included in the EIS:

- Reactive residue facility and initial tailings facility
- Tailings basin geotechnical
- Wastewater treatment
- Air emission control (cross media effects)
- Wetland mitigation
- Reactive waste segregation

- Tailings basin modification

The evaluation criteria for these reports would include effectiveness, implementability, and cost during and after operation. The results of the reports will be summarized in the EIS. The permitting process would determine the ultimate design of project components.

2.5.2 Mine Pit

Two Mine Pits – This alternative would evaluate the feasibility and environmental impacts of mining the NorthMet deposit as two mine pits, with one pit being completely mined out before beginning the second pit. Waste rock from the second pit would be placed into the first pit so that the final mine pit lake and waste rock stockpiles would be considerably smaller. Evaluation will include the issue of encumbering resources and feasibility of backfilling with both reactive and non-reactive waste rock.

2.5.3 Reactive Waste Rock Stockpiles

Chemical Modification of Reactive Waste Rock Stockpiles – This alternative will evaluate geochemical modification by incorporation of material into reactive waste rock stockpiles to reduce reactivity or treat reactive water within the stockpile. Full assessment of this alternative may require development of information that cannot be collected within the time period for preparation of this EIS. In that case the EIS would identify the data gaps and the impacts of these gaps for evaluation of this alternative.

Co-disposal of Reactive Waste Rock and Tailings on a Lined Tailings Basin – This alternative will evaluate the feasibility and environmental impacts of disposing reactive waste rock with tailings in a lined basin. The feasibility of this alternative is dependent on the project being developed with a lined tailings basin.

2.5.4 Wastewater

The EIS will consider the suitability and benefits of alternative designs and layouts for wastewater treatment. In addition to the Technical Design Evaluation Report described in section 2.5, there are several options for management of wastewater that will be considered. Results from the waste characterization and wastewater treatability studies will be needed to determine the suitability of these alternatives. The following options have been identified:

- Pretreatment of mine site reactive runoff and discharge to Publicly Owned Treatment Works (POTW). The cities of Babbitt and Hoyt Lakes each have a POTW that could be considered.
- Pretreatment of tailings basin process water and discharge to the City of Hoyt Lakes POTW.
- Use of mine site reactive runoff as make-up water for processing plant with single wastewater treatment at the Processing Plant. This option could also include pretreatment and discharge to a POTW.

2.6 SCALE OR MAGNITUDE ALTERNATIVES

The DNR and USACE will not evaluate an alternative scale or magnitude for the project. Although there may be environmental benefits from smaller amounts of mine waste associated with a smaller scale project, the cost of operating a smaller mine and ore processing facility for the diffuse ore body will adversely impact the feasibility of the project. As part of project development, the proposer evaluated various mill feed rates to estimate the economic feasibility of the project. The 32,000 tons per day (tpd) scale currently proposed was ultimately selected, however an 18,000 tpd scale was evaluated as part of the optimization process. During this analysis it was determined that the return on investment for an 18,000 tpd operation was not feasible. There is some smaller variability associated with the 32,000 tpd scale that would still be economically feasible, but the environmental benefits associated with this smaller degree of variability would not produce significant environmental benefits. The DNR and the USACE have determined that an alternative scale or magnitude would not feasibly meet the purpose of the project.

2.7 INCORPORATION OF MITITGATION MEASURES IDENTIFIED THROUGH PUBLIC COMMENTS

Several mitigation measures were identified through public and agency scoping comments. The following mitigation measures are being carried forward as the other mitigation measures identified during public scoping were excluded by one of the three exclusionary criteria identified in Minnesota Rules Chapter 4410.2300 Subpart G.

2.7.1 Monitoring

Monitoring of waste rock stockpiles and tailings basin –
The EIS will consider various monitoring programs associated with waste rock stockpiles and the tailings basin. These monitoring programs will address the material being placed in the stockpile/basin, performance of design/construction (i.e. liners, trenches, collection systems), and water quality and quantity associated with the stockpile/basin (i.e. drainage, groundwater, and surface water). Additional detail on the scope or how monitoring will be addressed in the EIS is provided in Section 7.0 Mitigation and Monitoring.

2.7.2 Tailings Basin

The project description in the Scoping EAW includes deposition of tailings on the existing LTVSMC tailings basin. Due to limited available data on these tailings, there is uncertainty about whether or not the tailings would be reactive. Humidity cell testing is currently developing information about the potential reactivity of tailings. These tests are long-term tests that may not provide definitive answers within the time period for preparation of this EIS. As a result, the project proposer has developed the following strategy to mitigate for any potential environmental impacts if the tailings are ultimately found to be reactive:

- Develop a lined tailings storage facility on top of Cell 2W of the existing LTVSMC tailing basin to provide storage for five years of tailings.

- Continue waste characterization during this period and collect field data during operations to determine if the tailings are reactive.
- If during the initial 5-year operation period, the tailings are determined to be non-reactive, the original proposal to use an unlined tailings basin could be implemented. Potential environmental impacts and mitigation measures of placing non-reactive PolyMet tailings in the unlined Cells 1E and 2E will be included in the EIS.
- If the tailings are ultimately determined to be reactive, the company has proposed to line Cells 1E and 2E for the entire life of the operation to prevent reactive runoff from seeping into the ground and surrounding environment. Any discharge from the tailings basin would be monitored and if necessary, directed to a water treatment plant for appropriate treatment prior to discharge. Potential impacts and mitigation measures of this alternative will be included in the EIS.

3.0 EIS ISSUES

Issues have been identified and described in the Scoping EAW and are categorized below by significance and amount of additional analysis required in the EIS. Mitigation measures that could reasonably be applied to eliminate or minimize adverse environmental effects will be identified in the EIS.

3.1 *Topic has been adequately analyzed in the Scoping EAW. Topic is not relevant or so minor that it will not be addressed in the EIS. The Scoping EAW will be appended to the EIS for reference; the relevant EAW number is provided in parentheses () after each topic.*

Land Use (Item 9)
Water-related Land Use Management District (Item 14)
Water Surface Use (Item 15)
Geologic Hazards and Soil Conditions (Item 19a)
Traffic (Item 21)

3.2 *Significant impacts are not expected but information beyond that in the Scoping EAW will be included in the EIS.*

3.2.1 Cover Types (Item 10)

The EIS will discuss potential impacts from changes in cover types as a function of time both during and after operation using available information.

The EIS will evaluate the potential for increased proliferation of non-native invasive plant species.

3.2.2 Vehicle Related Air Emissions (Item 22)

The EIS will include a qualitative discussion of the effects of mine haul truck emissions on air quality at receptor sites near the mining operation, including carbon monoxide, nitrogen oxides and particulate emissions. The EIS will discuss the effects of mitigation measures on projected air quality impacts. If the qualitative analysis shows anything other than insignificant impacts, further evaluation will be required.

3.2.3 Air Emissions (Item 23)

The EIS will include descriptions of air emissions sources from the mine and processing plant including crushing, grinding, flotation, all hydrometallurgical steps and copper electro-winning. Potential control technologies for emission sources will also be investigated. This information will be used in a model to complete a Class I and Class II analysis for air emissions from the project.

A Best Available Control Technology (BACT) analysis will be completed for PM_{10}, sulfuric acid mist and other pollutants as required by federal law. Maximum Available Control Technology (MACT) analysis may be required for some sources after case-by-case determinations have been made.

The EIS will verify the results of the previously completed Air Emission Risk Analysis (AERA). This verification will include the following analysis:

Conduct source-specific air dispersion modeling of those units that could influence the final risk estimates, specifically focusing on the risk drivers from the AERA (crusher/grinding operations and Hydromet plant; nickel and nickel compounds, hydrogen chloride, NO2, manganese) and/or conduct a quantitative sensitivity analysis of the critical sources using the new design parameters (location, height, exit velocity, emission database) to determine if the overall risks calculated in this AERA are still conservative estimates.

3.2.4 Odor and Noise (Item 24)

The EIS will verify potential sources and receptors of noise impacts previously conducted by PolyMet. Operational and structural mitigation to prevent potential impacts will also be discussed.

3.2.5 Archeology (Item 25)

The EIS will verify that Knot Camp will not be impacted by mining operations. The historical significance of the Cliff’s Erie plant site will be evaluated and mitigation proposed, if warranted. The EIS will also provide additional information on areas of “unknown” potential for containing archeological resources. These unknown areas are undisturbed portions of the project area:

- Within 500 ft. (150 m) of an existing or former water source of 40 acres (19 hectares) or greater in extent, or within 500 ft. (150 m) of a former or existing perennial stream;
- Located on topographically prominent landscape features;
- Located within 300 ft. (100 m) of a previously reported site; or
- Located within 300 ft. (100 m) of a former or existing historic structure or feature (such as a building foundation or cellar depression).

Any resources identified will be discussed and mitigation to prevent impacts will be proposed.

3.2.6 Visibility (Item 26)

The EIS will evaluate potential visibility impacts from nighttime glow of mine site lighting and obstruction of daytime visibility from stockpiles.

3.2.7 Compatibility with Plans and Land Use Regulations (Item 27)

The EIS will include an evaluation of project compatibility with the USFS Management Plan, Forest Resource Council Plan, and the Water Conservation Plan. The EIS will also evaluate mineland reclamation strategies to develop those designs that are most compatible with surrounding land uses and local community goals.

3.2.8 Infrastructure (Item 28)

The EIS will include an evaluation of wastewater treatment alternatives that propose to use the existing Hoyt Lakes or Babbitt POTWs. If any of these alternatives are deemed suitable for further evaluation, the EIS will include details about existing plant capacity and discuss options for increasing capacity and meeting pretreatment and NPDES permit conditions.

The EIS will also include additional detail on the electrical powerline and substation associated with the mine site. Potential impacts will be identified as well as mitigation to prevent or minimize impacts.

3.2.9 Other – Asbestiform Fibers (Item 30)

The EIS will provide information about the presence of fibers in the NorthMet deposit. Material from the flotation pilot plant process will be collected and analyzed for the presence of fibers. Samples of crushed and ground ore material (head feed), tailings, and process water will be collected. The crushing and grinding operation is expected to be the most significant source of fiber release to the air, so the head feed material will be used as an indicator of potential fiber emissions from the PolyMet facility. Tailings and process water samples will be used to provide information on fibers potentially associated with the tailings basin.

Samples will be analyzed for presence/absence of asbestos minerals and a fiber count by an initial scan using Polarized Light Microscopy (PLM). Head feed and tailings will be analyzed by a detailed scan using Transmission Electron Microscopy (TEM). This analysis will identify fibers according to the following criteria:

- “Minnesota Department of Health (MDH) Fiber” – particles with an aspect ratio of 3:1 or greater (MDH Method 852)
- “Occupational Fiber” – particles that are five micrometers in length or longer, and have a length to diameter ratio of at least 3:1 (NIOSH 7400 Method)
- “Asbestos Fiber” – particles that are five micrometers in length or longer, and have a length to diameter ratio of at least 20:1 (EPA/600/R-93-116)

TEM will also be used for fiber speciation into the following groups:

- Amphibole

- Chrysotile
- Non-amphibole
- Ambiguous

Process water samples will be analyzed using MDH Method 851, which also uses TEM technology. This method identifies fibers as particles with an aspect ratio of 3:1 or greater. Once fiber counts are obtained, fibers will be classified as amphibole, chrysotile, non-amphibole, and ambiguous. Water samples will also be analyzed using EPA method 100.2 for identification of asbestos structures in drinking water, measured as asbestos structures over ten micrometers in length and reported as fibers per liter of water.

The results of these analyses will be used to identify potential impacts and propose mitigation to minimize impacts.

In addition, a literature review will be performed on asbestos related diseases and risks from environmental exposure to short fibers, long fibers, and cleavage fragments. The results of this literature review will be summarized in the EIS.

3.2.10 Other –1854 Ceded Territory

The EIS will include a description of tribal rights reserved as part of the 1854 Ceded Territory. Impacts to these tribal rights as result of the project will be evaluated and mitigation proposed as needed.

3.3 *Potentially significant impacts may result; information beyond what was in the EAW will be included in the EIS.*

3.3.1 Fish and Wildlife Resources (Item 11a)

The EIS will discuss potential impacts to fish and wildlife habitats. In addition to threatened and endangered species identified below, this evaluation will include potential impact to USFS Management Indicator Species. This discussion will make use of existing studies that are appropriate for identification of the potential impact. Examples of studies that may be used include the Copper-Nickel Study Plots and previous work in the area completed by the proposer. The EIS will use existing information to determine whether the overall abundance in the Northern Superior Uplands Section of each growth stage that will be affected is within the Range of Natural Variation. The EIS will assess habitat types (i.e., growth stages of ecosystems types) identified at the mine site and compare them to existing information on the Range of Natural Variation for Northern Superior Uplands. Habitat types (forest growth stages) that are below the Range of Natural Variation in abundance in the Section, but present in the project area will be identified. The EIS will discuss potential mitigation for impacts to fish and wildlife habitat.

The EIS will verify the Biological Monitoring that was conducted by the proposer on fish and macroinvertebrates in Trimble Creek, Partridge River, and area wetlands. This information will be evaluated for use in developing an Index of Biotic Integrity (IBI) for potential impact areas, which can be compared to Minnesota Pollution Control Agency (MPCA) reference sites. This information will be used to establish a baseline for potentially impacted aquatic ecosystems. The EIS will assess the suitability of biological monitoring of aquatic ecosystems, including IBI, during project operation.

3.3.2 Threatened and Endangered Species (Item 11b)

The EIS will evaluate potential impacts to state and federal threatened and endangered species. This information will be used to support state and federal regulatory requirements for threatened and endangered species. Potential mitigation strategies and alternatives will be evaluated to prevent and minimize any identified impacts. The following species will be included in the analysis:

Fauna-

Gray Wolf –	Existing information will be used.
Canadian Lynx-	A winter time track survey will be conducted to supplement existing information on the number of Canadian Lynx in the area. The survey area will consist of a six-mile perimeter around the entire project impact area. Survey transects will make use of existing forest service roads, mining haul roads, railroad tracks, and trails. The survey will include collection of Lynx scat for DNA testing to identify individual cats.
Bald Eagle –	Existing information will be used.
Wood Turtle –	Existing information will be used. Emphasis will be placed on potential impacts to wood turtle habitat downstream of the project on the Partridge and Embarrass Rivers.

Flora- Evaluations of impacts to threatened and endangered state listed plants will use existing information including recent surveys conducted by the proposer. The following plants will be included in this assessment:

- Pale moonwort
- Temate grape-fern
- Least grape-fern
- Floating marsh marigold
- Neat spike-rush
- Northern commandra
- Lapland buttercup
- Clustered bur-reed
- Torrey’s manna-grass

3.3.3 Physical Impacts on Water Resources (Item 12)

Wetland impacts associated with the entire project will be identified and discussed in the EIS. A wetland delineation has been completed for the entire project that will be used to assess wetland impacts. Avoidance, minimization and mitigation of the entire direct wetland impact (~1,257 acres) will be evaluated as part of the EIS. Indirect impacts to wetland function from changes in hydrology and water chemistry will also be evaluated. The EIS will also describe and discuss the suitability and feasibility of various wetland mitigation strategies.

The EIS will include a watershed assessment of the upper Partridge River to assess the net hydrologic effects of PolyMet’s proposal. This watershed assessment will evaluate the changes in watershed discharge due to land surface changes (loss of wetlands, vegetation, and mine pit construction), as well as the direct hydrologic changes from mine pit dewatering and other mine site discharges. Section 3.3.4 below describes a hydrogeologic study that will be used to quantify the mine site discharges. A Level 1 Rosgen geomorphic survey will be conducted for the Partridge River, down to Colby Lake to identify any potentially geomorphologically sensitive stream reaches. If the watershed assessment combined with the Level 1 Rosgen geomorphic survey indicates a potential for fluvial geomorphic impacts resulting from PolyMet's proposal, there will be additional evaluation of the impact. If this additional evaluation determines that the changes in stream flow will cause significant adverse impacts, additional mitigation and monitoring will be developed.

3.3.4 Water Appropriations (Item 13)

Mine Site - The amount of water that must be discharged to dewater the mine pit is a significant issue that will be included in the EIS. The following information will be used to better estimate this amount of water:

- A report on the design and effectiveness of diking and trenching to prevent surface run-off into the pit.
- A wetland hydrology study
- Hydrogeology studies of the NorthMet Deposit including the potential for water to enter the pit from the Virginia Formation.
- A water balance model to estimate the quantity of water entering the pit from various sources (including direct precipitation into the pit) with consideration of seasonal changes and pit size.

Phase I and Phase II Hydrogeology Studies – The purpose of the hydrogeology studies is to provide information to estimate the quantity and quality of water that will be entering the mine pit. Phase I made use of an ongoing drilling program to gain information about water yield and to collect water samples for analysis and was completed in spring of 2005. Information from the Phase I study was used to evaluate potential water yield into the mine pit from the unconsolidated surficial aquifer and the Duluth Complex. The Phase II study will evaluate potential water yield from the Virginia Formation that would make up the northern boundary of the mine pit. This study will use a series of pumping wells combined with observation wells to collect data on the transmissivity of the Virginia Formation. Water quality samples will also be collected to assist in the evaluation and estimation of mine pit dewatering water quality.

This information will be used to help design water treatment facilities and estimate changes in Partridge River streamflow as part of the watershed assessment described above in Section 3.3.3. Hydrologic modeling will also be done to estimate the quantity and timing of outflow from the pit and runoff from stockpiles after mining. This information will be necessary to determine potential water treatment needs for reclamation. Because this water is likely to have come into contact with exposed ore or could be saline, it could be reactive and need appropriate treatment. The amount of water potentially needing treatment will be an important consideration in the EIS.

The affect of mine pit dewatering on groundwater levels in the unconsolidated aquifer will also be evaluated in the EIS. Information from the hydrogeology studies combined with estimates of mine pit pumping rates will be used to evaluate changes in groundwater levels.

Processing Plant and Tailings Basin – A water balance for the processing plant and tailings basin will be included in the EIS that will use the results of the pilot plant and the results of an existing hydrology study of the LTVSMC tailings basin. The following information will be used in the water balance model:

- Water generated from the flotation tailings and from the hydrometallurgical processing
- Water collected at the base of the existing tailings basin
- Makeup water needed for the processing plant
- Existing water inputs and outputs to the system from the environment (such as precipitation, evaporation, seepage, etc.)

Similar to the mine site this information will be used to discuss water quantity effects as well as to develop a better understanding of water treatment needs. Additional information will be presented on the proposed appropriation from Colby Lake.

3.3.5 Surface Water Runoff (Item 17) and Erosion/Sedimentation (Item 16)

The EIS will evaluate surface water runoff quantity and quality impacts associated with the mine site, processing plant, and tailings basin. For the purposes of this evaluation, water quality impacts from surface water runoff will be treated separately from water quality impacts associated with potentially reactive waste rock, lean ore, deferred ore, and tailings. Water quality runoff from these sources will be addressed as wastewater in Section 3.3.6 below. Water quality impacts from other sources will address potential erosion and sedimentation from areas of the project with ground disturbance.

A report with additional detail on surface water runoff systems that handle non-contact and non-reactive runoff as well as the quality and quantity of this water will be used for this evaluation. Characterization of non-reactive runoff will also be estimated to ensure the suitability of treating this runoff source as non-contact runoff. As identified in Section 3.3.4 a watershed assessment will be conducted to identify net changes in watershed runoff during project operations and post closure of the mine site and tailing basin.

The EIS will include existing information on the quality and quantity of existing water bodies and any potential for changes to these parameters from all aspects of the mining project. Estimation of hydrologic and chemical balances at the mine site during normal operations and after closure and the potential effect of discharges on receiving water biota will be evaluated in the EIS (the hydrologic and chemical balances for the tailings basin and reactive runoff from reactive waste rock stockpiles are addressed in Section 3.3.6).

As part of the EIS, conservative estimates as well as ranges of flow will be used to ensure that any environmental impacts are identified. (For example, the lowest reasonable estimate of 7Q10 will be used to insure that in stream water quality standards are met and variable storm events including but not limited to the typical design standard of a 25-year, 2-hour event will be used to ensure suitable design of water management systems.)

3.3.6 Wastewater (Item 18)

Estimates of the quantity and quality of industrial wastewater generated from the mine site, processing plant and tailings basin will be included in the EIS. Predictions of water quality will be made as a function of time, during both the operating life of the project and after operations cease.

The following studies and information will be developed as part of the EIS to better understand potential wastewater impacts, and methods of prevention and mitigation as appropriate.

Mine Site

The EIS will evaluate potential impacts to surface and groundwater from wastewater generated from contact with reactive waste rock, lean ore, and deferred ore at the mine site. The following data will be used to evaluate water quality from wastewater sources:

- Waste characterization study results
- Phase I and II Hydrogeological Evaluations
- A wetland hydrology study
- Effectiveness of mine site water management systems (including lining and capping systems for reactive waste rock stockpiles)
- Background water quality data from the Partridge River.
- Existing water quality data from other sources such as the AMAX test shaft, Copper-Nickel Study, and other mining operations.

Predictions of water quality from these sources will be used to model potential impacts to groundwater from leakage of waste rock, lean ore, and deferred containment systems.

Treatability studies for this wastewater will be conducted and modeled from information gained as part of the waste characterization study. The use of water quality data from existing Duluth Complex stockpiles will be considered and used as part of the treatability studies, as appropriate. Conceptual treatment designs will be evaluated on the ability to meet water quality effluent discharge limits. Water quality results from the treatability studies will be used to model potential water quality impacts to downstream resources.

Mine Site Open Pit

Water quality from mine pit dewatering will be predicted from a model that makes use of the same data used to estimate water quality from reactive waste rock, lean ore, and deferred ore. The use of water quality data from existing Duluth Complex stockpiles will be considered and used as part of the treatability studies, as appropriate. This will include water quality data from ore that could be exposed in the mine pit. The predicted water quality will also be used in water treatability studies, as it is envisioned that the mine pit dewatering and reactive waste rock/lean ore stockpile runoff will be treated with the same treatment system.

This modeling effort will include water quality estimates generated as a function of time during mine operation and after closure as the mine pit fills as part of mineland reclamation.

Plant-Tailings Basin

The EIS will evaluate water quality impacts from the ore processing plant and tailings basin. A water balance and chemical budget as identified below in Sections 6.2 and 6.12 will be included in the EIS. Data from Pilot Plant Process Testing will be as used as part of the waste characterization study to predict water quality in the tailings basin. As identified above in Section 2.7.2, any uncertainty about whether or not the tailings are reactive will be addressed by developing five years of lined tailings storage capacity on Cell 2W of the existing tailings basin. Continued waste characterization, including additional laboratory and field data, will determine if all tailings will need to be managed in a completely lined basin, or if they can be placed on top of Cells 1E and 2E of the existing LTVSMC tailings basin without a liner. The EIS will evaluate the potential environmental impacts for both of these possibilities. Available waste characterization data will be used to estimate a preliminary conservative range of water quality from the tailings basin. This range will be used to assess the potential environmental impacts of both lined and unlined disposal systems. Design and management of tailings basin water will include the following information:

- Technical design evaluation reports on tailings basin modification and tailings basin geotechnical
- Models of predicted water quality in the tailings pond to determine when treatment and discharge are needed.
- Wastewater treatability studies
- Models of water quality after interaction with underlying taconite tailings, surrounding groundwater, and surface water.
- Details on design and effectiveness of the tailings basin seepage collection system
- Existing water quality data from tailings basin seepage

Water quality information from the hydrometallugical processing facility will be generated from the Pilot Plant Process Testing data. This information will be used to provide the water balance and chemical budget of the facility to predict water quality in the reactive residue facility. Using modeling techniques, the EIS will evaluate potential leakage from the lined reactive residue facility and any subsequent interaction with the underlying taconite tailings, buried hornfels, groundwater, and surface water. Water quality data collected from the existing buried hornfels monitoring well will be used to assist in this evaluation.

A treatability study for wastewater from seeps and from the tailings basin ponds will be included in the EIS. The study will include:

- Conceptual treatment design and ability of the design to meet expected water quality permit effluent limitations. Synthetic laboratory water, which has the expected chemical composition of seep and pond wastewater, will be created for the test.
- A variety of treatment options will be evaluated. This may include both active and passive (low maintenance) treatment systems as well as combinations of treatment.

Water Quality of Receiving Waters

The EIS will provide information about existing water quality of the Partridge River, Trimble Creek, St. Louis River, Embarrass River and Lake Superior based on existing data and, where needed, additional monitoring. Potential water quality impacts to these water bodies as a result of the project will be evaluated in the EIS. The water quality of wastewater discharges will be estimated for purposes of identifying potential wastewater discharge limits or the need for the project to apply for variances from water quality standards. If it appears that a variance would be needed, the EIS will describe the process for evaluation of the variance and identify issues and/or the possibility of receiving a variance, as well as any impacts to downstream resources as a result of the variance.

Mercury

The EIS will include a mercury balance for wastewater from the mine site and the ore processing/tailings basin. An assessment of the ability for these wastewater sources to meet the 1.3 ng/L water quality standard for the Lake Superior Basin will also be included. If it appears that the project is unable to meet the mercury standard, additional wastewater disposal options will be evaluated. The use of existing publicly owned wastewater treatment plants combined with a variance to the mercury standard is an option that will be explored. Impacts and/or needed facility upgrades will be identified as well as potential impacts to downstream resources as a result of a mercury variance.

The EIS will evaluate the potential and any impacts from methylation of mercury due to increased sulfate concentrations in receiving waters.

Sanitary Wastewater Disposal

Sanitary wastewater disposal for the project will make use of traditional treatment technology and is not expected to cause significant environmental impacts. The EIS will however provide information on treatment options and receiving waters.

3.3.7 Solid Waste (Item 20)

The characterization, handling, and facility design associated with waste materials will be a significant issue addressed in the EIS. Waste characterization is a long-term activity that would continue after environmental review and permitting is complete and even into project operations. All available waste characterization data will be used to estimate a conservative range of water quality from all waste materials. If the conservative estimates demonstrate that some of the waste will not produce drainage that would adversely impact natural resources, then that waste can be handled in a manner similar to non-reactive waste from existing taconite operations. If the data is not definitive and the estimates indicate that the drainage could adversely impact natural resources, then the waste will be placed in lined systems and all drainage collected, monitored and treated if necessary. The waste will be handled in this manner until sufficient field and laboratory data has been generated to demonstrate that the waste is non-reactive. The three components of the project that will be the major focus of this discussion will be waste rock from the mine site, tailings from ore beneficiation process, and reactive residue from the hydrometallurgical processes. The behavior of existing LTVSMC tailings will also be investigated.

Below is a brief description of materials and issues that will be included in the EIS on each of these components:

Mine site waste rock:

- Estimation of amounts and composition of potentially non-reactive waste rock, potentially reactive waste rock, lean ore, and deferred ore using a block model.
- Evaluation of details and alternatives for reactive waste rock stockpile design and siting.
- Evaluation of the mine waste management plan including effectiveness of the Grade Control Program including details on blast hole sampling for waste rock management.
- Estimation of the quantity and quality of drainage to be generated over time.

Ore beneficiation process tailings:

- Characterization of tailings.
- A lined tailings cell on top of Cell 2W of LTVSMC existing tailings basin to dispose of five years of PolyMet tailings.
- Evaluation on the use of the existing unlined tailings basin if tailings are non-reactive.
- Evaluation of alternatives for design, construction, and siting of tailings basin, including the use of a liner if tailings are reactive.
- Evaluation of physical and chemical suitability of existing and new tailings for construction of tailings basin.
- Estimation of the quantity and quality of drainage to be generated over time including the post-operational phase.

Hydrometallurgical processes reactive residue:

- Characterization and quantities of residue.
- Design of reactive residue facility.
- Suitability of reactive residue facility siting on existing tailings basin Cell 2W.
- Evaluation of alternatives for design, construction and siting.
- Estimate the water quantity and quality to be generated over time.

Results from the Pilot Plant Processing Testing study and the waste characterization study will be used in conjunction with existing data to characterize the above-described material. The Pilot Plant Process Testing study will generate tailings and reactive residue from a sample of the NorthMet deposit that was subjected to the proposed ore beneficiation and hydrometallurgical processes. As stated above, the waste characterization study is a long-term study that would continue after the completion of the EIS. This study makes use of humidity cell tests on wastes from the NorthMet deposit, including tailings to determine the reactive nature of the materials. All available data will be used to develop conservative estimates for assessment of environmental impacts in the EIS. As part of the characterization study, PolyMet will conduct a complete chemical and mineralogical study of its waste. This information will be used to compare the predicted behavior of the PolyMet material with other samples of Duluth Complex material for which long-term data exists. Comparisons with existing data may be used to determine the applicability of the available results.

Identification, handling and facility design of other solid wastes and hazardous materials such as wastewater treatment sludge and explosives will be included in the EIS.

3.3.8 Cumulative Effects (Item 29)

The EIS will evaluate cumulative effects using guidance from the Council on Environmental Quality handbook for considering cumulative effects under the National Environmental Policy Act (CEQ, 1997). The affected resources that are related to the cumulative effect issues will be used to determine the appropriate geographic and temporal scope to the analysis. The geographic and temporal scope will in turn be used to identify the specific past, present, and reasonably foreseeable future actions to be considered. The following list of cumulative effect issues are proposed for evaluation in the EIS:

- Hoyt Lakes Area Projects and Air Concentrations in Class II Areas
- Class I Areas PM_{10} Increment
- Ecosystem Acidification Resulting From Deposition of Air Pollutants
- Mercury Deposition and Bioaccumulation in Fish
- Visibility Impairment
- Loss of Threatened And Endangered Plant Species
- Loss of Wetlands
- Loss or Fragmentation of Wildlife Habitat
- Streamflow and Lake Level Changes
- Water Quality Changes
- Economic Impacts
- Social Impacts

Additional detail about the specific analysis of each of these issues was included in response to the Scoping EAW Question 29. For clarity in the Scoping Decision Document and to address changes to the proposed evaluation of cumulative effect issues, the approach to evaluation of each issue is identified below.

3.3.8.1 Hoyt Lakes Area Projects and Air Concentrations in Class II Areas:

An air dispersion modeling study will be performed. Background information on the study will be provided:

- Description of the air dispersion modeling protocol (including relevant assumptions). If the number of stacks becomes cumbersome from a modeling standing point, professional judgment will be used to consolidate stacks or emissions as appropriate given available modeling guidance from regulatory agencies.
    - Summary of estimated emissions of SO_2, NO_x, and PM_{10} by emission unit (if available) for each of the three projects (Cliffs Erie Railroad Transfer Facility, Mesabi Nugget Plant, and PolyMet) proposed for the Cliffs Erie site (including relevant assumptions). Emission estimates will be provided by project proposers. If necessary, an emission scenario will be developed for projects lacking the necessary modeling details.

- Description of the air dispersion model; a regulatory approved model will be used for the analysis (either ISCST3 or ISC PRIME).
    - Description of the receptor grid; the receptor grid will be established outside of the Cliffs Erie site boundary, from the site boundary out to 10 kilometers. Receptors will be placed on the Cliffs Erie site boundary with a 100 meter spacing. Receptors will have a 100 meter grid spacing from the site boundary out to 2 kilometers. Receptors will have a grid spacing of 1 kilometer starting at 2 kilometers from the Cliffs Erie site boundary out to 10 kilometers.
    - Description of meteorological input data; 1972-1976 Hibbing data will be used for the analysis.
- Modeling results will be tabulated, summarized and compared to the national and state ambient air quality standards (NAAQS/MAAQS)
    - Background air concentrations will be added to the modeled air concentrations. By including background air concentrations in the analysis it is assumed that past and present actions will be reflected in these background air concentrations. Depending on the availability of data, this assumption may need to be revisited upon actually conducting the study.
- Timeframe: the proposed facilities are assumed to be constructed and at full operations by 2008
- Report preparation and submittal to the MPCA and EIS contractor so that results can be evaluated and included in the EIS.
    - Model input/output files made available to the MPCA.

The impact analysis will be completed based on the results of the modeling study. Background information (see above) and final modeling results will be summarized in a report to be submitted to the MPCA and the EIS contractor. Description of air emissions control technologies is expected to be a significant section of the report. Uncertainties in the modeling study will be identified and discussed. Results of the cumulative analysis will be incorporated into the EIS with guidance from the MPCA.

3.3.8.2 Class I Areas PM_{10} Increment:

A semi-quantitative assessment of Class I Areas PM_{10} Increment will be performed. Background information on Class I Areas PM_{10} Increment in Minnesota will be summarized:

- Summary of long-range regional transport issues for $PM_{2.5}$ (fine aerosol), sulfate, and nitrate
- Summary of the IMPROVE monitoring network data for particulates (including ammonium nitrate, ammonium sulfate, coarse particulate, and elemental carbon and organic carbon for the period of record for the Voyageurs National Park site and the Boundary Waters Canoe Area Wilderness (BWCAW) site
- Summary of the PM_{10} air concentrations available from any nearby state monitoring sites
- Summary of air modeling studies conducted to date and the available results, with particular emphasis on major source contributions of fine particulate from in-state sources and out-of-state sources (national studies, CENSARA, other state efforts)
- Summary of current and foreseeable future federal regulatory controls to $PM_{2.5}$, PM_{10}, sulfates, nitrates: implementation of the Taconite MACT standard (PM_{10} as a surrogate for metals);

Regional Haze Rule; NO_x SIP call (40 CFR parts 51, 72, 75, 96; Clean Air Interstate Rule; EPA proposed rule (Federal Register, Vol. 70, No. 35) for NO_x in Class I Areas); EPA "to-be" proposed rule for Best Available Retrofit Technology, BART (April 2005)

- Summary of current and foreseeable future state regulatory controls and/or actions (State acid rain rule and statewide SO_2 emissions cap; Title IV of the 1990 Clean Air Act Amendments, affected MN sources
- Timeframe: Emissions projections (increases, decreases) from the proposed facilities, as well as from existing facilities subject to the various regulatory requirements, will be through the year 2020.

Estimates of current PM_{10}, SO_2, and NO_x emissions from sources in Minnesota will be summarized based on the most current emission inventory available. Emissions will be reported for major geographic areas in the state (Twin Cities, Iron Range, etc.). The trend of statewide emissions will be assessed using existing historical emission inventory data. This analysis will cover the period of record for such data. Background monitoring data ($PM_{2.5}$) for Voyageurs National Park and Ely (Fernberg Road) will also be summarized as will PM_{10} monitoring data from nearby sites.

Cumulative impacts will be based on projections of the potential increases or reductions in SO_2, NO_x, PM_{10} emissions from current Minnesota sources. Emission estimates from the following list of projects will be considered and included in the evaluation if appropriate:

- Existing Taconite Plants with Proposed Modifications
- Proposed Mesabi Nugget Plant
- Proposed Cliffs Erie Railroad Pellet Transfer Facility
- Proposed Minnesota Steel DRI/Steel Plant
- Implementation of Taconite MACT Standards
- Shutdown of LTVSMC Taconite Furnaces
- Mesaba Energy Coal Gasification Plant located near Taconite MN
- Implementation of the Regional Haze Rule and BART Rule (to be proposed)

The assessment will summarize the potential implications for PM_{10} increment in the BWCAW. Description of air emissions control technologies is expected to be a significant section of the report. Results of the cumulative analysis will be incorporated into the EIS with guidance from the MPCA.

3.3.8.3 Ecosystem Acidification Resulting From Deposition of Air Pollutants:

A semi-quantitative assessment of cumulative acid deposition in Minnesota will be performed. Background information on acid deposition in Minnesota will be summarized:

- Summary of the long range pollutant transport issue (National Acid Precipitation Assessment Program; NAPAP)
- Summary of Minnesota's assessments of ecosystem buffering capacity (1980 – 2000)
- Summary of Minnesota's air modeling studies of source contributions (1986)
- Summary of Minnesota regulatory controls to protect sensitive ecosystems
- Summary of current and foreseeable future federal regulatory controls

- Timeframe: Emissions projections (increases, decreases) from the proposed facilities, as well as from existing facilities subject to the various regulatory requirements, will be through the year 2020.

Trend analysis will be conducted for SO_2 and NO_x statewide emissions (using existing state wide emission inventory data) and for deposition monitoring data at three sites in northern Minnesota. These analyses will cover the period of record for such data and will include comparisons to the statewide emission cap and the deposition standard (11 kilograms/hectare/year) which were established to protect Minnesota's aquatic terrestrial ecosystems.

The potential cumulative impacts will be based on projections of the potential increases or decreases in sulfate and nitrate deposition to Minnesota ecosystems from reasonably foreseeable actions. The following list of projects will be considered and included in the evaluation if appropriate:

- Existing Taconite Plants with Proposed Modifications
- Existing Power Plants
- Proposed Mesabi Nugget Plant
- Proposed Minnesota Steel DRI/Steel Plant
- Mesaba Energy Coal Gasification Plant located near Taconite MN
- Implementation of the Clean Air Interstate Rule.
- Implementation of the Regional Haze Rule and BART Rule (to be proposed)
- Shutdown of LTVSMC Taconite Furnaces

The results of the cumulative impacts assessment will be compared to the Minnesota annual acid deposition standard, which was promulgated to protect sensitive ecosystems. The assessment will summarize the potential implications for Minnesota ecosystems.

Description of air emissions control technologies is expected to be a significant section of the report. Results of the cumulative analysis will be incorporated into the EIS with guidance from the MPCA.

3.3.8.4 Mercury Deposition and Bioaccumulation in Fish:

A semi-quantitative assessment of cumulative mercury deposition will be performed. Background information on mercury deposition in Minnesota will be summarized:

- Summary of the long range transport issue
- Summary of studies assessing mercury deposition and bioaccumulation in fish tissue in Minnesota's aquatic ecosystems
- Summary of air modeling results for source contributions (national, state efforts).
- Summary of state actions and the state's proposed statewide Total Maximum Daily Load (TMDL) (93% reduction in MN emissions)
- Summary of current and foreseeable future federal regulatory controls
- Timeframe: Emissions projections (increases, decreases) from the proposed facilities, as well as from existing facilities subject to the various regulatory requirements, will be through the year 2020.

The assessment of potential impacts will be completed through mercury emission trend analyses using existing statewide emission inventory data and trend analyses of annual wet mercury deposition monitoring data at two sites in northern Minnesota. These analyses will cover the period of record for such data and will include comparisons to natural background.

Cumulative impacts will be based on projections of the potential increases or reductions in mercury emissions from general source categories (e.g., electric utilities, mining, products, etc). Emission estimates from reasonably foreseeable actions will be included in the analysis. The following list of projects will be considered and included in the evaluation if appropriate:

- Existing Taconite Plants with Proposed Modifications
- Existing Power Plants with Proposed Modifications
- Proposed Mesabi Nugget Plant
- Proposed Minnesota Steel DRI/Steel Plant
- Mesaba Energy Coal Gasification Plant located near Taconite MN
- Implementation of Taconite MACT Standards
- Shutdown of LTVSMC Taconite Furnaces
- Implementation of the Electric Utility MACT Standards
- Implementation of Minnesota's Regional Mercury TMDL

Potential emissions of mercury from current and reasonably foreseeable future projects will be subject to the statewide TMDL. The implementation plan for the TMDL will specify the actions necessary to control mercury emissions so as to meet water quality standards.

Description of air emissions control technologies is expected to be a significant section of the report. Results of the cumulative analysis will be incorporated into the EIS with guidance from the MPCA.

3.3.8.5 Visibility Impairment:

A semi-quantitative assessment of cumulative visibility impacts will be performed. The assessment will focus on Minnesota's Class I areas. Background information on visibility pollution in Minnesota will be summarized:

- Summary of long range transport issue
- Summary of IMPROVE monitoring network in Voyageurs National Park and Boundary Waters Canoe Area Wilderness
- Summary of air modeling results for source contributions (national, CENSARA, other state efforts).
- Summary of current and foreseeable future federal regulatory controls
- Timeframe: Emissions projections (increases, decreases) from the proposed facilities, as well as from existing facilities subject to the various regulatory requirements, will be through the year 2020.

The assessment of potential impacts will be completed through statewide SO_2, NO_x, and PM_{10} emission trend analyses using existing statewide emission inventory data (listing of sources and ton/yr emissions). Trend analyses will provide breakout of emissions by geographic area of the state (Twin Cities, Iron Range, etc.) In addition, a trend analysis of background monitoring data from Voyageurs National Park and Ely (Fernberg Road) will be provided, including plots of light extinction and other pertinent parameters, depending on data availability.

Cumulative impacts will be based on projections on the potential increases in SO_2 and NO_x emissions in Minnesota from current and reasonably foreseeable actions. Emission estimates (or decreases) from the following past, current and reasonably foreseeable actions will be included in the analysis. The following list of projects will be considered and included in the evaluation if appropriate:

- Existing Taconite Plants with Proposed Modifications
- Proposed Mesabi Nugget Plant
- Proposed Cliffs Erie Railroad Pellet Transfer Facility
- Proposed Minnesota Steel DRI/Steel Plant
- Mesaba Energy Coal Gasification Plant located near Taconite
- Implementation of Taconite MACT Standards
- Shutdown of LTVSMC Taconite Furnaces
- Implementation of the Electric Utility MACT Standards
- Emission reductions in other parts of Minnesota (Metropolitan Emission Reduction Project)
- Implementation of the Regional Haze Rule and BART Rule (to be proposed)

Description of air emissions control technologies is expected to be a significant section of the report. Results of the cumulative analysis will be incorporated into the EIS with guidance from the MPCA.

3.3.8.6 Loss Of Threatened And Endangered Plant Species:

A semi-quantitative analysis of cumulative impacts will be performed using available information. Because the Minnesota Department of Natural Resources is charged with administering the program to protect state-listed threatened and endangered species and managing species with the potential to become threatened or endangered within the state of Minnesota, the entire state will be defined as the geographic boundary for analysis. While the range of most of the potentially affected species extends beyond the state boundary, the regulatory program does not, and it would be difficult to determine "truly meaningful effects" within the species natural ranges that extend into other states and Canada. The species that will be addressed in the analysis are listed in Table 29-1.

Table 29-1: Rare species present within or near the PolyMet Mine Site

Common Name	Scientific Name	State Status[1]	PolyMet Mine Site Observations (populations)	Approx. # of Individuals	Habitat
Pale moonwort	*Botrychium pallidum*	E	4 pops .	58	Full to shady exposure, edge of alder thicket, along Dunka Road, and railroad and powerline right-of-way.

Ternate grape-fern	*Botrychium rugulosum (=ternatum)*	T	None identified		Disturbed habitats, fields, open woods, forests
Least grape-fern	*Botrychium simplex*	SC	20 pops .	1,337	Full to shady exposure, edge of alder thicket, forest roads, along Dunka Road, and railroad and power line rights-of-way.
Floating marsh marigold	*Caltha natans*	E	13 pops .	~150	Shallow water in ditches and streams, alder swamps, shallow marshes, beaver ponds, and Partridge River mudflat.
Neat spike-rush	*Eleocharis nitida*	T	11 pops .	~1,450 sq.ft.	Full exposure, moist ditches along Dunka Road, wet area between railroad grades, and railroad ditch.
Northern commandra	*Geocaulon lividum*	SC	11 pops .		On *Pleurozium* and *Sphagnum* moss mats under black spruce, open to partly shaded.
Lapland buttercup	*Ranunculus lapponicus*	SC	7 pops .	~825 sq.ft.	On and adjacent to *Sphagnum* hummocks in black spruce stands, up to 60 percent shaded with alder also dominant.
Clustered bur-reed (floating marsh marigold)	*Sparganium glomeratum*	SC	13 pops .	>100	Shallow pools and channels up to 1.5 feet deep in *Sphagnum* at edge of black spruce swamps, beaver ponds, wet ditches, shallow marshes
Torrey's manna- grass	*Torreyochloa pallida*	SC	8 pops .	~800 sq.ft.	In muddy soil along shore and in water within shallow channels, beaver ponds, shallow marshes, along Partridge River.

1- E - Endangered, T - Threatened, SC - Species of Concern

The life history of each species will be described including what is known about their preferred habitats, the role of disturbance in their life history, range, sensitivity to stresses, and the current level of understanding of the species. This characterization will differentiate between pioneering species and those that are part of mature communities.

Species losses from the following reasonably foreseeable actions will be included in the analysis as forecasted for 27-years consistent with the PolyMet projection of 2-years of construction, 20-years of operation and 5-years of closure:

- Proposed Minnesota Steel DRI/Steel Plant
- Proposed Ispat Inland Mine Pits
- Proposed Cliffs Erie pellet railroad loading project
- Proposed Mesabi Nugget Project

Losses from other projects with the potential to affect the species of interest will also be included in the analysis if the necessary species population information is available at the time of the analysis and can be provided by DNR (e.g. Mesaba Energy Coal Gasification Plant).

The past projects will include projects for which the DNR has issued takings permits for the species of interest.

Through compilation of known records of each species within the state from the Natural Heritage Information System, a distribution map for each species will be prepared. The data will be compiled to summarize the number of known populations, approximate numbers of plants, and locations. Takings permit information will be analyzed to determine the extent of past losses. The baseline condition will also include a description of how land use conditions affecting the various species have changed over time and how they are likely to change in the future; both with and without the proposed projects.

Impacts related to past, present, and reasonably foreseeable future impacts will be evaluated through a semi-quantitative summary of the number of populations and individuals of each species that may be affected and the magnitude of those effects based on the knowledge of the species within the state. This evaluation will include determining whether the various species are particularly vulnerable to decline. The "magnitude" of the effects will be evaluated within the context of the state, the affected region, and the DNR regulatory program.

Alternative configurations of the project will be evaluated to determine if the projected impacts can be minimized.

If it is determined that unavoidable impacts will result to threatened species; plans will be made to mitigate for those impacts. The mitigation for the loss of state-listed threatened, endangered, or special concern species will be developed in consultation with the DNR Natural Heritage and Non-game Research Programs and through administration of state threatened and endangered species permit requirements (Minnesota Rules Chapters 6134 and 6212) pursuant to statutory authority Minnesota Statutes, section 84.0895.

3.3.8.7 Loss of Wetlands

A semi-quantitative analysis of cumulative impacts to wetlands will be performed. Because several of the primary functions performed by wetlands are directly related to watershed processes, the analysis will be performed on a watershed basis. The geographic area of analysis will be the Partridge River watershed. Historical activities within the Partridge River watershed that have affected wetland resources are primarily mining activities and urban development that started on a large scale in the early 1950's. The remainder and majority of the watershed have seen limited disturbance and loss of wetlands. The baseline condition for wetland resources will be established using the following approach.

The National Wetland Inventory data will be used to help establish the baseline wetland condition in the undisturbed areas of the watershed since it is the best data representing the extent of wetland resources in the Partridge River watershed. In the areas of the watershed that have been significantly altered, wetlands will be mapped and classified to the extent feasible using a number of historic data resources layered in a geographic information system including:

- 1930's aerial photographs
- Original U.S. Geological Survey 7.5 minute quadrangle topography maps from the early 1950's, prior to the onset of significant mining activities

- DNR GIS data that incorporates notes from the original survey of the area and includes detailed wetland vegetation information

The baseline condition will also include a description of how conditions affecting wetlands have changed over time and how they are likely to change in the future both with and without the proposed projects.

A similar wetland mapping effort may be conducted to establish wetland conditions at an interim point in time, (e.g., 1970) to help track trends in wetland loss.

The next step will be to prepare a mapping of wetland resources, as they exist at the present time, before the start of any further projects in the Partridge River watershed. This wetland mapping will be prepared using information from the National Wetland Inventory mapping and from site-specific wetland surveys that have been conducted within the areas of the Partridge River watershed. This wetland mapping will be compared to the historic wetland (baseline) mapping to quantify the effects of past activities on wetland resources within the analysis area.

Wetland losses from the following reasonably foreseeable actions in the Partridge River watershed will be included in the analysis as forecasted for 27-years, consistent with the PolyMet projection of 2-years of construction, 20-years of operation and 5-years of closure:

- Proposed PolyMet Mine
- Portions of the proposed Cliffs Erie Railroad Pellet Transfer Facility in the Partridge River Watershed
- Future expansion of Northshore Mining Company's Peter Mitchell Mine Pits

Losses from other proposed projects with the potential to affect wetland resources in the Partridge River watershed will also be included in the analysis if wetland impact information is available at the time of the analysis.

Impacts related to past, present, and reasonably foreseeable future actions will be evaluated through a quantitative summary of the number of acres of various wetland types that may be have been affected in the past and may be affected in the future and the magnitude of those effects within the watershed. Trends that may be discernible from evaluating the data will be evaluated. This evaluation will include determining whether various wetland types are particularly vulnerable to rapid degradation. The "magnitude" of the effects will be evaluated within the context of the overall wetland resources within the watershed.

Alternative configurations of the project will be evaluated to determine if the projected impacts can be minimized. Unavoidable wetland impacts will be mitigated in accordance with the state and federal wetland permitting programs.

3.3.8.8 Wildlife Habitat:

Background

Since the state was established (1858), Minnesota's ecosystems have all been affected by both human and natural disturbances. The drastic reduction in native prairie, which has been converted to row-crop agriculture, is a well-known example of human disturbances. Much of the forested areas of the state are still forested and appear to have been less impacted by disturbance in that they remain forested with native species, although forest types changed and the diversity of forests have been reduced. Human activities (e.g. mining, urbanization and logging) and natural disturbances (e.g. fire, windstorms, and insect infestation) have altered the character of the original ecosystems in the Arrowhead Region.

Mining activity on the Iron Range has created a unique, but unnatural, impact on the landscape in the Arrowhead Region. The locations and orientation of mineralized deposits, and thus the mining activities, are in a relatively narrow, linear band from Ely to Grand Rapids. The length and extent of 125 years of mining activity and associated infrastructure (shear-walled mine pits, tailings piles, haul roads, railroads, tailings basins, and associated structural development) in its' entirety have contributed to habitat loss/fragmentation and could potentially cause a "landscape barrier" which obstructs wildlife travel corridors.

This EIS will evaluate the cumulative impacts additional industry (mining) and human activity may have on both habitat loss/fragmentation and creating barriers to wildlife travel corridors along the iron range. The evaluations are described below.

Wildlife Habitat Loss/Fragmentation

Wildlife habitat has been lost along the Iron Range due to increasing human activities (e.g. mining). Habitat loss can be described as the outright destruction of habitat, such as filling a wetland or channelizing a section of stream. Depending on the scale and temporal aspects of habitat loss the impacts upon a biological community may be delayed or immediate and catastrophic. Habitat fragmentation on the other hand is the gradually disassembly of terrestrial habitats in discontinuous, often isolated patches as a consequence of development. The adverse effects are usually cumulative and not immediately noticeable and stem from habitat loss.

The two largest industries in the area that have had the greatest affect on wildlife habitat are logging and mining. The DNR prepared a Generic Environmental Impact Statement (GEIS) to address environmental impacts from state timber harvests. This GEIS made the conclusion that loss of forest in the northern part of the state is a significant unavoidable adverse impact. This loss of forest can cause increased fragmentation and changes in types of habitat that could result in a loss of habitat to some specialist wildlife species, and a gain of habitat to other generalist wildlife species.

Both logging and mining have habitat loss impacts that can be tempered by managing timber harvests for re-growth and reclamation of mining areas. However, the habitat that develops after logging and mining is not equal to the original habitat and the time for mineland reclamation to provide habitat is significant. Urbanization and infrastructure impacts to wildlife habitat create a permanent loss and fragmentation.

Approach to Evaluation

The geographic boundary for impact analysis of habitat loss/fragmentation will be necessarily large: the Arrowhead Region including the Border Lakes, Laurentian Uplands, Nashwauk Uplands, Northshore Highlands, and Tamarack Lowlands Ecological Subsections.

Marschner's map of the original vegetation of Minnesota (see Heinselman, 1975) will be used to define the baseline vegetation condition. This map was compiled from the U.S. General Land Office (GLO) Survey Notes. This map is based on field notes of the GLO surveyors, who conducted the original land surveys of Minnesota during the period 1850 to 1905. It was drafted at a 1:500,000 scale. Marschner mapped 16 vegetative/ecosystem categories, ranging from marshes to pine groves. The map therefore is the best representation of the original ecosystems of Minnesota before the impact of European man

The actual acres of the various ecosystems that have been disturbed by past and current mining and infrastructure development will be tabulated as will the relative loss by ecosystem category. These tabulations will also be summarized by ecological subsection. Marschner's vegetation types will be classified into habitat types that relate to U.S. Forest Service Management Indicator Habitats or Minnesota's Comprehensive Wildlife Conservation Strategy.

The area disturbed will be derived from the U.S. Geological Service (USGS) Level 2 Gap Analysis Program (GAP) and 2003 Mine Features GIS mapping layer available from the DNR. A similar assessment will be carried out overlaying a GIS layer of the projected cumulative disturbance 30 years in the future (total time of construction, operation and closure of current mining proposals) as related to the following proposed future actions:

- Proposed PolyMet Mine
- Proposed Mesabi Nugget Plant
- Proposed Cliffs Erie Railroad Pellet Transfer Facility
- Proposed Minnesota Steel DRI/Steel Plant
- Future mining plans for existing taconite operations
- Proposed Mesaba Energy Coal Gasification Plant
- Community and infrastructure growth/expansion

The extent of habitat loss and fragmentation will be evaluated semi-quantitatively with respect to permanent or temporary loss/fragmentation. It is recognized that this assessment will not account for changes in the quality of various habitat types. However, an assessment will be made with respect to the losses and fragmentation of habitat types and what affect that may have on wildlife species. The assessment will consider existing literature on habitat loss/fragmentation as well as the U.S. Forest Service Management Indicator Species and Minnesota's Comprehensive Wildlife Conservation Strategy. Impacts to area sensitive and cover-type sensitive species will be evaluated and described.

<u>Wildlife Travel Corridor Obstruction/Landscape Barriers</u>

Wildlife travel corridors are areas that connect habitats and increase the effective amount and diversity of habitat available for a species and possibly mitigate for habitat fragmentation. Landscape barriers may have impacts on dispersal, migration, and/or seasonal movements of wildlife. Different species of wildlife have specific habitat needs at various times of the day, season, year, and lifetime in order to survive and reproduce. To meet those needs they must move from one type of habitat to another. Daily movements include travel from resting areas to foraging areas and to sources of water.

Seasonal and yearly movements may consist of travel from winter range to calving areas to summer range. Lifetime movements include dispersal of young animals from their areas of birth to establish new territories or home ranges. Human activities (i.e. mine pits) along travel corridors can block, deflect, or delay such movements**.**

The loss of any additional travel corridor through the Iron Range could potentially push this cumulative impact over a threshold. Once beyond that threshold, these species' normal/ historic movement and dispersal patterns could be altered forever. Negative consequences would be both short and long term, including effects on genetic distribution, food procurement, summer/winter range accessibility, annual dispersal and other yet unknown or unforeseen parameters.

Approach to Evaluation

The approach to evaluation of travel corridor obstruction will be to choose an appropriate analysis area, a baseline time and condition and then: 1) assess the cumulative disturbance of past and current mining and associated infrastructure development on that baseline condition; and 2) assess the presence of landscape barriers of past, current and proposed future actions and the effect on dispersal, migration, and/or seasonal movements of large mammals. It is assumed that large mammals will be the most sensitive to landscape barriers due to the size of potential barriers (mining operations) and the magnitude of large mammal movement. Smaller species with small travel distances may also be affected due to genetic isolation. However addressing the impact to large mammals is also likely to also prevent genetic isolation of smaller animals. Using other available information, a qualitative and quantitative description of the landscape barriers in areas disturbed by mining and non-mining activities will also be provided.

The cumulative impacts of landscape barriers on wildlife travel corridors will focus on habitats within a proximity of the iron formation that are likely to impact wildlife that use those habitats. A buffer of 15 miles around the Iron Range will be used to focus this evaluation. Travel corridors that exist as part of the current condition will be identified and evaluated for the reasonable foreseeable opportunity of preserving and maintaining those existing travel corridors.

It is reasonable to assume that prior to human disturbance habitat barriers were minimal with respect to the current condition and no additional effort will be given to characterization of baseline conditions for evaluation of habitat barriers.

DATA NEEDS FOR ANALYSIS OF CUMULATIVE IMPACTS

General Background Data

Previous assessments will be used to provide perspective on those changes in ecosystems that are associated with the cumulative effects of mining in contrast to those associated with other human and natural disturbances (e.g., logging, fire, windstorms, and insect infestations). These assessments were not specifically targeted on the mining areas of the state, but instead considered either the entire forested area of the state or some sub-area in northern Minnesota. The following assessments will be reviewed to provide a brief qualitative perspective on ecosystem changes not related to mining:

- Friedman, S.K. Landscape Scale Forest Composition and Spatial Structure: A Comparison of the Pre-settlement General Land Office Survey and the 1990 Forest Inventory in Northeastern Minnesota. University of Minnesota, St. Paul: Ph.D. Thesis, 2001.

  Friedman reconstructed the presettlement forest vegetation in northeastern Minnesota using General Land Office Survey Records and assessed change in this forest following the introduction of logging and the suppression of fire.

- Minnesota Generic Environmental Impact Statement (GEIS) Study on Timber Harvesting and Forest Management in Minnesota.

  The GEIS analyzed impacts resulting from timber harvesting and associated management activities in Minnesota, such as logging, reforestation, and forest road construction. Four sections of the GEIS may be useful in describing forest change not related to mining, including: Section 5.2.1 Forest Area and Cover Type Abundance, Section 5.2.4 Forest Fragmentation, Section 5.6.1 Forest Resources - Extent, Composition, and Condition, and Section 5.7.4 Cumulative Unmitigated Significant Impacts.

- Minnesota Forest Resource Council (MFRC) Landscape Project.

  The MFRC Landscape Project is a landscape level program and coordination effort. As part of the project, a number of reports have been generated that may be used in this evaluation of cumulative impacts. All reports are available from the MFRC website www.frc.state.mn.us/Info/MFRCdocs.html and include:

  - Changes in disturbance frequency, age and patch structure from pre-European settlement to the present in north central and northeastern Minnesota. LT-1203a
  - Contemporary forest composition and spatial patterns of north central and northeastern Minnesota: An Assessment using 1990s LANDSAT data (accompanying maps/plates). LT-1203b
  - Changes in forest spatial patterns from the 1930s to the present in north central and northeastern Minnesota: An analysis of historic and recent air photos (accompanying maps/plates). LT-1203c
  - Potential future landscape change on the Nashwauk Uplands in northeastern Minnesota: an examination of alternative management scenarios using LANDIS. LT-1203d
  - Background paper: relationships between forest spatial patterns and plant and animal species in northern Minnesota (Report) (Appendices). LT-1203f

- Forest Plan Revision Final Environmental Impact Statement for Chippewa and Superior National Forests.

  As part of their comprehensive planning process, the U.S. Forest Service developed an Environmental Impact Statement that discussed changes in forest conditions with time. This document can be found at www.superiornationalforest.org/analyses/2004Plan/feis/index.shtml.

- Minnesota's Comprehensive Wildlife Conservation Strategy

  Minnesota's Comprehensive Wildlife Conservation Strategy (CWCS) is designed to be a strategic plan for a partnership of conservation organizations within Minnesota. Species of greatest conservation need (SGCN) and priority habitat types within each Ecological Subsection are identified. The plan outlines priority conservation action that partners and interested individuals can use as a menu for action.

Wildlife Habitat Loss/Fragmentation Data Needs

- Marschner's Original Presettlement Vegetation Map of Minnesota. Minnesota Department of Natural Resources.
- Land Use – Minnesota, Forested Area. Manitoba Remote Sensing Centre
- 1969 Land Use. Minnesota Land Management Information Center
- Minnesota Land Use and Cover 1990s Census of the Land. Minnesota Land Management Information Center
- Ecological Provinces, Sections, and Subsections of Minnesota. Minnesota Department of Natural Resources
- 2003 Mine Features GIS mapping layer. Minnesota Department of Natural Resources
- Minnesota Land Cover, 1991-1992. Minnesota Land Management Information Center
- GAP Analysis (level 2). United States Geological Survey

Wildlife Travel Corridor Obstruction/Landscape Barriers Data Needs

- 2003 Mine Features GIS mapping layer. Minnesota Department of Natural Resources
- Recent (2005) aerial photographs

3.3.8.9 Streamflow and Lake Level Changes:

Background

Cumulative impacts to the physical character of streams and lakes can occur from increases or decreases in flow or changes in the pattern of flow. The causes can include both point discharges (e.g., mine dewatering discharges) and changes in watershed runoff caused by land uses such as mining, timber harvest, residential development, road construction, etc. The impacts of flow changes can include erosion, sedimentation, and stream ecology.

Changes in frequency of bankfull flow can cause stream degradation. Changes to streams may accumulate over time, even for non-contemporaneous impacts if, for example, a stream is eroded and degraded by one event and then further eroded by a second event.

Flow impacts to streams and lakes are regulated under the DNR's program for appropriations of water and for work in public waters. Physical impacts to wetlands are also regulated by the Corps of Engineers, the DNR and the MPCA.

PolyMet will have point discharges of industrial wastewater to the Partridge River (from the mine site) and to a tributary to the Embarrass River (from the processing facility and tailings basin). The discharges to the Embarrass River are expected to be relatively small in volume. (Other changes to the Embarrass River that might be cumulative are limited to the small and intermittent discharge from the Babbitt Wastewater Treatment Plant, forest harvesting and the impacts of rural residential development in Embarrass Township. Again, these are relatively small impacts. Most mining-related discharges for Northshore Mining Company and Cliffs Erie are not to the Embarrass but to the Partridge. Therefore, the possibility of significant impacts to the Embarrass River via either direct discharge or cumulative impacts of discharge (including PolyMet) is believed to be small, and will not be addressed in the EIS.

PolyMet's net effect on the hydrology of the upper Partridge River is expected to be larger than its effect on the Embarrass River. Northshore Mining Company also operates the Peter Mitchell Mine in the headwaters of the Partridge River, upstream of PolyMet, resulting in potential combined impacts. In addition, PolyMet will appropriate water for the processing plant from Colby Lake (which is part of Partridge River drainage), raising the possibility of decreases in lake discharge and lake levels from present conditions. Short-term peak discharges from the mine site can be mitigated by control of outflow from sedimentation and treatment basins, if necessary, to limit potential impacts on stream geomorphology. During reclamation, there will be a period of time when the PolyMet mine pit will be filling with water and the flow to the Partridge River will be reduced as water accumulates in the mine pit. The cumulative impact of greatest concern is the potential for combined peak dewatering from PolyMet and Northshore Mining, or combined reduction in base flow caused by abandoned pits filling with water.

Approach to Evaluation

A quantitative assessment of cumulative impacts due to changes in flow will be performed for the upper Partridge River. This assessment will focus on flow changes in the immediate vicinity of the proposed project. Following this quantitative assessment, a qualitative assessment will be made of resources further downstream to evaluate whether cumulative impacts may occur at greater distances.

An evaluation of the geomorphology of the Partridge River in the vicinity of the project was conducted in 2004. It found that the upper Partridge River was in good condition in the reaches evaluated, suggesting that historic mining upstream of PolyMet has not resulted in channel stability problems. Therefore it is proposed to take the present condition as the baseline condition.

Probable streamflow changes will be estimated using a calibrated hydrologic model. The model will be calibrated to available flow data. The predicted change in flow characteristics will be estimated at appropriate stream reaches near the PolyMet mine site.

There are limited streamflow data for the Partridge River. There are two United States Geological Survey stream gauging stations on the Partridge River with long term flow records: one above Colby Lake at Hoyt Lakes (#04015475) and one near Aurora downstream of Colby Lake (#04016000). From 1978 to 1988 the U.S.G.S. operated gaging station #04015475 on the Partridge River just upstream from the confluence with Colby Lake. During this period Reserve Mining Company (the predecessor to Northshore Mining Company) was not pumping to the Partridge River so these data will probably be usable for calibration. This assumption needs to be verified, especially with respect to the impacts of any overflows that may have occurred from Reserve Mining Co. pits.

There is also limited flow data (13 months) from DNR's 2004 East Range Hydrology Study. NorthShore discharge data are available for this time on at least a monthly basis. Streamflow data can be augmented by available geologic, soils and ecological data and summarized to describe the condition and sensitivity of the Partridge River in the study area. The river will be classified in terms of sensitivity to streamflow change, using the Rosgen classification approach.

The streamflow record will be adjusted to remove the effect of known pumping or pit overflow discharges. If a model can be calibrated to this record with reasonable accuracy, the flow record will be extended using meteorological data. This extended record will be long enough to include both wet and dry climatic conditions. The error of estimate associated with use of the model will be displayed and discussed in light of its intended use in the EIS.

Hydrologic modeling will include the effects of past and present actions (through the date of monitoring) including:

- Existing Cliffs Erie discharges from pits (as of date of monitoring)
- Modification of land use (including wetland loss) by past mining practices within the upper Partridge River watershed
- Existing discharge from Northshore Mining Company Mine
- Existing Syl Laskin Energy Center discharges
- Existing discharge from City of Hoyt Lakes POTW
- Operation of Whitewater Reservoir
- Typical timber harvest activities on Superior National Forest (SNF), state and county lands and private lands.
- Existing runoff from the development of City of Hoyt Lakes

The extended flow record will be used to create a synthetic, local streamflow record for points of interest near the PolyMet site. The relationship of the sub-model to the overall model calibration will be checked to a limited extent using individual streamflow measurements done by PolyMet in 2004. The synthetic local streamflow record will be summarized in relevant flow statistics, including 7Q10, 1.5-year, and, if reasonable, 10- and 100-year flow estimates. The latter may be estimated by single-event simulation using standard estimates of extreme rainfall events.

The hydrologic models will be modified to include actions since the date of the monitoring and potential future actions including:

- Net hydrologic effects of PolyMet mine site discharges to Partridge River and appropriations for PolyMet
- Long-term flow management of PolyMet mine pit during and after filling of pit
- Any potential changes in water discharge from Northshore Mining Company discharges in Partridge River watershed
- Any reasonably foreseeable changes to timber harvest activities on SNF, state and county lands and private lands.

The threshold of significance for this cumulative impact assessment for the upper Partridge River will be the likelihood of major change in stream morphology as defined by the Rosgen classification method (Rosgen, 1994) or other applicable method. This analysis will be based on stream reconnaissance completed in 2004 by PolyMet as a base condition and augmented by available geologic, soils and ecological data to describe the sensitivity of the stream in the study area. The predicted change in flow characteristics will be estimated at the different stream reaches. The possibility of significant changes in stream morphology and ecology due to flow changes will be evaluated, based on the Rosgen methodology, existing information, and applicable research.

Where significant impacts are predicted, the EIS will suggest and evaluate mitigative measures such as controls on rate or volume of discharge or modifications to the water management plan to redirect water to less-sensitive stream locations. It will also evaluate the need for additional data collection to be addressed in the permitting processes.

After completion of the quantitative analysis of the upper Partridge River, the EIS will semi-quantitatively evaluate the probable cumulative impacts on Colby Lake/Whitewater Reservoir. This assessment will not be as rigorous as the Partridge River assessment since cumulative impacts on water levels and lake outflow are expected to be well within the range of historic conditions. Colby Lake/White Water Reservoir served as a water source for the former Erie Mining Company and LTVSMC operations, from 1950 through May, 2000. PolyMet is expected to appropriate less water from Colby Lake, with less impact on water levels and lake outflow than occurred under the previous mining operations. A minimum Colby Lake water level of 1439 ft msl was set by provision in the company’s water appropriation permit, 49-0135. Minnesota Power presently holds this permit, with the same provision. Proposed PolyMet water withdrawal from Colby Lake and impacts on water levels will be evaluated and compared with historic effects from Erie and LTVSMC. The recent record of lake levels and outflow for Colby Lake will also be summarized for comparison to existing conditions. The effect of the project on the lake in view of the operating plan and recent experience will be evaluated. Potential changes in either the proposed project or the operating plan for the Colby Lake/Whitewater Lake outlet will be suggested as appropriate. The need for additional hydrologic data to monitor accumulative effects on Colby Lake/Whitewater Reservoir will be discussed.

Data Needs for Analysis of Cumulative Impacts

- Flow data for Partridge River
- Lake level data for Colby Lake and Whitewater Reservoir
- Operating plan for Colby Lake outlet and Whitewater Reservoir
- Historic air photos or GIS coverages showing modification of land use (including wetland loss) by past mining practices within the upper Partridge River watershed
- Discharge data from Northshore Mining Company mine and crusher areas and evaluation of possibility of changes to Northshore Mining Company discharges in future
- Operation plans and historic lake levels for Whitewater Reservoir
- Data on typical timber harvest activities on SNF, state and county lands and private lands.
- Estimates of future PolyMet Mine Site discharges for mine development, operation and closure, including long-term flow management of the PolyMet mine pit during and after filling of pit

3.3.8.10 Water Quality Changes:

A quantitative assessment of cumulative water quality impacts will be performed for the upper Partridge River (including Colby Lake) and the Upper Embarrass River (including Wynn and Sabin Lakes). PolyMet's discharges will be treated to meet chronic aquatic toxicity-based standards but levels of metals such as nickel may be elevated above natural background levels. At the plant site and tailings basin, discharges from the wastewater treatment plant may contain dissolved solids, hardness, chlorides and possibly sulfate at levels above background. Other common pollutants such as Biological Oxygen Demand (BOD), bacteria and suspended solids are not expected to be present in significant quantities in the discharges. The actual construction of the PolyMet facility can be expected to generate sediment but this impact is readily mitigated by use of stormwater best management practices such as sedimentation basins and will be of short duration. Therefore, this impact is not proposed as a suitable subject for cumulative impact analysis.

A number of models are available to analyze the generation, fate and transport of pollutants in streams. Models recently used in Minnesota EIS's and National Pollutant Discharge Elimination System (NPDES) permitting procedures include HSPF and QUAL2E and dilution models. Toxic metals will be modeled using a conservative dilution model of the stream water quality. If this indicates that potential cumulative impacts may be experienced, a more comprehensive model could then be applied. It appears likely that the initial modeling phase will be required for the NPDES permit and will be available to the EIS contractor. In this phase, both streams will be modeled using the hydrologic loading of water from tributary sub-watersheds for dry, normal and wet conditions. The background loading of pollutants from the watershed will be estimated based on historic and recent monitoring results. For each hydrologic scenario, loading from the PolyMet facility will be included and the resultant concentrations will be calculated as a simple dilution model. Upstream and downstream additions of pollutants from other discharges will be evaluated for past, present and future actions by other parties

The models will first be calibrated to existing conditions monitoring data from 2004. This will inherently include the effects of past and present actions (through the date of monitoring) including:

- Embarrass River
    - Existing discharges from Babbitt POTW
    - Existing Cliffs Erie tailings basin seepage
    - Other existing sources within the former LTVSMC site (e.g. waste rock piles tributary to Spring Mine Creek)
    - Modification of land use (including wetland loss) by past mining practices within the Embarrass River watershed above Sabin and Wynne Lakes
    - Typical timber harvest activities on SNF, state and county lands and private lands
    - Existing rural and residential development in Embarrass township
    - Construction of Embarrass Wetland Bank by LTVSMC
    - Closure of LTVSMC

- Partridge River and Colby Lake
    - Existing Cliffs Erie discharges (overflow) from pits
    - Other existing sources within the former LTVSMC (e.g. waste rock piles adjacent to Wyman Creek)
    - Modification of land use (including wetland loss) by past mining practices within the upper Partridge River watershed
    - Existing discharge from Northshore Mining Company Mine and Crusher area
    - Existing Syl Laskin Energy Center discharges
    - Existing discharge from City of Hoyt Lakes POTW
    - Operation of Whitewater Reservoir
    - Typical timber harvest activities of SNF, state and county lands and private lands
    - Existing runoff from the development of the City of Hoyt Lakes

The hydrologic models will than be modified to include actions since the date of the monitoring and potential future actions including:

- Embarrass River
    - PolyMet tailings basin wastewater treatment plant discharge
    - Changes to existing discharges from Cliffs Erie tailings basin due to PolyMet's proposed collection and treatment of seeps
    - Implementation of Regional Mercury TMDL
    - Any reasonably foreseeable changes to discharges from Babbitt POTW due to development and/or treatment system changes
    - Any reasonably foreseeable changes to timber harvest activities on SNF, state and county lands and private lands

- Partridge River and Colby Lake
    - PolyMet discharges from mine site and long-term discharges from closed pit and stockpiles
    - Potential future discharge from Mesabi Nugget facility
    - Proposed Cliffs Erie Railroad Pellet Transfer Facility construction and operation

- o Any reasonably foreseeable changes to timber harvest activities on SNF, state and county lands and private lands
- o Changes in runoff quality due to future development of City of Hoyt Lakes
- o Implementation of Regional Mercury TMDL
- o Any reasonably foreseeable changes to discharges from Hoyt Lakes POTW due to development and/or treatment system changes

Minnesota water quality standards were promulgated to protect the designated uses of waters of the state, which include protection for domestic consumption (human health), aquatic life, and recreation, industrial consumption, and agriculture and wildlife. The threshold for this cumulative impacts assessment will be the most restrictive water quality standards that apply to the respective waters being evaluated which, at a minimum, would be the chronic aquatic toxicity-based standards applicable to the respective waters being evaluated and the Class I drinking water standards that are applicable to Colby Lake as a drinking water source for the City of Hoyt Lakes. The future conditions scenarios will be completed for both operation and post-closure conditions, assuming that all other reasonably foreseeable actions have been completed.

3.3.8.11 Economic Impacts:

A quantitative assessment of cumulative employment and economic effects will be performed. Background information on employment and the economy of St. Louis County and the East Range will be summarized:

- Historical population trends by county and major population centers since 1980*
- Historical employment trends by county since 1980*
- Historical tax revenue trends by county since 1980*
- Summary of historical economic activity (major industries, major sources of employment) by county since 1980*
- Summary of population, employment, tax revenue and economic activity in 2002 (the baseline year)

* *Approximate date. Actual historical data will be collected based on availability of primary sources and the economic/fiscal impact model used for the assessment.*

Impact analyses will be completed through input-output mathematical modeling to estimate employment impact, output impact and value added measures in terms of total (direct, indirect and induced) impacts for the construction period, operations period and closure period. Analyses will also assess impacts to State, Local and Federal taxes and royalties. All prices will correspond with the most recent data available.

Baseline conditions will be based on the economic activity reported in the most recent tax year available in the County/East Range. Cumulative impacts will be assessed by combining the baseline economic activity and projections of average annual employment (year by year) and estimated construction cost (year by year) for each of the following future (if they meet the criterion for “reasonably foreseeable”) and past actions:

- Proposed NorthMet Project (PolyMet)
- Proposed Mesabi Nugget Plant (Mesabi Nugget, LLC)

- Proposed Cliffs-Erie Railroad Pellet Transfer project (Cliffs-Erie, LLC)
- Proposed NOνA Off-Axis Detector (University of Minnesota)
- Proposed expansions of existing taconite plants
- Shutdown of LTVSMC

The analysis will report findings for a typical year in four discrete periods: baseline year, construction period, operating period and closure period. Findings will be reported as employment, output impact (dollars), value added impact (dollars) and tax impact (dollars).

3.3.8.12 Social Impacts:

A qualitative assessment of cumulative social structure effects will be performed. Background information on social structure of the East Range [specifically the municipalities of Aurora, Babbitt, Biwabik, Ely, Hoyt Lakes, Soudan and Tower and surrounding areas] will be summarized:

- Summary of 2002 (or latest available data year) population characteristics including: structure by age, sex, family size, ethnicity, income, type of employment (including unemployed)
- Summary of 2002 (or latest available data year) community structure for project area cities and towns, including: size of government organizations (cities, townships and counties); participation in voluntary associations (description of groups and linkage to national organizations, if any); and inequities (economic, social or cultural) among community groups.
- Summary of 2002 (or latest available data year) housing availability and community services in major communities, including: police protection, health care, elderly care, schools, libraries, retail centers, recreational facilities, gathering places, computer access facilities.

Impact analysis will be completed through trend analyses:

- Trend analysis of population characteristics (structure by age, sex, family size, ethnicity, income, type of employment - including unemployed).
- Trend analysis of change in community structure: size of government organization (cities, townships and counties); participation in voluntary associations (description of groups and linkage to national organizations, if any); and inequities (economic, social or cultural) among community groups.
- Trend analysis of projected changes in availability of housing and community services including: police protection, health care, elderly care, schools, libraries, retail centers, recreational facilities, gathering places, computer access facilities
- Assessment of stakeholder perception toward proposed projects as related to perceived changes in quality-of-life issues such as: health, safety, security (personal and economic), political power, family stability, use of the natural environment, environmental quality, displacement or relocation, and trust in political and social institutions (intended to gauge community and stakeholder consensus on the cumulative effects of proposed projects on their shared vision for the future of the East Range).

Baseline conditions will be based on the social structure of the East Range in 2002. Cumulative impacts will be assessed by combining the baseline social structure and projections of change related to the following future (if they meet the criterion for "reasonable foreseeable") and past actions:

- Proposed NorthMet Project (PolyMet)
- Proposed Mesabi Nugget Plant (Mesabi Nugget, LLC)
- Proposed Cliffs-Erie Railroad Pellet Transfer project (Cliffs-Erie, LLC)
- Proposed NOνA Off-Axis Detector (University of Minnesota)
- Proposed expansions of existing taconite plants
- Shutdown of LTVSMC

The analysis will report findings for a typical year in four discrete periods: baseline year, construction period, operating period and closure period. Findings will be reported as projected changes in population characteristics, community structure, public attitudes, and availability of housing and community services.

3.3.9 Other – Reclamation (Item 30)

The EIS will evaluate the proposal with consideration for compliance with DNR rules for mineland reclamation. Minnesota Rules for nonferrous metallic metal mining (Chapter 6132) describe the DNR's policy for nonferrous mines, "…that mining be conducted in a manner that will reduce impacts to the extent practicable, mitigate unavoidable impacts, and ensure that the mining area is left in a condition that protects natural resources and minimizes to the extent practicable the need for maintenance." Alternative designs, layouts, and siting will also be evaluated to determine the most feasible reclamation strategy. Reclamation requirements and strategies for reactive waste rock will be included as part of this assessment. The three criteria that will be used in this evaluation will be protection of natural resources, minimization of long-term maintenance, and eventual land use objectives.

The Mining, Minerals and Sustainable Development Project Final Report will be reviewed and opportunities to incorporate recommendations from the report will be considered as part of PolyMet's reclamation plan. The EIS will suggest additions to the plan, to the extent that additions would provide mitigation for identified environmental impacts. Mineland reclamation planning will take into consideration local community land use goals.

As part of the permit to mine, financial assurance estimates will be developed on an annual basis for reclamation of mining activities that have occurred and are anticipated to occur during the upcoming year. This will include costs for reclamation in case of a premature shut down of mining operations. An evaluation of reclamation costs and its effect on facility design, construction and closure will be discussed in the EIS. This evaluation will include an assessment of reasonable closure maintenance costs to prevent release of reactive runoff into the environment. Although mineland reclamation rules allow for financial assurance for corrective action, the amount of financial assurance cannot be developed until the needed corrective action is known. For this reason financial assurance estimates associated with corrective action will not be included in the EIS. However, the EIS will describe the corrective action procedure and how financial assurance will be addressed in case a corrective action is needed.

4.0 <u>IDENTIFICATION OF PHASED OR CONNECTED ACTIONS</u>

There are no phased or connected actions associated with this project.

5.0 EIS SCHEDULE (TENTATIVE)

June 2005	Scoping EAW comment period (included public meeting)
October 2005	Final Scoping Decision Document
January 2006	EIS Preparation Notice Published
August 2006	Draft EIS issued for public review (includes public meeting)
February 2007	Final EIS Issued
May 2007	EIS Adequacy Determined

6.0 SPECIAL STUDIES OR RESEARCH

Many reports and studies will be developed to support the assessment of environmental impacts from the project. The project proposer will provide the following reports to the DNR and USACE for review and incorporation into the EIS. The content of these will be independently reviewed and confirmed by state/federal agencies or the EIS contractor prior being incorporated into the EIS.

6.1 Process Design - Tailings Basin Water Balance

This report will provide an estimate of the water balance for the tailings basin, quantifying both discharge and makeup water demand. The discharge will consist of two parts: 1) the unrecovered seepage through the dams and 2) a permitted discharge from the basin (this could either be on site or pumped to a POTW). The water balance will include precipitation, evaporation, runoff from upland areas, water from the concentrator used to transport tailings, water to the concentrator for reuse, seepage between cells, seepage from the basin and water retained in the tailings. A discussion of the HydroMet plant water balance demonstrating that the plant will be a net water user will be included. Assumptions made and modeling methods will be explained. The water balance will include operation, closure, and post-closure and will include an evaluation of average conditions as well as wet and dry cycles.

6.2 Hydrology - Mine Water Model & Balance

This report will provide an estimate of the overall quantity of water to be discharged from the mine site. The discharge will consist of three parts: 1) non-contact runoff including seepage from wetlands (based on Mine Diking/Trenching Effectiveness Study) and runoff from undisturbed portions of the site (based on Surface Water Runoff Systems); 2) non-reactive runoff including runoff from capped stockpiles and general runoff from non-reactive stockpiles (both based on Mine Wastewater Management Systems Study) and 3) reactive runoff including stockpile seepage and pit inflow. The water balance will include precipitation, evaporation soil/stockpile storage and groundwater inflow to the mine pit. Assumptions made and modeling methods will be explained. A groundwater flow model will be developed to predict the amount of groundwater inflow into the mine pit/pits at various stages in pit development (i.e., year 1, year 5, year 10, year 20). The model will take into account groundwater inflow from the Duluth

Complex, the Virginia Formation, and the surficial sediments. The water balance will include operation, closure, and post-closure and will include an evaluation of average conditions as well as wet and dry cycles. As part of the closure evaluation, the time required for the pit to fill will be evaluated for a variety of filling scenarios, including flooding the pit by using water from the Partridge River.

6.3 Mine Wastewater Management Systems

This report will review and discuss plans to segregate reactive and non-reactive mine wastewater with a focus on reactive mine wastewater. At least 2 scenarios will be evaluated, separate collection systems for segregated waste stockpiles and segregated collection systems for a combined stockpile. The following aspects of stockpile design investigated in the Reactive Waste Segregation report will be incorporated: capping systems to minimize the amount of precipitation passing through the stockpile and liner systems to capture the water flowing through the stockpile and keep groundwater from entering the stockpile. Liner systems for ditches and ponds transporting or storing reactive wastewater will be studied. Plans will minimize the use of ditches by using pipelines wherever practical. Transfer from operating mode to closure mode will also be discussed. The report will include operation, closure, and post-closure and will include an evaluation of average conditions as well as wet and dry cycles. Long-term maintenance will also be addressed. The report will also address the possibility of overflow due to uncommon storm events and the impact of uncollected runoff. Transfer of all of part of this water to the plant as makeup water will also be included.

6.4 Mine Surface Water Runoff Systems

This report will review and discuss plans to segregate non-contact and non-reactive mine surface runoff from reactive runoff with a focus on non-contact and non-reactive runoff. Aspects to be included are the design of conveyance systems from stockpiles to minimize erosion, sediment pond design and transition from systems for use during mining operations to systems for use after mine closure. The report will also provide an estimate of the quality of non-reactive runoff. Note that this report is closely related to the Mine Diking/Trenching Effectiveness Study in that both studies address aspects of non-contact runoff water management. The design of sediment ponds for non-contact water emanating from the interceptor dikes/trenches will be addressed in this report.

6.5 Mine Diking/Trenching Effectiveness Study

This report will review and discuss plans to intercept and handle non-contact runoff water from wetland areas adjacent to the mine. Aspects to be investigated include the design of conveyance systems around the mine, permeability of dikes, corrective actions to be implemented if a sand/gravel zone is encountered in the construction of the interceptor system and transition from systems for use during mining operations to systems for use after mine closure.

6.6 Wastewater Treatment Options

This report will review and discuss the options for the location of wastewater treatment plants. Because it may become necessary to discharge mine site reactive wastewater via the tailings basin to comply with Great Lakes Initiative (GLI) mercury constraints, mine site treatment options (no treatment, pretreatment, full treatment) and tailings basin treatment options (pretreatment, full treatment) will be discussed. Discussion on mine site/tailings basin locations will include the ability of the receiving waters to accept the quantity and quality of water expected. Because it may become necessary to discharge via a POTW to comply with GLI mercury constraints, pretreatment at site with discharge via the Hoyt Lakes or Babbitt POTW will be discussed. Discussion on POTWs will include their ability to accept the quantity and quality of water expected. On-site treatment plant location options are one at the mine site and one at the tailings basin or a single treatment plant at the tailings basin. The report on Wastewater Treatment Technologies will provide input to this report.

6.7 Reactive Waste Rock Stockpile Chemical Modification

This report will present a waste management plan implementing the concept of adding materials to reactive mine waste stockpiles to modify the chemical reactions that take place within the stockpile to prevent release of acid or dissolved metals. The plan will include stockpile design and impacts of this approach on reactive mine wastewater management systems and wastewater treatment systems.

6.8 Mine Pit Water Quality Model

This study will use available waste rock/lean ore characterization data, other laboratory and field data, literature results, and scientific principles to estimate mine pit water quality as a function of time. Estimates will be made for the operating, closure and post-closure periods and will model water quality under various closure scenarios. The study will explain the assumptions made to develop the model and the rationale for modeling tool selection and provide a range of water quality estimates (sensitivity analyses).

6.9 Mine Waste Management Plan

A draft Mine Waste Management Plan will be developed. The plan will include sections on waste categorization criteria, mine block model (including update methods - in-fill core/RC drilling and blast hole drilling), a blast hole monitoring program to field verify waste grade and volume, waste disposal control/monitoring via automated mine dispatch system, and stockpile design. The final operating plan will be finalized as part of the permit to mine and updated annually to reflect changes in knowledge of waste behavior and management technology.

6.10 Wastewater Modeling - Waste Rock and Lean Ore

This study will use available waste rock/lean ore characterization data, other laboratory and field data, literature results, and scientific principles to estimate reactive mine waste rock stockpile water quality as a function of time. Estimates will be made for the operating, closure and post-closure periods and will model water quality under various closure scenarios. The study will explain the assumptions made to develop the model, the rationale for modeling tool selection and provide a range of water quality estimates (sensitivity analyses).

6.11 Water Treatability Study - Waste Rock and Lean Ore

One to three technologies identified in the Water Treatment Technology report using data from various sources including but not limited to Hydrology - Mine Water Model & Balance, Mine Pit Water Quality Model and Waste Water Modeling - Waste Rock and Lean Ore will be evaluated in bench-scale testing to determine operating parameters needed to achieve the required discharge standards for waste rock and lean ore wastewaters.

6.12 Wastewater Modeling – Tailings

This study will use available tailings waste characterization data, other laboratory and field data, literature results, predictions of process water chemistry and scientific principles to estimate water quality in the tailings basin and in seepage from the tailings as a function of time. Estimates will be made for the operating, closure and post-closure periods and will model water quality under various closure scenarios. The study will explain the assumptions made to develop the model, the rationale for modeling tool selection, and provide a range of water quality estimates (sensitivity analyses).

6.13 Water Treatability Study – Tailings

One to three technologies identified in the Wastewater Treatment Technology report using data from various sources including but not limited to Process Design - Tailings Basin Water Balance, and Wastewater Modeling - Tailings will be evaluated in bench scale testing (using water from the flotation pilot testing activities) to determine operating parameters needed to achieve the required discharge standards for tailings basin water.

6.14 Closure Plan

A draft Mine Closure Plan will be developed. The plan will include sections on watercourse restoration, mine and plant site reclamation, structure demolition, site remediation and ongoing maintenance/water treatment. An estimate for all closure costs will be included. The final closure and reclamation plan will be finalized as part of the permit to mine and updated annually to reflect changes in closure costs and integration with area mine reclamation/reuse strategies.

7.0 Mitigation and Monitoring

Minnesota Rules Chapter 4410.2300 identifies that the EIS shall include mitigation measures that could reasonably eliminate or minimize any adverse environmental, economic, employment, or sociological effects of the project. To meet this requirement the EIS will evaluate and discuss mitigation measures to address adverse effects identified as a result of analyses proposed in Section 3.2 and 3.3 of the Scoping Decision Document.

The EIS will also provide information about the types of monitoring needed to verify predictions made in the EIS and ensure compliance with permit conditions. Specific monitoring plans will be developed and included in the permitting process, which may or may not occur simultaneously with preparation of the EIS. To the extent that specific monitoring plans are available, they will be included as part of the EIS. If a specific monitoring plan is not available, and has been recognized in the EIS process as needed, a conceptual monitoring plan will be developed as part of the EIS. Monitoring programs will provide a means to identify non-compliance with permit requirements, so that corrective action can be developed to minimize unforeseen impacts from the project.

8.0 Government Permits and Approvals

The EIS will identify all permits and approvals required for this project. While some permit application review may occur concurrently with EIS preparation, the EIS will not necessarily contain all information required for a decision on those permits. No permits have been designated to have all information developed concurrently with the preparation of the EIS nor will any require a record of decision pursuant to Minnesota Rules part 4410.2100, subpart 6.D. However, the USACE will use the Final EIS to develop a Record of Decision on PolyMet's the Clean Water Act Section 404 permit.

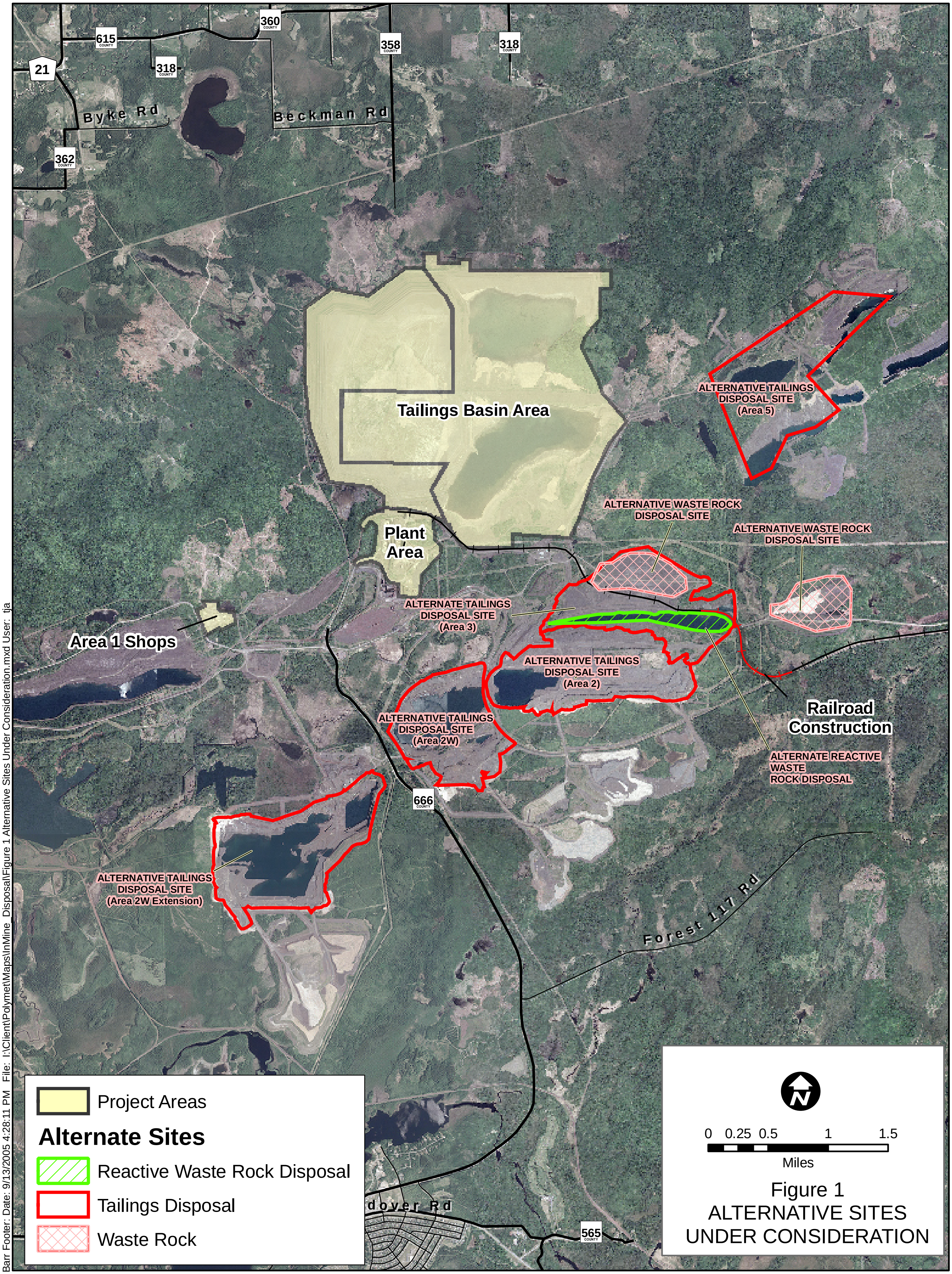
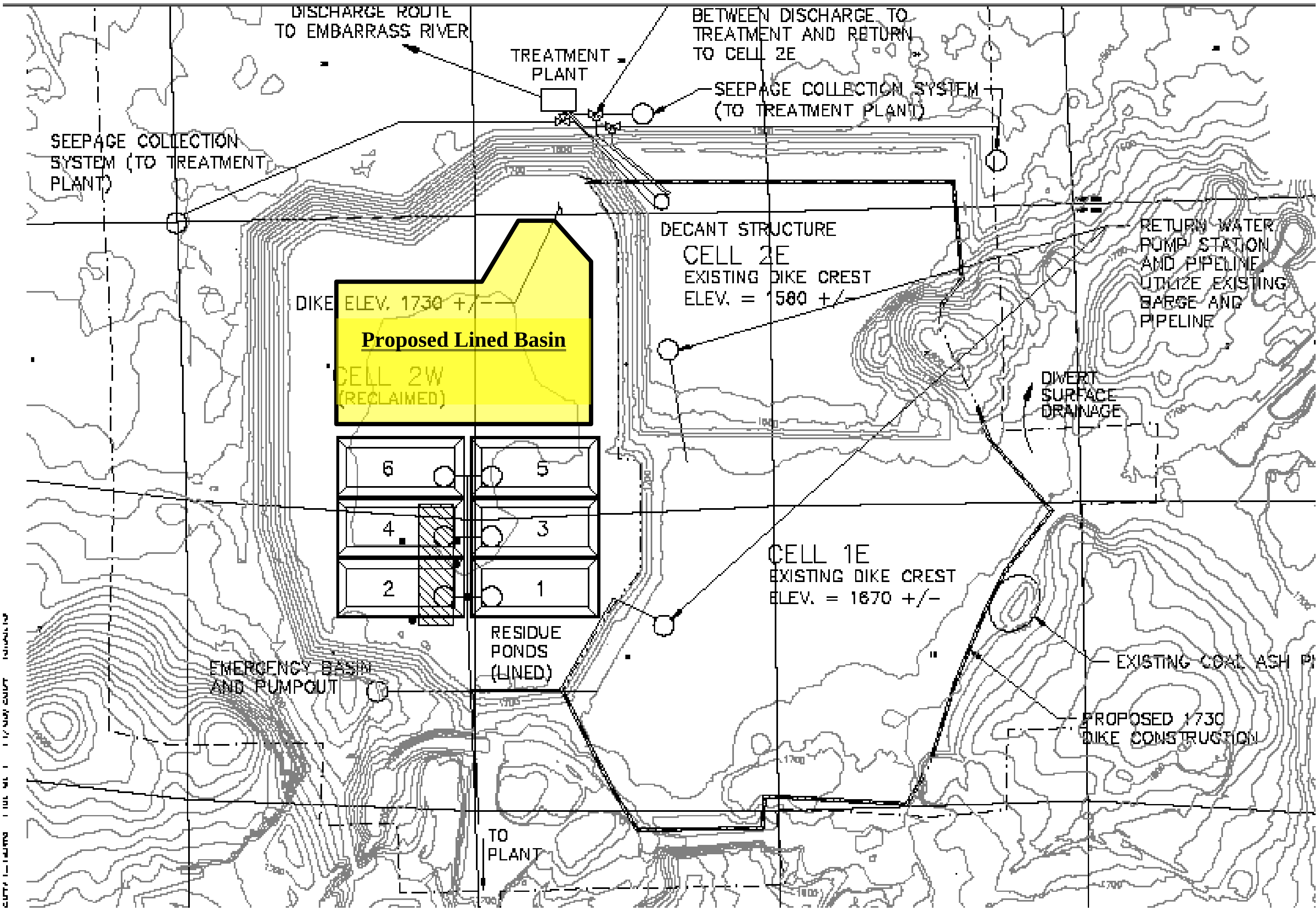


Figure 1
ALTERNATIVE SITES
UNDER CONSIDERATION

Figure 2 – Location of Lined Tailings Basin (conceptual)



Appendix C
NorthMet EIS Preparation Revised Memorandum of Understanding, May 19, 2008

REVISED MEMORANDUM OF UNDERSTANDING AMONG THE U.S. ARMY CORPS OF ENGINEERS, THE MINNESOTA DEPARTMENT OF NATURAL RESOURCES, THE U.S.D.A. FOREST SERVICE, THE BOIS FORTE BAND OF CHIPPEWA, THE FOND DU LAC BAND OF LAKE SUPERIOR CHIPPEWA, AND POLYMET MINING, INC. FOR THE PROPOSED POLYMET MINING, INC. NORTHMET PROJECT IN NORTHEASTERN MINNESOTA

This Memorandum of Understanding (MOU) is made and entered into this date, May 19, 2008, by and among the U.S. Army Corps of Engineers (USACE), the Minnesota Department of Natural Resources (MnDNR), the U.S.D.A. Forest Service (USFS), the Bois Forte Band of Chippewa (Bois Forte), the Fond du Lac Band of Lake Superior Chippewa (Fond du Lac), and PolyMet Mining, Inc. (PolyMet) for the purposes of preparing a joint Environmental Impact Statement on the environmental impacts of the proposed NorthMet mining project near Babbitt, Minnesota, referred to hereafter as the proposed project. Upon execution of this revised MOU, the MOU dated February 23, 2005, and the amendment executed on March 15, 2005, shall expire.

WHEREAS, PolyMet proposes to excavate a large polymetallic disseminated magmatic sulfide deposit, approximately 6 miles south of the town of Babbitt, and process the material at the Cliffs Erie crusher/concentrator facility in Hoyt Lakes, Minnesota;

WHEREAS, the proposed project requires preparation of a mandatory state Environmental Impact Statement (EIS) under Minnesota Rules 4410.4400(8)(C), which designates the MnDNR as the Responsible Governmental Unit (RGU);

WHEREAS, the MnDNR is responsible for ensuring the Project's compliance with the Minnesota Environmental Policy Act (MEPA; Minn. Stat. ch. 116D);

WHEREAS, the proposed project will require a permit from the USACE under Section 404 of the Clean Water Act (33 U.S.C. § 1344);

WHEREAS, the proposed mine lies within the Superior National Forest, which is managed by the USFS, requiring the USFS to negotiate the operating conditions of the mining operation;

WHEREAS, the proposed project is a major Federal action significantly affecting the quality of the human environment, requiring the preparation of a Federal EIS pursuant to the National Environmental Policy Act (NEPA) (42 U.S.C. §§ 4321-4347) and its implementing regulations (40 C.F.R. parts 1500-1508);

WHEREAS, the USACE and the USFS are responsible for complying with NEPA;

WHEREAS, the proposed project would be conducted within the territory ceded in the Treaty of 1854;

WHEREAS, Bois Forte and Fond du Lac are federally recognized Native American Tribes that retain hunting fishing and gathering rights in the 1854 Treaty ceded territory, and want to serve as cooperating agencies for the NEPA process;

WHEREAS, the USACE, the MnDNR, the USFS, Bois Forte, Fond du Lac, and PolyMet have a common interest in preparing an EIS that satisfies both state and Federal requirements;

NOW THEREFORE, the USACE, the MnDNR, the USFS, Bois Forte, Fond du Lac, and PolyMet agree as follows:

GENERAL

This MOU describes the respective responsibilities of, and procedures to be used by, the aforementioned parties. The goals of the USACE, the MnDNR, the USFS, Bois Forte, Fond du Lac, and PolyMet are:

- to evaluate the proposed project in accordance with NEPA (42 U.S.C. §§ 4321-4347), NEPA's implementing regulations (40 C.F.R. parts 1500-1508), and MEPA (Minn. Stat. ch. 116D);
- to objectively identify, examine, and analyze the potential environmental, social, and economic impacts of the proposed project and reasonable alternatives in order to avoid, minimize, and/or mitigate the adverse impacts of the proposed project;
- to appropriately identify, examine and analyze the potential impacts to resources of interest to the tribes:
- to identify information that assists PolyMet in making project-related decisions;
- to ensure public involvement in the preparation and review of the EIS;
- to ensure that sufficient information is provided to assist the USACE, the MnDNR, the USFS, and other Federal, state and local agencies in regulatory decisions; and
- to reduce duplication of effort for the USACE, the MnDNR, the USFS, Bois Forte, Fond du Lac, and PolyMet.

RESPECTIVE RESPONSIBILITIES

The USACE and the MnDNR agree to:

- Jointly develop a scope of work for EIS preparation and evaluate the MnDNR's selection of a third-party contractor to prepare the EIS.
- Utilize the MnDNR's third-party contractor process for EIS preparation.
- Jointly prepare an EIS to evaluate the proposed project in accordance with NEPA (42 U.S.C. §§ 4321-4347), NEPA's implementing regulations (40 C.F.R. parts 1500-1508), and MEPA (Minn. Stat. ch. 116D).
- Involve the USFS, Bois Forte, and Fond du Lac as Cooperating Agencies in the EIS preparation, and incorporate the USFS, Bois Forte, and Fond du Lac input to the maximum extent possible.
- Complete a final EIS that contains the positions of both the USACE and the MnDNR, and complies with their respective legal requirements.
- Report periodically on the progress of the joint EIS to PolyMet, with particular regard to identifying issues and matters that may result in delays, and to advise on proposed actions/measures to minimize delays.

U.S. ARMY CORPS OF ENGINEERS (USACE)

The USACE will serve as co-lead agency in the EIS preparation with the MnDNR. The USACE will conduct scoping jointly with the MnDNR, pursuant to both NEPA and MEPA, and provide input to the MnDNR for the EIS scope of work. The USACE will assist the MnDNR in third-party consultant selection by reviewing the Request for Proposals, reviewing the proposals submitted, and participating in consultant evaluation and interviews. The USACE will provide input to the MnDNR on consultant requirements and the acceptability of consultant candidates. The USACE will not be a party to the contract between the MnDNR and the third-party contractor. The USACE will coordinate with other Federal agencies (e.g. the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service), and will consult with Native American Tribes, as appropriate, in the preparation of the EIS. The USACE will schedule and hold agency and public meetings jointly with the MnDNR pursuant to NEPA and MEPA. The USACE will determine whether the EIS satisfies NEPA and will prepare the Federal Record of Decision. The USACE, in conjunction with the MnDNR, and in consultation with the cooperating agencies and PolyMet, shall determine appropriate schedules for review and comment on draft documents prior to issuance of the draft EIS and prior to issuance of the final EIS.

MINNESOTA DEPARTMENT OF NATURAL RESOURCES (MnDNR)

The MnDNR will serve as the other co-lead agency in the EIS preparation. The MnDNR will conduct scoping jointly with USACE, pursuant to both NEPA and MEPA, and propose a preliminary scope for the EIS. The MnDNR will include NEPA-related issues, submitted by the USACE, in the proposed scope. The MnDNR will assume the lead role in third-party consultant selection, enter into a contract with the consultant, and perform all requisite contract oversight. The MnDNR will enter into a cost agreement with PolyMet to obtain funds to cover third-party consultant fees, and other EIS-related costs incurred by the MnDNR. The MnDNR will assume primary responsibility for managing the EIS preparation and review. The MnDNR will coordinate with other state agencies (e.g., the Pollution Control Agency and the Department of Transportation) and will participate with the USACE at any public meetings, public hearings, or other public involvement pursuant to NEPA and MEPA. The MnDNR will be responsible for determining EIS adequacy pursuant to MEPA, and prepare the state Record of Decision. The MnDNR, in conjunction with the USACE, and in consultation with the cooperating agencies and PolyMet, shall determine appropriate schedules for review and comment on draft documents prior to issuance of the draft EIS and prior to issuance of the final EIS.

U.S.D.A. FOREST SERVICE (USFS)

The USFS will serve as a cooperating agency in the EIS preparation and will provide input to the USACE and the MnDNR to address the USFS issues in the document.

BOIS FORTE BAND OF CHIPPEWA (Bois Forte)

Bois Forte will serve as a cooperating agency in the EIS preparation and will provide input to the USACE and the MnDNR to address the Bois Forte issues in the document.

FOND DU LAC BAND OF LAKE SUPERIOR CHIPPEWA (Fond du Lac)

Fond du Lac will serve as a cooperating agency in the EIS preparation and will provide input to the USACE and the MnDNR to address the Fond du Lac issues in the document.

CONFLICT RESOLUTON PROCEDURES

Every effort will be made for the USACE, USFS, Bois Forte, Fond du Lac, and the MnDNR to reach mutual agreement regarding the issues addressed in the joint EIS. In the event that conflicts arise between the USACE, USFS, Bois Forte, Fond du Lac, and the MnDNR on any aspect of this effort, the following procedures will be used, in sequence, to attempt to resolve these conflicts.

- The agency points of contact will make a concerted effort to resolve the dispute.

- Matters unresolved by the agency points of contact will be referred to the Commissioner or his/her designee, the USACE District Engineer or his/her designee, the USFS Laurentian District Ranger or his/her designee, the Bois Forte Chairperson or his/her designee, and the Fond du Lac Chairperson or his/her designee for resolution.

- In the event that unresolved issues remain, the agency/tribal positions will be presented in the EIS and any public summaries. Should disagreement remain over issues, impacts, or alternatives to be included and analyzed, the respective agency/tribe promoting inclusion or analysis of the issue shall be responsible for its analysis and documentation.

SELECTION OF A THIRD-PARTY CONSULTANT

The USACE and the MnDNR will formulate criteria for selecting a third-party consultant in consultation with PolyMet. The criteria will satisfy requirements imposed upon the USACE and the MnDNR by the statutes and regulations applicable to selecting a consultant for EIS preparation.

TIME TO PREPARE EIS

To facilitate the preparation of a joint EIS, PolyMet consents to MnDNR exceeding the rule-designated EIS preparation timelines, which are found in Minnesota Rules 4410.2000 to 4410.2800. The parties intend to prepare the Draft EIS and have it ready for printing by March 31, 2008. However, the parties acknowledge that this is a best-case scenario, assuming no delays in the process, and that the Draft EIS may not be ready for printing by that date.

The USACE and the MnDNR will propose a schedule for preparation of the Final EIS within 30 days after the close of the public comment period on the Draft EIS. PolyMet and the cooperating agencies will provide any comments on the proposed schedule to the USACE and the MnDNR within 14 days after the Final EIS schedule is proposed. The USACE and the MnDNR will make a final decision on the schedule for preparation of the Final EIS within 60 days after the close of the public comment period on the Draft EIS. The schedule will be a best-case scenario, assuming no delays in the process, and may be exceeded.

EFFECTIVE DATE

The MOU will be effective upon execution by all parties hereto.

AMENDMENT

The MOU may be amended only by written agreement of all parties.

EXPIRATION OR TERMINATION

Unless specifically terminated by either the USACE or the MnDNR, this MOU will remain in effect until issuance of the state Record of Decision on the Adequacy of the EIS and the federal Record of Decision. Agency termination of the MOU is accomplished upon written notice to the other agency, the cooperating agencies, and PolyMet.

PolyMet or the cooperating agencies may withdraw from this agreement upon written notice to both the USACE and MnDNR. Any such termination does not negate PolyMet's obligation to reimburse the State for any costs incurred to date by the third-party contractor and in closing out the third-party contract. In addition, any such termination does not negate PolyMet's obligation to provide information to the USACE and the MnDNR for their permit evaluations.

FUNDING

All obligations of the USACE under this agreement are subject to and dependent upon the appropriation and allocation of sufficient funds to the St. Paul District for such purposes.

All obligations of the MnDNR are contingent upon receipt of appropriations from the Legislature and/or other funds allotted or lawfully available for preparation of the EIS.

JUDICIAL REVIEW

Nothing in this MOU shall affect any otherwise available review of agency action. This MOU is intended only to facilitate preparation of a joint EIS and does not create any right, benefit, or legal obligation, substantive or procedural, enforceable at law or equity against the MnDNR, the USACE, or any other party to this MOU.

LIABILITY

Each party to this MOU shall be liable for its own acts and the results thereof to the extent authorized by law and shall not be responsible for the acts of the other party, its officers, employees or agents. Nothing in this agreement shall be deemed to be a waiver by any of the parties of any applicable state or federal immunities or limits of liability.

POINTS OF CONTACT

The agency points of contact may be changed at the discretion of the respective agencies with written notice to the other. The points of contact for this MOU are:

Jon Ahlness, U.S. Army Corps of Engineers, St. Paul District, Regulatory Branch, 190 5th Street East, Suite 401, St. Paul, MN 55101

Stuart Arkley, Minnesota Department of Natural Resources, Division of Ecological Services, Box 25, 500 Lafayette Road, St. Paul, MN 55155

Steve Kuennen, District Ranger, U.S.D.A. Forest Service, Superior National Forest, Laurentian Ranger District, 318 Forestry Road, Aurora, MN 55705

Rosemary Berens, Bois Forte Tribal Historic Preservation Officer, Bois Forte Heritage Center, 1500 Bois Forte Rd. Tower, MN 55790

Nancy Schuldt, Fond du Lac Band of Lake Superior Chippewa, 1720 Big Lake Rd., Cloquet, MN 55720

Jim Scott, PolyMet Mining, Inc, P.O. Box 475, Hoyt Lakes, MN 55750

BY THEIR SIGNATURES, THE UNDERSIGNED ATTEST THAT THEY HAVE THE AUTHORITY TO COMMIT TO THIS MOU ON BEHALF OF THE PARTIES THAT THEY REPRESENT.

Jon L. Christensen, Colonel District Engineer U.S. Army Corps of Engineers	2/22/08 Date
Mark Holsten Commissioner Minnesota Department of Natural Resources	5/13/08 Date
James W. Sanders Forest Supervisor, Superior National Forest U.S.D.A. Forest Service	5-02-08 Date
Kevin Leecy Chairman Bois Forte Band of Chippewa	04 08 08 Date

Karen R. Diver ____________________ 4/28/08
Karen R. Diver
Chairwoman
Fond du Lac Band of Lake Superior Chippewa

Date

____________________ 3/7/08
Joseph Scipioni
President and CEO
PolyMet Mining, Inc.

Date

Approved as to form and execution:

Lori Swanson
Attorney General
State of Minnesota

By: ____________________

Title: Asst. Atty. General

Date: May 19, 2008

Appendix D
Cover Email for Tribal Positions and Tribal Positions on July 2009 PDEIS

Appendix D - Tribal Positions on July 2009 PDEIS

This appendix contains all tribal cooperating agency position statements submitted to the MnDNR and USACE on the July 2009 Preliminary Draft EIS (PDEIS) exactly as received by the lead agencies. The PDEIS was an interim document prepared by the MnDNR's EIS contractor. It was reviewed by the MnDNR, USACE, other state and federal agencies, and Tribal Cooperating Agencies prior to finalizing the Draft EIS.

The Tribal Cooperating Agencies submitted position statements in the form of embedded text within the individual PDEIS chapters as a result of their document review. The MnDNR and USACE received a single, coordinated set of marked-up chapters from the three cooperating agency bands and two intertribal agencies. Positions were offered in blue font to distinguish them from the main text.

The Draft EIS conforms to both NEPA and MEPA requirements regarding participation of cooperating agencies and consideration of their perspectives in the respective environmental documents. *Minnesota Rules* 4410.2300 subitem H requires that the RGU identify and briefly discuss major differences of opinion concerning significant impacts of the proposed project on the environment within the EIS. Similarly, CEQ regulations at 40 C.F.R. part 1502.9(a) require the lead federal agency to "make every effort to disclose and discuss at appropriate points in the draft statement all major points of view on the environmental impacts of the alternatives including the proposed action." Finally, the Draft EIS was developed in accordance with agreements under the Memorandum of Understanding (MOU; May 19,2008) enacted between the lead and cooperating agencies; see Appendix D.

The position statements noted in this appendix are incorporated into the Draft EIS in Volume I as described in Section 1.6.1. They are incorporated verbatim where possible, generally in footnote format. Some position statements led to an update to the text in the Draft EIS, so are not reproduced in the footnotes. Some position statements were not incorporated due to factual error.

This appendix is provided solely to disclose the original text of the tribal agency position statements in their original context. It helps ensure that project-related decisions reflect consideration of the Tribal Cooperating Agencies' positions, as treated in the Draft EIS and within the context they were received.

Reviewers are advised that this appendix reflects content of a preliminary document and does not replace the Draft EIS. Text differences are present between the PDEIS and Draft EIS; the PDEIS underwent multi-agency review and subsequent document refinement to produce the Draft EIS. Reviewers are advised to base comments on the Draft EIS and not the earlier, preliminary document.

From: Esteban Chiriboga <edchirib@wisc.edu>
To: Stuart Arkley <Stuart.Arkley@dnr.state.mn.us>, Jon Ahlness <jon.k.ahlnes...
CC: Nancy Schuldt <nancyschuldt@fdlrez.com>, Margaret Watkins <watkins@borea...
Date: 9/2/2009 4:33 PM
Subject: Tribal Cooperating Agency Positions on PDEIS of July 28, 2009
Attachments: Tribal_literature_cited .doc; 2_0 Scoping Process Tribal language (final).doc; 3_0 Proposed Action and Project Alternatives Tribal language (final).doc; 4_1 Water_Resources Tribal language (final).doc; 4_2 Wetlands Tribal language (final).doc; 4_3 Vegetation Tribal Language (final).doc; 4_4 Wildlife Tribal language(final).doc; 4_5 Fish and Macroinvertebrates Tribal language (final).doc; 4_6 AIR CHAPTER Tribal language (final).doc; 4_7 Noise Tribal language (final).doc; 4_8 Cultural Resources 4 8 (final).doc; 4_9 Compatibility Tribal language (final).doc; 4_10 Socioeconomics Tribal language (final).doc; 4_11 Visual Resources Tribal language (final).doc; 4_13 Geotechnical Stability Tribal language (final).doc; 4_14 Cumulative Effects Tribal language (final).doc; 5_0 Comparison of Alternatives Tribal language (final).doc

Mr. Arkley and Mr. Ahlness,

Attached please find the tribal cooperating agencies' positions on the analysis and conclusions contained in the pre draft EIS for the proposed PolyMet project released on July 28, 2009. The tribal cooperating agencies (Grand Portage, Bois Forte and Fond du Lac) have worked together with their respective intertribal agencies (1854 Treaty Authority and GLIFWC) to produce one set of language for insertion into the draft EIS. As you will see, the language submitted by the cooperating agencies is in blue font throughout the document. As required by the MOU, these tribal positions must be presented in the EIS and any public summaries, unless the issues are resolved prior to the issuance of the draft EIS.

The tribal cooperating agencies will be available to discuss these positions as the preparation of the draft EIS proceeds. Please do not hesitate to contact me with questions. I can then direct your inquiry to the tribal cooperator responsible for that particular position.

Thank you,

Esteban Chiriboga
Great Lakes Indian Fish and Wildlife Commission
550 Babcock Dr. Rm. B-102
Madison, WI 53706

608.263.2873
edchiribo@wisc.edu

2.0 EIS DEVELOPMENT

This section of the DEIS describes the public and agency involvement process to develop the scope of, and identify the major issues to be discussed in, the DEIS. This includes a discussion of the scoping process, alternatives to the Project, issues identified during the scoping process, and opportunities for public and agency involvement during EIS development.

2.1 SCOPING PROCESS

The scoping process is an open public process initiated prior to the preparation of an EIS to define a reasonable scope for and reduce the magnitude of, an EIS by:

- Identifying only those potentially significant issues relevant to the Project;
- Defining the form, level of detail, content, alternatives, time table for preparation, and preparers of the EIS; and
- Identifying the required permits to facilitate the collection of information during the EIS process to support those permits.

The scoping process involved the preparation of three documents: the Scoping Environmental Assessment Worksheet (EAW); the Draft Scoping Decision Document (Draft SDD); and the Final Scoping Decision Document (Final SDD). The scoping process was followed as outlined by *Minnesota Rules*, part 4410.0200, subpart 24. MEPA contains the legal basis for the preparation of the scoping documents and the MEQB is responsible for the environmental review program. The scoping process in Minnesota includes all procedural and substantive requirements to satisfy scoping for preparation of a federal EIS under NEPA. As the RGU for this EIS, the MnDNR was responsible for administering the scoping process.

2.1.1 Identification of Scoping Documents

The Project falls into the State of Minnesota mandatory EIS category; therefore, the EAW was intended solely as a scoping document. The Scoping EAW provided information on required permits, informed the public about the Project, and identified ways to protect the environment.

The Draft SDD is a companion to the Scoping EAW. The primary purpose of a Draft SDD is to communicate the issues and analyses proposed to be contained in the EIS. The information in a Draft SDD is preliminary and subject to revision based on the entire record of the scoping process. It is also used to disclose information about alternatives and impacts. The Draft SDD is typically published concurrently with the Scoping EAW as the first report for projects in the mandatory EIS category under MEPA. It is distributed prior to the public scoping meeting(s) so that comments can be received and used to prepare the Final SDD. The Final SDD serves as the "blueprint" for the EIS.

2.1.2 Proposed Action and Supporting Documentation

PolyMet submitted an initial Project Description (PD) for the Project on April 26, 2006; however, additional data and agency consultation led to a revised PD in January 2007. PolyMet subsequently made changes to the Project and submitted a supplemental PD in July 2007. Between July 2007 and June 2009, additional changes were made, culminating in a newly-defined Proposed Action Tailings Basin design, as documented in the Jim Scott June 16, 2009 email titled, "PolyMet Proposed Action and Alternative." The majority of supporting documentation for the PD and potential impacts of the Project were submitted by PolyMet between July 2006 and July 2009, including documents and technical memoranda and reports as listed in Section 7.0.

The Tribal cooperating agencies' position is that the public notice of the section 404 permit should be reissued because of significant changes in the Project design that have occurred since the initial public notice in 2005.

2.2 ALTERNATIVES IDENTIFIED DURING THE EIS SCOPING PROCESS

The MEQB rules require that an EIS include a No Action Alternative and at least one alternative for each of the following categories of alternatives, or provide an explanation as to why no alternative is included in the EIS (*Minnesota Statutes*, sections 116D.04 and 116D.045; and *Minnesota Rules*, part 4410.0200 through part 4410.7500):

- alternative sites;
- alternative technologies;
- modified designs or layouts;
- modified scale or magnitude; and
- alternatives incorporating reasonable mitigation measures identified through comments received during the EIS scoping and draft EIS comment periods.

The alternatives discussed below were identified during the Scoping EAW and Final SDD process. During development of the DEIS, the list of reasonable alternatives was revised to reflect changes that PolyMet made to the PD and the availability of new information. Some additional alternatives were included, while others were eliminated. The reasonable alternatives included for consideration in the DEIS are discussed in Section 3.2.

An alternative may be excluded from analysis in the EIS if "it would not meet the underlying need for or purpose of the project, it would likely not have any significant environmental benefit compared to the project as proposed, or another alternative, of any type, that will be analyzed in the EIS would likely have similar environmental benefits but substantially less adverse economic, employment, or sociological impacts" (*Minnesota Rules*, part 4410.2300, subpart G). Section 3.2.4 of this DEIS discusses alternatives considered but eliminated.

2.2.1 Site Alternatives

In the Final SDD, the MnDNR and USACE identified three site alternatives to be considered for the Project:

- In-pit reactive waste rock disposal;
- Off-site non-reactive waste rock disposal; and
- In-pit tailings disposal.

2.2.2 Alternative Technologies

In the Final SDD, the MnDNR and USACE identified underground mining as the only alternative technology to be considered for the Project.

2.2.3 Modified Designs or Layouts

In the Final SDD, the MnDNR and USACE identified six alternative designs or layouts to be considered for the Project:

- Two mine pits;
- Chemical modification of reactive waste rock stockpiles;
- Co-disposal of reactive waste rock and tailings on a lined tailings basin;
- Pretreatment of Mine Site reactive runoff and discharge to publicly owned treatment works (POTW);
- Pretreatment of tailings basin process water and discharge to the City of Hoyt Lakes POTW; and
- Use of Mine Site reactive runoff as make-up water for the Processing Plant with single wastewater treatment at the Processing Plant. This option could also include pretreatment and discharge to a POTW.

2.2.4 Alternative Scale or Magnitude

During the Scoping EAW process, multiple ore processing rates were analyzed to determine the economic feasibility of the Project at various scales. Reduced scale operations (e.g., processing ore at 18,000 tpd) offered significant environmental benefits relative to the Proposed Action (processing ore at 32,000 tpd), but was not economically feasible and therefore did not meet the Purpose and Need for the Project. It was also determined that a lesser variation in production rate around the Proposed Action would be economically feasible; however, these smaller changes to the processing rate did not offer significant environmental benefits when compared to the Proposed Action. Therefore, it was determined that no alternative scale and magnitude alternatives would be carried forward for further consideration.

2.2.5 Alternatives Incorporating Reasonable Mitigation Measures

In the Final SDD, the MnDNR and USACE identified two alternatives incorporating reasonable mitigation measures to be considered for the Project:

- Monitor waste rock stockpiles and Tailings Basin, including the material being placed in the stockpile/basin; performance of liners, trenches, and collection systems; and water quality and quantity associated with the stockpile/basin (i.e., drainage, groundwater, and surface water); and

- Develop a lined tailings storage facility on top of Cell 2W of the existing LTVSMC tailings basin to provide storage for five years of tailings while waste characterization testing develops additional data. Waste characterization would continue during this period and the field data collected during operations would determine if the tailings are reactive. If during the initial five-year operation period the tailings are determined to be non-reactive, construction of an unlined tailings basin would be possible thereafter. Conversely, if the tailings are ultimately determined to be reactive, Cells 1E and 2E would possibly be lined for the entire life of the operation to prevent reactive runoff from seeping into the ground and surrounding environment. Any discharge from the Tailings Basin would be monitored and, if necessary, directed to a wastewater treatment plant for appropriate treatment prior to discharge. The January 2007 revised Project Description removed the proposed lined tailings storage facility. Mitigation measures that included lining the tailings facility were assessed by MnDNR and USACE during preparation of the DEIS.

2.2.6 Alternatives Incorporated into the Project

Following the scoping process, PolyMet incorporated the following modified design and layout alternatives into the Project, which are therefore analyzed in this DEIS as part of the Proposed Action rather than as alternatives:

- Two mine pits (the East and Central pits will ultimately become one pit, with the West pit being the second);

- Use of Mine Site reactive runoff as make-up water for the Processing Plant with a single wastewater treatment plant at the Mine Site; and

- Relocation of the overburden stockpile to avoid National Forest System lands with a U.S. Bureau of Land Management mineral interest (e.g., PolyMet-owned land west of current stockpile site)[1].

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1 This alternative was developed in response to USFS comments in 2006, subsequent to completion of the Final SDD.

Additional mitigation measures and alternatives were also incorporated into the Project and analyzed in the DEIS, however these additional mitigation measures and alternatives were identified during the EIS development process (not scoping) and are discussed in Section 3.2.

2.3 ISSUES IDENTIFIED DURING THE EIS SCOPING PROCESS

2.3.1 Potentially Significant Issues

The Final SDD also identified the following topics that may result in potentially significant impacts and would require a substantial amount of additional information in the EIS beyond that included in the Scoping EAW. These specific topics are addressed in Chapter 4.0 of this DEIS and include:

- Fish and wildlife resources (Sections 4.4 and 4.5);
- Threatened and endangered species (Sections 4.3, 4.4, and 4.5);
- Physical impacts on water resources (Section 4.1);
- Water appropriations (Section 4.1);
- Surface water runoff and erosion/sedimentation (Section 4.1);
- Wastewater (Section 4.1); and
- Solid waste (Sections 4.1 and 4.12).

Examples of the type of additional information that would be needed in the EIS for these specific topic areas would include such items as the results of the project-specific special studies and research relative to process design, hydrology, water, wastewater, solid waste, chemical modification of reactive waste rock, and the mine closure plan.

The Final SDD determined that the EIS would also address the potential cumulative impacts associated with the combined environmental effects of the Project and of past, present, and reasonably foreseeable future actions relative to:

- Air Quality - Hoyt Lakes area projects and air concentration in Class II areas, Class I areas, PM_{10} increment, ecosystem acidification resulting from deposition of air pollutants, mercury deposition and bioaccumulation in fish, and visibility impairment;
- Biological Resources - loss of threatened and endangered plant species, loss of wetlands, and loss or fragmentation of wildlife habitat;
- Water Quality - streamflow and lake level changes, and water quality changes;
- Economic Impacts; and

- Social Impacts.

The cumulative impacts analyses are presented by resource in Chapter 4.0 of this DEIS. A summary of the cumulative effects is presented in Section 4.14.

The Final SDD stated that the EIS would also determine the most feasible mine reclamation strategy, including evaluation of alternative designs, layouts, siting, and reclamation requirements and strategies for reactive waste rock. The evaluation would be based on protection of natural resources, minimization of long-term maintenance, and the ability to meet eventual land use objectives including local community land use goals. The Mining, Minerals, and Sustainable Development Project Final Report[2] was also reviewed and opportunities to incorporate recommendations from the report were considered as part of PolyMet's reclamation plan, including incorporating closure planning as part of the Project design and analysis and providing for financial assurance for relcamation. The EIS will suggest additions to the plan, to the extent that additions would provide mitigation for identified environmental impacts. The amount of financial assurance associated with reclamation actions cannot be estimated until these actions are understood at a more detailed level of design. This detail is more typically available during the permitting process. Therefore, discussion of financial assurance figures and instruments are not included in the DEIS. It is the tribal cooperating agencies' position that financial assurance can and should be discussed in the draft EIS. Additional details in support of this position can be found in Section 3.1.7 of this EIS. However, the DEIS does describe reclamation procedures and acknowledges that Minnesota regulations require that financial assurance requirements be determined at the permitting phase.

2.3.2 Other Issues

The Final SDD determined that the following topics are not expected to present significant impacts, but would be addressed in the EIS using limited information beyond that provided in the Scoping EAW commensurate with the anticipated impacts. These specific topics are addressed in Chapter 4.0 of this DEIS and include:

- Cover types (Section 4.3);
- Vehicle related air emissions (Section 4.6);
- Air emissions (Section 4.6);
- Noise (Section 4.7);
- Archeology (Section 4.8);

[2] The Mining, Minerals and Sustainable Development Project was an independent study completed by the International Institute for Environment and Development in 2002 aimed at understanding how the mining and minerals sector could maximize its contribution to sustainable development at the global, national, regional, and local level.

- Visibility (Sections 4.6 and 4.11);
- Compatibility with Plans and Land Use Regulations (Section 4.9);
- Infrastructure (Section 4.10);
- Asbestiform fibers (Section 4.6); and
- 1854 Ceded Territory (Section 4.8).

The Tribes were not involved as Cooperating Agencies during Scoping, or when the Final SDD was issued. It is the Tribal cooperating agencies position that additional consultation and evaluation is needed to determine the degree of impact on the ceded territory as a result of this project.

The DEIS will also consider additional issues that arise as the understanding of the potential impacts of the Project evolves through the detailed analyses and commenter input.

2.3.3 Issues Considered But Eliminated During Scoping

The following topics were reviewed and considered by the MnDNR and the USACE in the Scoping EAW, and it was determined that they were not relevant or were so minor that they would not be addressed in the EIS:

- Land Use: conflicts are not anticipated due to previous and ongoing mining in the area;
- Water-related Land Use Management District: the Project is not located in a shoreland zoning district, a delineated 100-year floodplain, or a state or federally designated wild or scenic river land use district;
- Water Surface Use: the number or type of watercraft is not anticipated to change as a result of the Project;
- Geologic Hazards and Soil Conditions: there are no geologic site hazards to groundwater and soil condition conflicts are not anticipated due to previous and ongoing mining in the area;
- Traffic: the projected traffic count is within the capacity of the Project roads; and
- Odors: odors are not expected from the mine and air scrubbers are expected to eliminate any offensive odors from the stack emissions.

2.3.4 Issues Incorporated into EIS After Scoping

During an EIS process, changes to the Project, changes in the regulatory framework, heightened public concern, or availability of new information related to potential impacts, may make it necessary to refine the scope or structure of an EIS. Accordingly, this DEIS will contain greater emphasis on the following issues than was envisioned at the time of the Final SDD:

- Groundwater hydrology and impacts to groundwater;
- Potential for methylation of mercury in wetland or lake systems;
- Cultural resources from a Native American tribal perspective;
- New federal regulations regarding fine particulate emissions ($PM_{2.5}$);
- Greenhouse gas emissions and climate change; and
- Impacts to wild rice.

The Tribes were not involved as Cooperating Agencies during Scoping, or when the Final SDD was issued. Although groundwater hydrology and impacts to groundwater, Cultural Resources, and impacts to wild rice were "incorporated" after scoping, cumulative effects for a number of resources were not added. To adequately determine impacts and mitigation strategies a greater understanding of groundwater hydrology at the site is required. In addition, impacts resulting from groundwater drawdown and inundation cannot be determined without additional data. Consultation is ongoing with the USACE regarding Cultural resources and impacts to wild rice.

2.4 PUBLIC AND AGENCY INVOLVEMENT DURING EIS DEVELOPMENT

Public and agency notification and opportunity to comment on the Project began during the Project scoping process. The USACE issued a Section 404 Permit Public Notice for the PolyMet Project on May 10, 2005. In June 2005, the MnDNR, in partnership with the USACE and USFS, prepared a Scoping EAW and a Draft SDD to provide information about the Project, identify potentially significant environmental effects, and determine what issues and alternatives will be addressed in the EIS and the level of analysis required.

The public review period for the Scoping EAW and Draft SDD began on June 6, 2005 and concluded on July 6, 2005. A public meeting was held during the comment period on June 29, 2005, in the city of Hoyt Lakes to provide additional information on the Project and allow for comments (verbal and written) and questions. Approximately 70 people attended the meeting. On July 1, 2005, the USACE published the Notice of Intent (NOI) to prepare a Draft EIS in the Federal Register. The comments received during the scoping period were considered by the MnDNR and the USACE prior to the issuance of the Final SDD on October 25, 2005.

Throughout the DEIS writing process, which occurred primarily between July 2006 and July 2009, the cooperating agencies worked in collaboration with the permitting agencies to assist in the review and critique of the various technical supporting documents, ultimately providing input through meetings and written comment to several versions of the DEIS document.

The MnDNR maintains a webpage at:
http://www.dnr.state.mn.us/input/environmentalreview/polymet/index.html to enable the public to have access to most of the agency-prepared Project documents that led to the preparation of

this DEIS. This web page also provides contact information so that members of the public may submit questions and comments about the Project.

This DEIS will be published and circulated for a 45-day comment period in accordance with MEPA requirements set forth in *Minnesota Rules*, chapter 4410, and with NEPA requirements. Public comments will be accepted during this period.

Two public information meetings will take place during the DEIS comment period: one in the city of Hoyt Lakes and one in the Minneapolis - St. Paul Metropolitan area. Comments received will be taken into account in assessing Project impacts and potential mitigation. Following the end of the comment period, responses to substantive comments will be prepared and a Final EIS will be issued. Following issuance of the Final EIS and a ten-day comment period, the MnDNR will review the EIS for adequacy with MEPA. The USACE will prepare the federal ROD; although the ROD cannot be issued until 30 days after the Final EIS is published. The state notice of adequacy will be noticed in the EQB Monitor and the USACE will issue a Public Notice regarding the availability of the ROD. Appeals to the USACE must be received within 60 days of the ROD. The USACE will make a final decision on an appeal within 90 days of the receipt of an acceptable appeal or within 30 days of a site visit.

3.0 PROPOSED ACTION AND PROJECT ALTERNATIVES

This section describes the Proposed Action as described by PolyMet in the January 2007 revised Project Description and in an update to the Project Description provided in July 2007. Many supporting documents submitted to the MnDNR and USACE by PolyMet between 2006 and 2009 were used to add detail to the Proposed Action description in this section. This section also includes descriptions of the No Action Alternative as well as two action alternatives - the Mine Site Alternative and the Tailings Basin Alternative. Finally, this section describes alternatives that were considered but eliminated from detailed analysis.

3.1 PROPOSED ACTION

The Project calls for surface mining and mineral processing of approximately 228 million tons[1] of Copper-Nickel-Platinum Group Element (PGE) ore over approximately a 20-year mine life. The Project would be the first large-scale non-ferrous metallic mineral mine in the State of Minnesota. The environmental impacts associated with the Project are different from ferrous mines and require a level of analysis that differs from those performed for those activities.

3.1.1 Mine Site – Location and Ownership

The Project would primarily consist of a proposed Mine Site and a largely existing Plant Site (Figure 1.1-2). The Mine Site, which contains the NorthMet copper-nickel-PGE deposit, is located eight miles east of the Plant Site, six miles south of the town of Babbitt, and two miles south of the Peter Mitchell open pit taconite mine. A layout of the Mine Site, showing maximum stockpile heights can be seen in Figure 3.1-1. The Mine Site is connected to the Plant Site by a private railroad and a segment of the private Dunka Road. PolyMet has acquired ownership or the right to use additional lands, trackage, and other railroad assets to secure the access between the Mine Site and the Plant Site.

Mine Site surface and mineral ownership is shown in Figure 3.1-2. The majority of the mineral rights of the area proposed for the Mine Site were originally held by U.S. Steel (USS). In 1989, mineral rights to 4,102 acres covering the deposit and adjacent areas were leased to PolyMet (previously Fleck Resources of Vancouver, BC). Subsequently, USS sold the mineral and mining rights to RGGS Inc. (RGGS), but RGGS maintained PolyMet's exclusive lease on the minerals. As can be seen in Figure 3.1-2, there are three 40-acre areas within the Mine Site in which the mineral rights are owned by the Longyear Mesaba Company, but are under lease to PolyMet. The majority of the surface land ownership at the Mine Site is held by the USFS, with smaller portions owned by PolyMet, the South Kawishiwi Cabin Group (SKCG, LLC), Cliffs Erie (Cliffs Natural Resources Inc.) and the State of Minnesota. In 2007, PolyMet entered into discussions with the USFS to acquire surface ownership of lands totaling approximately 6,700

[1] Unless specified otherwise, all tons in this document are short tons.

acres that are on top of and adjacent to its existing mineral lease through a land exchange. At the time that this DEIS was drafted, the land exchange was still being discussed between USFS and PolyMet and no decisions had been made (see Section 1.0 for more information). PolyMet also acquired approximately 400 acres around the Mine Site from Cliffs Erie in 2006 to serve as a buffer for the primary mining area. In summary, at the Mine Site, the land owned or leased by PolyMet totals 4,552 acres (11,252 acres if the land exchange is completed) of which 3,016 acres are predicted to have ground-level impacts due to Project construction and operations.

3.1.2 Mining Activities

Mine Site maps, which include the proposed mine pit, stockpile outlines, and mining infrastructure, for Years 1, 5, 10, 15, and 20 are shown in Figures 3.1-3 through 3.1-7. Cross-sections of the proposed pits showing their maximum depths and with maximum footprints over 5-year increments are shown in Figure 3.1-8. Similarly, cross-sections of the proposed waste rock stockpiles with maximum heights and footprints are shown in Figure 3.1-9.

PolyMet expects to mine, on average, 91,200 tons per day (tpd) of material, which would include about 32,000 tpd of ore and 59,200 tpd of waste rock overburden and 55,300 tpd of rock (RS18, Barr 2007). Annually, this would result in the removal of about 19.7 million tons of waste rock and 1.4 million tons of overburden, although most overburden would be stripped during the construction period at the beginning of the Project. Operating at these rates, annual metal production would total about 38,821 tons of copper, 9,037 tons of nickel, 400 tons of cobalt, 22,184 ounces of platinum, 87,129 ounces of palladium, and 13,824 ounces of gold.

3.1.2.1 Pre-production Mine Development

Several construction activities would be completed during the estimated 9 to 12 months of pre-production mine development (RS21, Barr 2007; RS22, Barr 2008; and RS24, Barr 2007). These activities would include:

- Upgrading the existing Dunka Road;
- Constructing site access roads;
- Constructing surface water exclusion dikes and ditches;
- Constructing engineered foundations, liners, and water collection/transport systems for waste rock stockpiles;
- Constructing surface water collection and drainage ditches, water collection ponds, and sumps;
- Constructing the wastewater treatment facility (WWTF) and the central pumping station (CPS) south of the West Pit (Section 3.1.2.9);
- Constructing the rail spur between the Cliffs Erie track and existing PolyMet track that serves the Coarse Crusher Building (Section 3.1.3);

- Constructing the Rail Transfer Hopper (Section 3.1.2.6);
- Constructing the substation drop from the 138 kV transmission line and installation of a 13.8 kV mine site power distribution system;
- Constructing the Mine Site to Plant Site water pipeline; and
- Constructing the field service and fueling facility.

Electrical service would be provided by a new Minnesota Power electrical substation located on Minnesota Power property southwest of the Mine Site near the Dunka Road. This substation would be fed from the existing 138 kV transmission line that passes just south of the Dunka Road and would feed the newly constructed 13.8 kV mine power distribution line that would supply electrical service to the mine pits, WWTF, CPS, Rail Transfer Hopper, pit dewatering pumps, process water pond pumps, stockpile foundation pumps, and the field service and refueling facility. This power line would form a loop around the perimeter of the mine pits (Figure 3.1-36).

Heating required by the WWTF, CPS, Rail Transfer Hopper, service and fueling facility, and railroad switch heaters would be provided by LPG suppliers. No natural gas service would be provided.

Domestic wastewater service would be provided by portable facilities serviced by a supplier. A bottled water supplier would provide drinking water.

Clearing, grubbing, and harvesting of marketable timber would be completed prior to the initiation of mining. The surface overburden consists of glacial till and organic wetland soils (i.e. peat). The peat would be removed and stockpiled separately in the Overburden Storage and Laydown Area before being reused for off-site wetland restoration activities, stockpile reclamation in covers, other on-site reclamation, or hauled directly to the overburden stockpile (CP03, Barr 2008, Overburden Information - Response to Comments in RS52). The overburden that is not peat would be removed to the extent required, separated based on reactivity, and hauled from the mine pit and stockpile footprint areas to the appropriate disposal areas. Based on the reactivity, the overburden will be used on-site as construction material in areas to be approved with the MnDNR through permitting, disposed of in the overburden portion of the Category 1 and 2 stockpile, or stored in the Overburden Storage and Laydown Area for future use (GC10, Kearney 2009). The overburden portion of the Category 1 and 2 waste rock stockpile and would be constructed in a series of lifts and managed in accordance with the requirements of *Minnesota Statutes*, sections 93.44 to 93.51 and the MnDNR Mineland Reclamation Rules for Nonferrous Metallic Mineral Mining (*Minnesota Rules*, chapter 6132).

In addition to the separate portion of the Category 1 and 2 waste rock stockpile, an Overburden Storage and Laydown Area would be constructed to the west of the Rail Transfer Hopper. This area would be used to screen, sort, and temporarily store overburden that may be used for some on-site construction or reclamation purposes (Barr 2009, NorthMet Response to Overburden Material Comments from MnDNR). Characterization of overburden from the Project has indicated that some of the overburden may be suitable for construction purposes. Rock and overburden from the nearby and inactive LTVSMC Area 5 mine site (Figure 1.1-2) to the north and east of the Tailings Basin or a state-owned waste rock stockpile located approximately 5 miles west of the Mine Site along Dunka Road may be considered for some construction purposes, however, characterization of those materials has not yet been completed (GC07, PolyMet 2008).

Once bedrock is exposed, pre-production mine development would generate Category 1 waste rock that would be used as appropriate to construct the ramps and roads in the pit, roads from the pit to the stockpiles and Rail Transfer Hopper, Rail Transfer Hopper and Ore Handling Area foundation, and Category 1 and 2 stockpile foundations (GC07, PolyMet 2008).

The pre-production mine development would be followed by a gradual ramp-up of ore output over 6 to 12 months to reach full capacity. Since the Processing Plant feed rate would progressively increase as plant operations ramp up, mining would be scheduled so that the excavated area in the mine pits would also progressively increase to provide an adequate supply of ore and ensure continuity of plant feed.

3.1.2.2 Open Pit Mining

The Project would use open pit mining methods. The mining method would be similar to those currently in use at ferrous metallic mining operations on the Iron Range. The mine would consist of three separate open pit excavations known as the East, Central, and West pits, as shown in Figure 3.1-1. For about half of the mine life, mining would continue in the East and West Pits simultaneously, with the Central Pit mining occurring between Years 11 and 13 (RS22, Barr 2008). It is planned that the East Pit would be mined out by the end of Year 11, thereby providing space for waste rock from the West and Central pits. With completion of mining from the Central Pit by Year 13, the East and Central pits would form one large pit (East/Central Pit).

By placing Category 1 and 2 waste rock (the least reactive material) into the East/Central Pit through the end of the mine life with an inflow of water, the rock would be stored in a sub-aqueous environment to reduce the environmental impact associated with the oxidation and decomposition of sulfide minerals. Moreover, once backfilled, the combined East/Central Pit is proposed for the creation of wetlands (Figure 3.1-37).

The pit configuration, staging, mine schedule, and stockpile layout would be progressively refined prior to the start of mining and throughout the projected 20-year life of the mine to account for changes in the price of metals, energy, labor, and other factors. The final mine configuration, prior to filling any pit with waste rock, is shown in Figure 3.1-7. The maximum size of each pit is projected to have the approximate area and approximate maximum depth shown in Table 3.1-1.

Table 3.1-1 Maximum Pit Dimensions

Mine Pit	Area (acres)	Maximum Depth (feet below ground surface)
West	278	840
Central	54.5	550
East	118	760

The northwest edge of the mine would be constrained by the northward extent of the Duluth Complex, which hosts the mineral deposit. The northwest side of the pit would follow the mineralization, which dips southeast at about 25 degrees, and roughly parallels the top of the Virginia Formation. The mine would be developed in a series of benches that would be approximately 40 feet high. These benches would be accessed by ramps approximate 85 feet wide (to accommodate broken ore, mine traffic, and water sumps) and having additional width for safety berms and possibly ditches, power lines/cables, and pipes on an as-required basis. The pit slope design indicates an overall pit slope angle of approximately 51 degrees. This would be continuously monitored and refined during the mine life.

3.1.2.3 Drilling and Blasting

Although the details of the drilling and blasting design would be refined and optimized as the mining operation continues, the proposed typical blasting parameters are presented in Table 3.1-2. In addition, PolyMet would conduct blasting in accordance with *Minnesota Rules*, part 6132.2900 Air Overpressure and Ground Vibrations from Blasting.

Table 3.1-2 Proposed Blasting Parameters

Blast hole diameter (range)	10 – 16 inch
Explosive type/blasting agent	ANFO and emulsion
Burden (distance from free face) and spacing (distance between holes)	Approximately 20 feet x 30 feet
Powder factor	Approximately 0.45 pounds ANFO equivalent/ton
Drilling rate – approximate	20 feet/hour
Assumed drilling time/rig	24 hours/day

Conventional electric or diesel powered rotary drilling rigs would be used. Because Project ore has physical characteristics very similar to Project waste rock, drilling and blasting would share a common drilling fleet and similar blast design specifications. Based on a proposed annual ore movement rate of 11.7 million tons, and a blast design as shown in Table 3.1-2, it is estimated that the total annual amount of blasting agent used for breaking ore would be 5.3 million pounds, including initiators and blasting accessories. Secondary breaking of oversize boulders would be done using a wheel loader or excavator-mounted drop weight hammer. Blasting of ore and waste rock would take place approximately every 2 to 3 days. This would usually include separate blasts of ore and waste rock benches totaling about 200,000 – 300,000 tons broken rock per blast.

3.1.2.4 Excavation and Haulage

After being drilled and blasted, the ore would be loaded by excavators into haul trucks that would transport the rock to the Rail Transfer Hopper. Diesel-hydraulic or electric-hydraulic excavators with 31 cubic yard [cy] capacity would be the primary rock loading tools in the mining fleet with a large diesel front-end loader (21.5 cy capacity) available to provide operational flexibility and additional loading capacity.

The haul truck fleet would consist of up to a maximum of eight[2] conventional 240 ton diesel-powered rear dump trucks. Haul trucks would be able to be re-assigned between excavators loading ore, waste rock, and overburden.

Should a delay or shutdown of any part of the rail haulage system occur, the ore haulage would be staged on the lined Lean Ore Surge Pile for future transport to the mill, allowing for haul trucks already loaded with ore to have a controlled location to dump and stockpile material. Once the rail haulage system is operational again, temporarily stockpiled ore would be loaded by front-end loader into the haul trucks for the short haul to the Rail Transfer Hopper dumping platform.

3.1.2.5 Lean Ore Surge Pile

Table 3.1-3 shows tons of ore moved for Years 0 (pre-production site preparation) through 20. A Lean Ore Surge Pile is proposed near the Rail Transfer Hopper to allow for temporary storage of marginal ore until it can fit into the processing schedule. Use of this surge pile would allow for delivery of a steady annual flow, and assist in providing a uniform grade of ore to the Process Plant. Lean ore would flow into and out of this pile allowing it to reach a maximum tonnage of 5.5 million tons and a footprint of 54.5 acres in Year 13.

The Lean Ore Surge Pile would have one 40 foot high lift and side slopes at the angle of repose. A large front-end loader would excavate the lean ore from the south side of the stockpile and transport it either to the Rail Transfer Hopper or to the Direct Rail Loadout Area. Because material in this stockpile is classified as Category 4 waste rock (from a reactivity characteristic), a lined base and foundation would be constructed to Category 4 specifications (see Section 3.1.2.10). All active areas at the Mine Site, including the Lean Ore Surge Pile, would be subject to a Fugitive Dust Control Plan approved by MPCA for managing fugitive dust generated at rock dumping and loading locations. The Lean Ore Surge Pile would be removed at the completion of mining activities. Drainage from the Lean Ore Surge Pile would be collected on the liner and routed to two sumps (S-6 and S-7 as shown in Figures 3.1-10 to 3.1-12) for conveyance to the WWTF (RS 22, Barr 2008).

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[2] Equipment number as presented in air modeling.

Table 3.1-3 Ore Movement (tons)

			Lean Ore Surge Pile		
Year	**Mined**	**To Plant**	**To**	**From**	**Balance**
0	78,335		78,335	0	78,335
1	6,468,692	6,497,515	0	28,823	49,512
2	11,934,642	11,680,000	254,642	0	304,154
3	13,903,050	11,680,000	2,223,050	0	2,527,204
4	10,469,506	11,680,000	0	1,210,494	1,316,710
5	12,691,704	11,680,000	1,011,704	0	2,328,414
6	12,599,220	11,680,000	919,220	0	3,247,633
7	12,729,069	11,680,000	1,049,069	0	4,296,702
8	9,878,679	11,680,000	0	1,801,321	2,495,381
9	11,079,752	11,680,000	0	600,248	1,895,133
10	14,013,411	11,680,000	2,333,411	0	4,228,544
11	11,120,755	11,680,000	0	559,245	3,669,298
12	12,735,906	11,680,000	1,055,906	0	4,725,205
13	12,443,434	11,680,000	763,434	0	5,488,638
14	11,271,732	11,680,000	0	408,268	5,080,370
15	6,857,189	11,680,000	0	4,822,811	257,559
16	11,422,441	11,680,000	0	257,559	0
17	15,663,317	11,680,000	3,983,317	0	3,983,317
18	11,660,624	11,680,000	0	19,376	3,963,941
19	11,794,752	11,680,000	114,752	0	4,078,693
20	7,286,269	11,364,962	0	4,078,693	0
Total	228,102,477	228,102,477	13,786,839	13,786,839	0

3.1.2.6 Rail Transfer Hopper

PolyMet would use the same type of Rail Transfer Hopper system that was used by LTVSMC to load rail cars at the Mine Site. The Rail Transfer Hopper would consist of a raised platform from which haul trucks dump into a hopper over a pan feeder. The pan feeder would pass through an opening in a retaining wall and discharge into a rail car positioned under the feeder outlet. The pan feeder and the control gate would be hydraulically powered and could be controlled by the locomotive operator using a radio remote control pack. Loading time would be approximately one minute per 100-ton rail car, or about 45 to 60 minutes to load a 30-car train.

The Rail Transfer Hopper would be located to the south of the mine pits and would be connected to the existing main line track by a new spur line. The rail track entering the Rail Transfer Hopper would be designed to allow rail cars to be loaded directly by front-end loader should the Rail Transfer Hopper breakdown or be unavailable during maintenance.

3.1.2.7 Other Equipment

In addition to the drilling, excavating, and hauling equipment described above, the Project would use auxiliary and support equipment as shown in Table 3.1-4 at the Mine Site.

Table 3.1-4 Proposed Mine Auxiliary Equipment Fleet

Typical Machine Type	Power	Number	Duties
Cat D10R tracked dozer	582 hp	2	Stockpile maintenance, construction, stockpile reclamation
Cat 834G wheel dozer	450 hp	1[1]	Excavator pit maintenance, pit clean-up
Cat 16H Grader	275 hp	2	Haul road maintenance
Cat 777D Water Truck	937 hp	2	Haul road maintenance, dust suppression, auxiliary fire fighting duties
Cat 992G Wheel Loader (construction, site reclamation and misc.)	800 hp	1	General purpose loading, reclamation
Cat 446D Backhoe with Hammer	110 hp	1	Secondary breakage
Cat IT62H Integrated Tool Carrier	230 hp	1	Miscellaneous tasks (e.g. snow plowing, fork lift, sweeper, etc.)
Field service trucks	114 hp	6[2]	Field maintenance flat bed trucks fitted with hydraulic arm lift
Fuel truck	150 hp	2[2]	Field fueling of excavators, and dozers
Line truck	100 hp	1[2]	Excavator service and power line maintenance
Low bed transporter, tractor and 120T capacity low loader	200 hp	1[2]	Transporting tracked equipment around mine and to service area/workshops
Haul truck retriever	1,120hp	1[2]	Retrieving and transporting haul trucks unable to move under their own power
Light vehicles	74 hp	20[2]	Supervisors transport, general duties

1 equipment number as presented in air modeling.
2 these units are not included individually in air emissions calculations

3.1.2.8 Fueling and Maintenance Facilities

Equipment fueling and minor service and repair work would be done at a field service and fueling facility proposed near the Rail Transfer Hopper. The fueling bay and field service bay structures would be roofed structures that have reinforced concrete floors graded to drain to a sump to collect any spillage and oil-contaminated water. A licensed disposal contractor would periodically pump out the sump.

In addition to fueling systems, there would also be dispensing equipment for lubricating and hydraulic oils, antifreeze/coolant, windshield washer fluid, and compressed air for tires. The building would contain limited-capacity storage tanks containing lubricating and hydraulic oils and antifreeze. Three 12,000 gallon bulk diesel storage tanks, enclosed with a spill containment system, would be provided at a safe distance. Interior and area lighting would be provided to enable safe operation at nighttime. In addition, a metering system would record the amount of fuel dispensed to each vehicle and emergency shut-off valves would be present at all necessary locations.

Stationary or slow-moving equipment such as excavators, dozers, and drill rigs would be fueled from mobile fuel tankers specially equipped with pumping and metering devices. The fueling tankers would arrive with fuel or be replenished at the service and fueling facility.

Major scheduled maintenance and repair work on most mobile equipment would be done in the refurbished and reactivated former LTVSMC Area 1 Shop located about one mile west of the Processing Plant. The Area 1 Shop is a fully enclosed maintenance facility built specifically to handle maintenance and repair work. A heavy-duty low bed trailer and tractor would be used to transport equipment (e.g., dozers and front-end loaders) to the Area 1 Shop from the mine. A large scale tow-truck would haul trucks that are unable to move on their own. The Area 1 Shop would collect and store used oils and antifreeze/coolant as well as residue from steam cleaning equipment. Used oils, antifreeze/coolant, and solvents would be collected by a specialist contractor for recycling, while used filters, oily rags and other oil-contaminated waste would be collected for proper offsite disposal in suitably licensed disposal facilities.

To access the Area 1 Shop, mine vehicles would follow an access road through parts of the former LTVSMC taconite mine area. Heavy equipment would cross County Road 666 at an established haul truck crossing point, which would be illuminated at night and during inclement weather and would have warning lights/devices.

The former LTVSMC Area 2 Shop, located about seven miles west of the Mine Site, would be reactivated to provide for mining and railroad operations supervision and management, as well as including change house facilities, toilets, lunch rooms, first aid facility, emergency response center, and training and meeting rooms for mining and railroad crews. The Area 2 Shop facilities would include a Locomotive Fueling Station, Locomotive Service Building, and Mine Reporting Building. The Locomotive Fueling Station, where locomotives would be fueled and lubricated, has a roof and sides, but is open at the ends to allow access. The concrete floor would collect any spilled fuel and route it to a collection sump for proper disposal. It also has a 15,000-gallon bulk fuel storage tank with containment systems.

Because of the size and weight of the primary excavators and blast hole drill rigs, most of their maintenance and repair work would be done in the field in accordance with the facility's NPDES/SDS Permit and associated Mine Site SWPPP.

3.1.2.9 Mine Site Water Management

Both MIne Site non-contact stormwater and Mine Site process water would be managed at the Mine Site. Non-contact stormwater, the result of precipitation that falls on natural or non-reactive reclaimed vegetated surfaces, would be routed through sedimentation ponds prior to discharge to the Partridge River (RS24, Barr 2007). Process water, which includes precipitation runoff and groundwater (pit dewatering water) that has contacted disturbed surfaces as well as water collected on stockpile liners, would be treated using a combination of membrane separation and chemical precipitation technologies at the Mine Site WWTF located south of the West Pit (RS29T, Barr 2007). Tribal cooperating agencies note that under the proposed project, this facility will need to treat water for hundreds or thousands of years to avoid contamination to the Partridge River.

Using the CPS located adjacent to the WWTF, the effluent from the WWTF would be pumped to the Tailings Basin for use as plant make-up water (RS22, Barr 2008) or pumped back to the Mine Site to be used to supplement flooding of the East/Central Pit while the East/Central Pit is being backfilled (RS22, Barr 2008). Reuse of the Mine Site process water at the Plant Site would eliminate the need to discharge any process water from the Mine Site to surface waters. The solids removed from the Mine Site process water in the WWTF would be reprocessed to recover any potential metals in the Hydrometallurgical Facility as described in Section 3.1.5.2 (RS29T, Barr 2007). Tribal cooperating agencies note that under the proposed project, the CPS would need to operate for hundreds or thousands of years in conjunction with the WWTF.

Figures 3.1-10, 3.1-11, and 3.1-12 show the process water management systems, including the pump and pipe networks that dewater the pits in Years 1, 10, and 20. Figure 3.1-13 shows the existing subwatershed boundaries and drainage flows at the Mine Site, while Figures 3.1-14, 3.1-15, and 3.1-16 show proposed surface water (stormwater) management at the Mine Site in Years 1, 10, and 20. (RS22, Barr 2008; RS24, Barr 2007). Existing drainage patterns and the proposed stormwater management system are described in further detail below.

Mine Site Perimeter and Pit Rim Dike and Ditch Systems

A system of dikes and ditches constructed at the Mine Site perimeter would minimize the amount of surface water flowing onto the site, minimize the amount of surface runoff flowing into the mine pits, manage the amount of process water, and control non-contact stormwater flowing off the site (Figures 3.1-14, 3.1-15, and 3.1-16) (RS24, Barr 2007; RS25, Barr 2007 and 2008).

Dikes would be constructed of silty sands or glacial till material that would be excavated during construction of ditches and removal of overburden. Side slopes would be vegetated to control erosion. Small dikes would be constructed at the rims of the mine pits in all areas where the existing ground surface does not naturally drain surface runoff away from the and would be rebuilt as the pit perimeter expands. Small dikes would also be constructed, as needed, along interior stormwater ditches and around stockpile construction areas to separate stormwater and process water around the Mine Site.

In order to convey non-contact stormwater adjacent to the dikes, prevent surface runoff from entering the mine pits, intercept stormwater prior to reaching process water areas, and prevent water from pooling in areas where the dikes cut across low areas, ditches would be constructed along the interior of most of the perimeter dike system and throughout the interior of the Mine Site. In addition, there would be some areas along the site perimeter where the existing ground is already relatively high so that a ditch would be able to capture the site surface runoff without a dike. Non-contact stormwater captured by the ditches would be directed to sedimentation ponds and then routed into a natural drainage system. The layout of drainage ditches is illustrated in Figures 3.1-14, 3.1-15, and 3.1-16 for Years 1, 10 and 20, respectively.

Dike Design for Shallow Groundwater Control

Where glacial till is present in the dike foundation zone below the water table and where inspection trenching (conducted at the time of construction) indicates potential for high-permeability conditions or where peat is present, seepage control measures would be installed to restrict groundwater movement (RS25, Barr 2007 and 2008). In areas where glacial till is present, these seepage control measures would include soil cut-off trenches constructed of compacted silty sand or compacted glacial till, or slurry trenches. The decision on which to use would depend on depth to bedrock and soil type in which the dike was being built. In areas where peat is present, seepage would be prevented by compressing the peat with earthen dike materials to create a low-permeability layer. If a sand seam or other high-permeability material is found in the dike foundation zone below the peat deposit, a soil cutoff trench, slurry wall, or sheetpile wall would be installed (depending on depth to bedrock) to cut off seepage. Geotechnical testing indicated that silty sand soils found at the Mine Site are a relatively low-permeability material in their natural state (RS 49, Appendix B, Barr 2007). Therefore, seepage cutoffs are generally not planned to be used in these areas.

Pit Dewatering

It is necessary to dewater the pits during mining to remove groundwater and precipitation runoff. Precipitation runoff and groundwater flow would be directed to low areas in the pits where it would be collected in sumps and pumped to the WWTF. The mine pit sump areas and pump capacities were designed to minimize delay to mining operations during the typical spring snowmelt or major precipitation events (RS22, Barr 2008).

East and Central Pit Filling

After mining activities are complete in the East and Central Pits, the pits would be filled with Category 1 and 2 waste rock from the West Pit, along with groundwater, in-pit runoff, direct precipitation, and treated process water from the WWTF, as necessary. Subsequent flooding of these backfilled pits with water would minimize the amount of pit wall and backfilled waste rock exposed to the atmosphere, thus limiting the oxidation of the sulfide minerals and reducing the amount of metals leaching to the pit water.

The quantity of waste rock placed in the East and Central pits would change every year of operation, depending on the quantity of Category 1 and 2 waste rock generated. During filling, the water elevation would be kept slightly below the surface of the waste rock to avoid equipment working in the water and to maximize the amount of rock used to fill the pit. At Closure, the water level in the East and Central Pits would be allowed to increase above the level of the waste rock. Once backfilling is complete, which is estimated to be approximately Year 21, the top of the backfilled pit would be designed to function as a treatment wetland (RS52, Barr 2007).

If natural inflow of water into the East and Central Pits is insufficient, water can be pumped from the CPS, which is designed to send water that has been treated at the Mine Site WWTF to the Tailings Basin, to keep the water surface at the required level. During periods of high precipitation or during spring snowmelt, dewatering may be required to allow placement of the waste rock. Given the estimates for combined pit inflows, it is predicted that treated water would be needed from the CPS during most years of the pit filling operation. As shown in Table 3.1-5, there are two years, Years 13 and 14, when water balance estimates indicate that excess water in the East and Central Pits would need to be diverted to the WWTF.

Table 3.1-5 Water Balance for East and Central Pit Filling

Mine Year	Combined Pit Inflows[1] (gpm)	Annual Flow Required to Fill Pits[2] (gpm)	Additional Water Needed from CPS (gpm)	Excess Pit Water Diverted to WWTF (gpm)
Year 12	960	1,001	41	0
Year 13	953	432	0	521
Year 14	946	328	0	618
Year 15	940	1,427	487	0
Year 16	781	1,274	493	0
Year 17	622	1,122	500	0
Year 18	415	913	498	0
Year 19	209	1,024	816	0
Year 20	2	976	973	0

1 Combined pit water includes direct precipitation, in-pit runoff, and groundwater inflows for the East and Central Pits.
2 Annual flow required to fill pits is the volume required to keep the water surface within 5 feet from the backfilled rock elevation and varies with the rock volume placed in the pits.

3.1.2.10 Waste Rock and Overburden Management

PolyMet proposes to categorize waste rock into four categories which are defined according to their geochemical and associated acid-producing and metals-leaching properties and are summarized below (Table 3.1-6).

Table 3.1-6 Summary of Waste Rock Properties

Waste Rock Categorization	Sulfur Content (%S)[1]	Copper to Sulfur Ratio (Cu/S)[2]	Approximate % of Waste Rock Volume[3]
Category 1	%S ≤ 0.12		74%
Category 2	0.12 < %S ≤ 0.31	≤ 0.3	9%
Category 3	0.31 < %S ≤ 0.6	>0.3	14%
Category 4	0.6 < %S	Includes all Virginia formation rock	3%

1 In general, the higher the rock's sulfur content, the higher its potential for generating ARD or leaching heavy metals.
2 Copper to Sulfur Ratio (Cu/S) assists in distinguishing between Category 2 and Category 3 waste rock with respect to ARD.
3 ALT 10, Barr 2008.

- Category 1 – Least reactive waste rock. This material is not predicted to generate acid rock drainage (ARD), but may leach heavy metals in excess of anticipated water quality compliance levels. PolyMet proposes to use some of this waste rock for construction material at the Mine Site, if approved by MnDNR during permitting. The Category 1 waste rock that would not be used as construction material would be placed on the Category 1 and 2 Stockpile (See Figures 3.1-3 – 3.1-7) (GC07, PolyMet 2008).

- Category 2 – Low reactivity waste rock. This material may generate ARD, and is predicted to leach heavy metals resulting in drainage with metal concentrations in excess of anticipated water quality compliance levels. Category 2 material would be placed on the Category 1 and 2 Stockpile.

- Category 3 – Medium reactivity waste rock. This material may generate ARD and is predicted to leach heavy metals resulting in drainage with heavy metal concentrations in excess of anticipated water quality compliance levels. Category 3 material would be placed on the Category 3 Waste Rock Stockpile or stored on the Category 3 Lean Ore Stockpile.

- Category 4 – High reactivity waste rock. This material would generate ARD and leach heavy metals resulting in drainage with heavy metal concentrations in excess of anticipated water quality compliance levels. This category would be placed on the Category 4 Stockpile, or stored on the Lean Ore Surge Pile.

- Overburden – This material represents the remainder of the non-ore volume (about 9% of the total excavated volume). The deeper saturated overburden material would be selectively managed through placement on the overburden portion of the compacted soil lined Category 1 and 2 waste rock stockpile to address its potential for metals leaching. The overburden coming from near the surface may contain relatively low sulfur and metal concentrations and has been shown to leach low concentrations of metals (GC05, SRK 2008). Therefore, the near-surface unsaturated portions of overburden would potentially be used for some construction purposes, pending further demonstration of non-reactivity.

As indicated above, Category 3 and Category 4 rock are further divided into waste rock and lean ore. The criterion for lean ore is economic rather than geochemical. Lean ore would be material that is not economic to process at the time of mining, but could become economic in the foreseeable future.

The decision on where to haul the waste rock would depend on the rock's sulfur and copper content that would have been determined through a sampling and analysis program approved by the MnDNR. Depending on its designated category, rock would be hauled to one of four main waste rock stockpiles - Category 1 and 2 waste rock, Category 3 waste rock, Category 3 Lean Ore or Category 4 waste rock. Category 4 lean ore would be hauled to the lean ore surge pile or the Rail Transfer Hopper (Figure 3.1-1).

As seen in the schedule shown in Table 3.1-7, from production years 1 through 11, until the East Pit is mined out, Category 1 and 2 waste rock would be placed on the Category 1 and 2 Stockpile (Figures 3.1-3 to 3.1-5). After Year 11, when mining of the East Pit would be complete, approximately 125 million tons of Category 1 and 2 waste rock (32% of the total waste rock) would be placed back in the East Pit.

Surface overburden would be screened and sorted into three types based on the material's physical and chemical properties as identified through visual observation: (1) organic soils (peat); (2) unsaturated overburden; and (3) saturated overburden. The peat and unsaturated overburden would be stockpiled in the Overburden Storage and Laydown Area located along Dunka Road. From here the non-reactive material would ultimately be sorted for use in foundations and reclamation, with any unused or reactive material being placed in the overburden portion of the Category 1 and 2 waste rock stockpile. The saturated overburden would be placed directly in the overburden portion of the Category 1 and 2 waste rock stockpile (Figures 3.1-3 – 3.1-7) (GC10, Kearney 2009).

The deeper saturated overburden material would be selectively managed to address its potential for leaching. Overburden coming from near the surface that contains relatively low sulfur and metal concentrations and has been shown to leach low concentrations of metals would be sorted and stored at the unlined Overburden Storage and Laydown Area for processing and re-use, or alternatively, be placed within the overburden portion of the Category 1 and 2 waste rock stockpile (GC05, SRK 2008; GC10, Kearney 2009). The volume of overburden generated is estimated to be about four times more than the construction material needed in the first five years, and two and a half times more than what would be needed overall. In the event that there are insufficient soils with the proper characteristics, additional overburden may be available in PolyMet-owned stockpiles at LTVSMC Area 5 (Figure 1.1-2).

Table 3.1-7 Waste Rock Placement

Waste Rock Placement in Tons

Year	Category 1 and 2 Waste Rock	Category 3 Waste Rock	Category 3 Lean Ore	Category 4 Waste Rock	Category 4 Lean Ore	East Pit (East/Central after Yr 13) or used for other purposes	Total
0	18,203	0	0	74,559	0	0	92,762
1	6,187,320	214,660	1,605,061	8,208	0	0	8,015,248
2	16,503,153	225,169	1,793,557	252,209	9,005	0	18,783,092
3	13,715,483	597,893	2,129,494	1,254,741	0	0	17,697,612
4	14,636,063	854,261	1,701,833	1,025,464	0	0	18,217,621
5	22,776,226	561,879	1,070,203	1,173,278	71,027	0	25,652,613
6	17,198,285	627,254	1,347,766	1,398,799	124,855	0	20,696,959
7	10,907,307	469,536	1,288,444	637,857	140,799	0	13,443,943
8	28,131,562	743,072	2,495,861	498,023	160,832	0	32,029,350
9	15,480,940	604,242	1,093,809	581,364	125,119	0	17,885,475
10	18,988,087	431,299	1,769,310	464,726	178,297	0	21,831,718
11	11,078,713	703,394	1,251,543	653,878	186,248	0	13,873,776
12	0	1,243,567	3,202,453	188,528	187,144	20,819,956	25,641,648
13	0	1,027,466	2,861,908	98,160	158,747	16,077,320	20,223,601
14	0	919,439	2,330,837	26,241	88,532	14,286,631	17,651,680
15	0	860,386	4,775,347	77,016	34,564	22,878,678	28,625,991
16	0	547,644	3,650,319	110,320	88,755	18,526,917	22,923,956
17	0	715,639	1,491,121	59,945	168,404	14,580,631	17,015,740
18	0	931,031	1,903,476	58,422	52,919	17,036,139	19,981,987
19	0	886,215	1,605,809	59,243	8,723	13,620,063	16,180,054
20	0	1,591,732	2,101,973	191,726	106,190	13,625,514	17,617,135
Total	**175,621,343**	**14,755,777**	**41,470,125**	**8,892,706**	**1,890,162**	**151,451,850**[1]	**394,081,962**
% Total	**83.0%**	**3.7%**	**10.5%**	**2.3%**	**0.5%**		**100.0%**

[1] Approximately 125 million tons of Category 1 and 2 waste rock would be backfilled into the East and Central Pit and the remainder (26.4 million tons) would be used for MnDNR-approved on-site construction or placed in additional lifts on the Category 1 and 2 waste rock stockpile (RS 22, Barr 2008).

When at its maximum size, each stockpile is projected to have the approximate area, height, and elevation shown in Table 3.1-8.

Table 3.1-8 Stockpile Dimensions at Year 20

Stockpile	Area (acres)	Max Height (feet)	Max Elevation (feet above sea level)
Category 1 and 2 waste rock	464.4[1]	240	1840
Category 3 waste rock	72.0	160	1760
Category 3 lean ore	156.8	200	1800
Category 4 waste rock	63.3	130	1730

[1] The area for the Category 1 and 2 stockpile includes 27.4 acres for overburden disposal. The Category 1 and 2 stockpile is 437.0 acres without overburden – see Table 4.1-B in RS-22, Draft 02, Barr 2007.

Waste Rock Liner and Cover Systems

The waste rock stockpiles would include liner systems to capture water passing through the stockpile. All stockpiles would be constructed using foundation underdrains to provide gravity drainage where elevated groundwater is encountered to prevent or minimize the potential for excess pore pressures as the facility is loaded (RS 49, Golder 2007). In addition, all liner systems would consist of a barrier layer (that limits the vertical infiltration of water through the liner system) and an over-liner drainage layer (that promotes the conveyance of water that reaches the barrier layer to a collection removal point via gravity) (RS 23T, Barr 2007). These three design details enhance liner integrity.

In addition to the liner systems, the waste rock stockpiles would have cover systems to limit water infiltration into the stockpile after the stockpiles are closed. Liner and cover system designs are based on the degree of predicted heavy metal leaching expected from each waste rock classification type. Local till overburden soils, generated from the processing of overburden removed from the mine pit and stockpile footprint areas, could be used in constructing the liner and cover systems (GC10, Kearney 2009). The proposed liner and cover systems are shown in Table 3.1-9. See RS23T for information regarding liner performance (RS23T, Barr 2007).

It is the position of the tribal cooperators that this section should describe expected leakage rates as well as the long-term effectiveness of both the liner and cover systems. Given that the applicant has not proposed any long-term maintenance of these systems, these parameters should be described in this section and taken into account in section of the EIS that predict long term surface and ground water quality.

Table 3.1-9 Summary of Proposed Stockpile Liners and Covers

Stockpiles	Stockpile Duration	Stockpile Area (Post-Closure)	Liner System	Cover System
Category 1 and 2 and Overburden	Permanent	563.8 acres (Cat 1 and 2 – 464.4 ac) (OB – 99.4 ac)	12-inch compacted ($5x10^{-7}$ cm/s) subgrade covered by 12-inch overliner drainage layer.	2-foot soil cover
Category 3 Waste Rock	Permanent	72.0 acres	12-inch compacted ($1x10^{-5}$ cm/s) subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 12-inch overliner drainage layer	3-foot soil cover on outer slope and textured geomembrane plus 1.5-foot vegetated soil layer for top and bench areas
Category 3 Lean Ore	Permanent	156.8 acres	12-inch compacted ($1x10^{-6}$ cm/s) subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 12-inch overliner drainage layer	3-foot soil cover on outer slope and textured geomembrane plus 1.5-foot vegetated soil layer for top and bench areas
Category 4 Waste Rock	Permanent	63.3 acres	12-inch compacted ($1x10^{-6}$ cm/s) subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 12-inch overliner drainage layer.	Textured geomembrane plus 1.5-foot vegetated soil layer for top, bench areas, and outer slopes
Lean Ore	Temporary	0 acres (max of 54.5 acres during operations)	12-inch compacted ($1x10^{-6}$ cm/s) subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 12-inch overliner drainage layer.	Stockpile to be completely removed and reclaimed

Source: Table 4-4 and page 30, RS74A, Barr 2008.

3.1.3 Proposed Transport of Ore

Three trains, each consisting of up to twenty 100-ton side dumping ore cars and one 2,100 hp diesel-electric “Gen-Set” locomotive, would transport the ore from the Mine Site to the Process Plant. The cars would have hinged sides that drop down when the cars are tipped at the crusher for unloading. Small amounts of ore could escape the confines of the rail cars during transport via two primary routes:

1) Fines through the gaps at the hinges - the Rail Transfer Hopper discharge feeder and track alignment is designed so that cars would be loaded along the centerline. In this loading procedure, ore size may be classified as the car is loaded so that fines would be at the center of the car and the larger ore pieces would be at the edge. This would keep much of the fines from reaching the edge of the car where they would be subject to spillage through the hinge gaps. PolyMet noted that no evidence of significant fines spillage was observed during LTVSMC operations using this same loading system and cars. Tribal cooperating agencies disagree that the amount of ore that could escape from rail cars would be “small.” Taconite pellets currently litter most of the railroad right of way between the plant site and the proposed mine site, confirming that ore can and does spill from the gaps along the side door. Second, fugitive dust escaping through these gaps is also a concern. These very small particles have the potential to cause contamination of soils and wetlands that are located along the rail route, as evidenced by ongoing contamination issues at the Flambeau Mine in Wisconsin.

2) Large pieces of ore over the tops - standard operating procedure would be to use a rubber-tired dozer to push any large ore pieces that extend out of the car into or off of the car near the Rail Transfer Hopper because these pieces can damage the crusher building and car dumping equipment. In the event that a large ore piece would fall over the top edge of the cars during transit, it would be recovered during routine track maintenance. Tribal cooperators are unsure how ore debris can be visually distinguished by rail track maintenance crews from other rocks and ore that litter the embankments. In addition, spillage of ore pieces into the wetlands and creeks that are located along the rail line could not be easily identified and recovered. It is reasonable to assume that some acid drainage and metal leaching would occur along the waterbodies located along the rail line.

The route of track from the Mine Site to the Processing Plant would be from a new spur at the Rail Transfer Hopper, to existing track between Mile Posts 8.4 and 3.9 on the Cliffs Erie LLC private railroad, to a new approximately 5,750-foot connecting track between the Cliffs Erie track and existing PolyMet track that serves the Coarse Crusher Building at the Processing Plant (Figure 3.1-17).

3.1.4 Plant Site – Location and Ownership

The Plant Site includes the Processing Plant, Area 1 Shop, Area 2 Shop, and the Tailings Basin, plus additional land around these facilities to serve as a buffer (Figure 3.1-17 and 3.1-17a). The Processing Plant, which is in an area that was previously disturbed by mineral processing operations, would include a Beneficiation Plant and a Hydrometallurgical Plant.

The majority of the Plant Site infrastructure already exists at this brownfield site as follows:

- County Road 666 ends at the Main Gate for the industrial area that would include the Processing Plant, Area 1 Shop, and Area 2 Shop;
- The Canadian National Railroad serves the industrial area that would include the Processing Plant and existing PolyMet track connects to the Area 1 Shop and the Area 2 Shop;
- Three Minnesota Power Company 138Kv transmission lines serve the Project substation;
- The existing Sanitary Treatment Plant would be replaced or upgraded to meet current construction and performance standards and sized as appropriate; and
- The existing Processing Plant potable water treatment plant located near the Plant Reservoir will be refurbished and reactivated. The potable water distribution system extends to the Area 1 and Area 2 Shop. (PolyMet 2007, Supplemental DPD). This water will be used for showers and sinks and will be treated (chlorinated) to be drinkable. However, bottled water will be brought in for drinking as well.

PolyMet acquired surface ownership of approximately 7,000 acres of real property and portions of the taconite processing facility formerly owned by LTVSMC, and approximately 8,100 additional acres from Cleveland-Cliffs, Inc. Some of this land was additional acreage that would not be used for the Project. PolyMet acquired the necessary surface licenses, easements, and rights-of-way for the remainder of the Plant Site (e.g., roadways, railroad, electrical service, gas pipeline, and water facilities) to enable production at the Plant Site (Figure 3.1-18). PolyMet also acquired the necessary easements and rights-of-way to use an 8-mile segment of Dunka Road, which is co-owned by Minnesota Power, PolyMet, and Cliffs Erie.

In summary, at the Plant Site, the surface owned or leased by PolyMet is 15,100 acres of which approximately one-third is predicted to have ground-level disturbance due to Project operations. Most of the area that would be disturbed has already been contaminated by LTVSMC operations. Polymet will assume responsibility for these legacy contamination issues if it is granted operating permits for its proposal. At the Rail Connection Area, the area owned or leased by PolyMet and the area impacted by PolyMet operations are included in the Plant Site areas above.

3.1.5 Ore Processing

The Processing Plant would consist of a Beneficiation Plant and Hydrometallurgical Plant that would process the ore to recover base metals, gold, and PGE metals. The processing steps that would be involved in each operation are described below. The Processing Plant would also include a Tailings Basin, Hydrometallurgical Residue Facility, and a rail car maintenance shop.

3.1.5.1 Beneficiation Plant

The purpose of the Beneficiation Plant would be to produce final bulk flotation concentrate (all metallic minerals) or two separate saleable concentrates (one of mostly nickel minerals and a second of mostly copper minerals) that could be shipped to customers, used as a feedstock to the hydrometallurgical process, or divided for both uses (PolyMet 2007, Supplemental DPD). The Beneficiation Plant processes would include ore crushing, grinding, and flotation; and concentrate regrinding, separation, dewatering, and shipping, which would occur in the existing Coarse Crusher Building, Fine Crusher Building, and Concentration Building, all of which remain from the LTVSMC operations.

Ore Crushing

During the ore crushing process (Figure 3.1-19), ore as large as 48 inches in diameter would be delivered by rail from the mine to the Coarse Crusher Dump Pocket where each car would be emptied into a primary crusher (gyratory) at an average feed rate of 1,667 tons/hour[3] (t/hr). From the primary crusher, ore would be discharged to the product surge bin, and then moved by gravity into four parallel secondary crushers (gyratory). A conveyor system would move the ore, 80% of which would now be smaller than 2.5 inches, to the coarse ore bin.

The coarse crushed ore would be fed into one of three operating fine crushing lines. Each line would consist of a tertiary crusher (cone), two quaternary screens, and two quaternary crushers (cone). The material would pass from the tertiary crushers through vibrating feeders and onto a

3 Average is calculated using the hours the Primary Crusher is actually running, as it would not run continuously.

double deck screen. The material that did not pass through the screen (oversize material) would discharge to the quaternary crusher, while material that passed through the screen (undersize material) would pass directly to a conveyor below the fine crushing area. This conveyor would collect all screened undersize material and quaternary crusher products that would then discharge to a second conveyor where the crushed ore would be transferred to the fine ore bin. At this stage of the process, approximately 80% of the ore in the fine ore bin would be smaller than 0.315 inch.

Ore Grinding

The ore grinding process (Figure 3.1-19), which occurs in the Concentrator Building, would reduce the ore particle size to the point at which 80% of the product is less than 120 microns (4.7 x 10^{-3} inches). During ore grinding, the fine ore bin would feed groups of twelve vibrating feeders - one group for each mill line. The feeders would discharge to a rod mill feed conveyor with a belt scale that would be used to adjust the vibrating feeders and regulate delivery of crushed fine ore to each rod mill. In the rod mills, the ore would pass through the mill once and the ground product would be delivered to the feed end of a matched ball mill. Once in the ball mills, the ore would re-circulate through the mill and the primary cyclones until the particle size was small enough to become overflow from the primary cyclones. Overflow from the primary cyclone would be suitable for flotation and would flow by gravity to a collection sump and be pumped to the flotation area, while the cyclone underflow (i.e., larger material) would be returned to the ball mill feed chute.

Metal alloy balls and rods used as grinding media would maintain a constant mill power draw. In addition, water would be added to each mill feed at a rate sufficient to maintain the mill discharge density at nominally 70-75% solids by weight.

Flotation

Once at 120 microns, the ore would be processed using flotation to recover the sulfide minerals and the base and precious metals. The flotation process would consist of two flotation roughing and scavenging lines that would share common cleaning stages, all completely contained within the Concentrator Building (Figure 3.1-20).

Each rougher/scavenger flotation line would consist of one rougher flotation and five scavenger flotation cells. Flotation of the liberated sulfide minerals would be achieved using a collector/frother combination. Each cell would be mechanically agitated to create a layer of bubbles or froth. The frother (methyl isobutyl carbinol and polyglycol ether, or MIBC/DF250), would provide strength to the bubbles formed in the flotation cells and the collector (potassium amyl xanthate, or PAX) would cause air bubbles to attach to the sulfide minerals.

The rougher flotation concentrate from both rougher flotation lines would be pumped to the cleaner circuit via a single cleaner 1 conditioning tank. Additional frother and collector would be added before the slurry flows by gravity to a bank of six cleaner 1 flotation cells. The rougher flotation tailings from both lines would go to a bank of five scavenger flotation cells through the scavenger conditioning tank. Collector and frother would be added, along with copper sulfate as a flotation activator. The activator would ensure that the particles that are difficult to float (i.e., contain minor amounts of sulfide) are recovered in the concentrate, which reduces the total sulfer content of the tailings. The concentrates from the first cell of each of the scavenger flotation lines would go to the cleaning circuit, while the remainder would be pumped to a common regrind milling circuit.

Two stages of concentrate cleaning would be provided. The first stage cleaner flotation would be conducted in six cleaner 1 flotation cells. The cleaner 1 flotation tailings would go to the regrind hopper, while the concentrate is pumped to four cleaner 2 flotation cells. The cleaner 2 flotation tailings would be recycled back to the cleaner 1 conditioning tank. The cleaner 2 concentrate would be pumped to a single concentrate thickener, where flocculant would be applied to promote particle settling. This material would feed the concentrate regrind area.

The regrind milling circuit, which would be designed to grind scavenger flotation concentrate and cleaner 1 flotation tailings to a size suitable for liberating partially locked sulfides, would consist of a regrind cyclone and regrind mill. The combined streams in the regrind hopper would be pumped to the regrind cyclone. Cyclone overflow (small particles) would be re-circulated to the rougher flotation cells, while underflow (larger particles) would return to the regrind mill feed chute.

The scavenger flotation tailings from each circuit, projected by PolyMet to be approximately 645 t/hr solids and have a solids density of 37%, would be pumped to the Flotation Tailings Basin where the solids would settle and be stored permanently. The clear water would be re-circulated to the mill process water system.

Concentrate Regrinding

The next process that would occur in the Beneficiation Plant is concentrate regrinding (Figure 3.1-21), which would occur completely within the Concentrator Building and only when producing feedstock for the Hydrometallurgical Plant. During this step, the thickened underflow from the concentrate thickener would go to a concentrate fine grinding isamill. The isamill is a grinding technology based on high intensity stirred milling, which would reduce the particle size from 120 microns to 15 microns, which is the size required to enhance the efficiency of the pressure oxidation process in the Hydrometallurgical Plant. The finely ground concentrate would then flow to the concentrate storage tank that provides surge capacity between the Beneficiation and Hydrometallurgical Plants.

Concentrate Separation and Dewatering – Concentrate Mode[4]

During this step, which occurs only in the concentrate mode, the bulk copper/nickel flotation concentrate would be delivered to a concentrate separation conditioning tank where the pH would be adjusted to approximately 12.5 by adding lime (Figure 3.1-21). The concentrate conditioning tank would feed a series of concentrate flotation cells. In the flotation cells, the

[4] Note that the Project would only operate in Concentrate Mode temporarily, such as during construction/commissioning and maintenance of the Hydrometallurgical Plant. A more extensive Concentrate Mode operation would not occur unless additional environmental review was completed.

high pH would cause the copper to remain highly floatable, forming the majority of the new concentrate. The high pH would also depress the floatability of nickel, which would cause the nickel to remain in the tailings slurry. Because copper and other associated minerals would be removed here, this tailings slurry would have higher nickel concentration and would now be considered a nickel concentrate.

The nickel and copper concentrates would each be delivered to identical but separate dewatering lines consisting of a concentrate thickener, concentrate filter, and concentrate dryer. Each thickener underflow, containing the thickened concentrate portion, would be transferred to a storage tank and to a filter where the filtered concentrate moistures would be reduced to approximately 8 to 10%. The filtered concentrate would then be conveyed into a dryer that would reduce the moistures to 1 to 2%. The dried concentrate would be delivered to an existing concentrate storage silo (former soda ash silo) for storage.

In the above process, each concentrate thickener overflow would be returned to the Beneficiation Plant process water tank and provisions would be made to neutralize the nickel return water if it is determined that the high pH water cannot be returned directly. The filtrate water would be returned to the corresponding concentrate thickener.

Concentrate Shipping – Concentrate Mode

While processing in the concentrate mode, the concentrate shipping area would be used to store dried copper and nickel concentrate and to load the concentrates into covered and/or sealed rail cars, which would be specifically built for this purpose. The concentrate shipping area would be within the heating plant and additive building and a car loading shed extension to that building. Additional railroad tracks on disturbed ground are also proposed as part of this area.

Dried concentrate would be transferred from the concentrate separation and dewatering area to one of two concentrate storage silos for loading into rail cars (Figure 3.1-21). Each of the two silos would have about 3.5 days of production capacity for its concentrate (copper or nickel) if all flotation concentrate is directed to the concentrate separation and dewatering area.

Depending on the customer's requirements, two methods would be considered for loading the dried concentrate into storage containers and unloading the concentrate from those containers into rail cars for shipping:

1) Shipping a very dry concentrate that would flow like ground dry cement. In this option, the concentrate would be conveyed pneumatically in a sealed tube to covered hoppers, such as those used to transport ground cement. These cars have a filling valve that would directly connect to the sealed pneumatic tube, and a vent valve that would be connected to a sealed tube, which would route the air exhausted from the sealed car back to the concentrate storage bin. This bin would have a vent, with a small baghouse attached, that vents to the atmosphere.

2) Shipping a less dry concentrate that would be produced by filtering a concentrate slurry and having the filter cake drop from the filter into an open, rail car. Once the car is

loaded, a rigid cover would be placed over the car for shipping. In this option, the concentrate would be stored as a slurry in a tank.

In both loading methods, car loading would be performed indoors on concrete floors and rail cars would be enclosed prior to movement outdoors.

Processing Parameters

Table 3.1-10 shows PolyMet's estimates for daily production rates, size reduction, and percent sulfur (%S) through the processing steps in the beneficiation process. Rates and sizes provided are the values PolyMet would use to design plant piping and equipment. The percent sulfur values were results from pilot plant testing completed by PolyMet on the beneficiation process technology.

Water needed for the milling and flotation circuits would primarily be return water from the Tailings Basin, which would include treated Mine Site process water. Any shortfall in water requirements would be made up by raw water from Colby Lake using an existing pump station and pipeline.

Table 3.1-10 Key Processing Parameters

	Input				Output			
Step	**Material**	**Rate (stpd)**	**Size (inches)**	**%S**	**Material**	**Rate (stpd)**	**Size (inches)**	**%S**
Ore Crushing	ore	32,000	48	0.88	Ore	32,000	0.315	0.88
Ore Grinding	ore	32,000	0.315	0.88	Ore	32,000	4.7×10^{-3}	0.88
Flotation	ore	32,000	4.7×10^{-3}	0.88	Concentrate	1,038	4.7×10^{-3}	20.60
					Tailings	30,962	4.7×10^{-3}	0.12
Concentrate Grinding	concentrate	1,038	4.7×10^{-3}	20.60	Concentrate	1,038	5.9×10^{-4}	20.60
Concentrate Separation and Dewatering	concentrate	0 to 1,038	4.7×10^{-3}	20.60	Dried nickel and copper concentrates	0 to 1,038	4.7×10^{-3}	20.60

Source: From PolyMet 2006 DPD, Table 3.3-A.
Note: Because %S values are based on the averages of four Pilot Plant tests, but rate and size are only theoretical design numbers, calculating a sulfur tonnage for input of flotation versus output of concentrate and tailings may not produce corresponding values.

Process Consumables

PolyMet anticipates the raw materials shown in Table 3.1-11 would be consumed by the Beneficiation Plant processes.

Table 3.1-11 Beneficiation Plant Consumables

Consumable	Quantity	Mode of Delivery	Delivery Condition	Storage Location	Containment

Consumable	Quantity	Mode of Delivery	Delivery Condition	Storage Location	Containment
Grinding Media (metal alloy grinding rods and balls)	15,600 t/yr	Rail (13 rail cars/ mo)	Bulk	Concentrator Building	None required
Flotation Collector (PAX)	1,075 t/yr	Truck (4-5 trucks/mo) [1]	Bulk bags	Concentrator Building	None required
Flotation Frother (MIBC and DF250)	1,124 t/yr[1]	Tank truck (4-5 trucks/mo) [1]	Bulk	Concentrator Building	Separate 13,200 gallon storage tanks
Flotation Activators (copper sulfate)	650 t/yr	Truck (2-3 trucks/mo) [1]	Bulk bags[1]	Concentrator Building	9,200 gallon Activator Storage Tank
Flocculant (MagnaFlox 10)	16.5 t/yr	Truck (1 truck/2 mo)	1,875 lb bulk bags	Concentrator Building	None required

1 Updated information per Scott 2009, Personal Communication

3.1.5.2 Hydrometallurgical Plant

Hydrometallurgical processing technology would be used for the treatment of concentrates. This process would involve high pressure and temperature autoclave leaching followed by solution purification processes to extract and isolate platinum group, precious metals, and base metals. All equipment proposed for use in the hydrometallurgical process would be located in one of three new buildings: the Hydrometallurgical Processing Facility, Copper (Cu) Solvent Extraction Building, or the Copper (Cu) Electrowinning Tank House (Figure 3.1-17a).

High Pressure Oxidation Autoclave

The hydrometallurgical process would begin with the combination of flotation concentrate, WWTF sludge, and a recycle stream from the leach residue thickener underflow in an autoclave feed tank (Figure 3.1-22). Hydrochloric acid would be added to maintain the proper chloride concentration in the solution to enable leaching of the gold and platinum group metals. This mixture would then be pumped to two autoclaves operating in parallel.

Each autoclave would be injected with liquid oxygen gas supplied by a 770 tpd cryogenic oxygen plant at a rate that is controlled to ensure complete oxidation of all sulfide sulfur in the autoclave feed. Partially neutralized copper solvent extraction (SX) raffinate[5] from the raffinate neutralization thickener overflow would be pumped to each of the autoclaves to control the leaching temperature.

In the autoclaves, the sulfide minerals in the flotation concentrate would be oxidized and dissolved in a solution containing copper sulfate, nickel sulfate, cobalt sulfate, zinc sulfate, ferric sulfate, and sulfuric acid. Gold and platinum group metals would dissolve as soluble chloride salts. The solid residue produced would contain iron oxide, jarosite, and any insoluble gangue (non-ore silicate and oxide minerals) from the flotation concentrate. Generation of acid from the oxidation of major sulfide minerals would result in leaching of the silicate, hydroxide, and carbonate minerals present in the flotation concentrate. To remove excess heat from the leached

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5 Raffinate is a solution that has been upgraded or refined by a process step.

slurry, a dedicated autoclave flash vessel would be used to reduce the slurry to atmospheric pressure and allow the release of steam.

Slurry discharging from the autoclave flash vessel would be further cooled using dedicated spiral heat exchangers. The majority of heat transferred here would be used to pre-heat the feed solution for the residual copper removal precipitation tank. The remainder of the heat transferred would be used to heat the mill process water. The cooled slurry would be pumped to the leach residue thickener where the solids would be settled with the aid of a flocculent. The underflow would be split with the majority being recycled to the autoclave feed tanks and the remainder to the leach residue filter. The leach residue filter would separate the leached autoclave residue solids from the process solution that contains the solubilized metals. Residual entrained metals would be recovered by washing the autoclave residue. The washed residue would be repulped, combined with other hydrometallurgical residues, and pumped to the Hydrometallurgical Residue Facility.

Gold and Platinum Group Metals Precipitation

To begin gold and platinum group metals precipitation (Figure 3.1-23), leach residue thickener overflow and leach residue filter wash water would go to the first of three gold and platinum group metals precipitation reactors where sulfur dioxide gas would be added to reduce ferric ions to ferrous ions.

Complete reduction of ferric ions would be achieved by the addition of copper sulfide (CuS) recycled from the residual copper removal thickener underflow. Recycled CuS would also be used to recover precious metals; specifically platinum, palladium, and gold from the autoclave leach solution. Produced here would be a mixed gold and platinum group metals sulfide precipitate with a relatively large proportion of CuS (an important substrate for gold and platinum group metals reduction) and elemental sulfur. The discharge from the gold and platinum group metals precipitation reactors is pumped directly to the gold and platinum group metals thickener where CuS enriched with gold and platinum group metals settles with the aid of a flocculant and produces thickened slurry suitable for filtration. The resultant filter cake would contain platinum, palladium, gold, CuS and sulfur.

The thickener underflow would be pumped to the gold and platinum group metals filter feed tank. This feed tank would provide additional storage capacity between the gold and platinum group metals filter and thickener. The filter would separate the gold and platinum group metals precipitate solids from the process stream. Residual metals still being carried along in the process stream would be recovered by washing the gold and platinum group metals precipitate with demineralized water and recycling the wash water to the thickener. The filter would produce a concentrate cake that would be bagged for sale to a third party refinery.

The thickener overflow would be pumped to a candlestick filter to ensure all residual solids containing the remaining gold and platinum group metals are recovered. The resultant clear solution would go to the solution neutralization area while the captured solids would be returned to the thickener.

Solution Neutralization

During solution neutralization (Figure 3.1-23), the copper-rich solution from the gold and platinum group metals precipitation circuit would be pumped to a plate heat exchanger to cool the solution and heat the process water. Once cooled, the solution would be discharged into the first of four agitated solution neutralization tanks. Limestone slurry and recycled gypsum slurry from the solution neutralization thickener underflow would be added to the first tank and stage added to the remaining neutralization tanks. Slurry from the last neutralization tank would flow to the solution neutralization thickener to produce a thickened underflow, 75% of which would be recycled to the first solution neutralization tank, and the remainder of which would be pumped to the gypsum filter to produce a separate gypsum residue. A final gypsum filter cake would be washed with acidified wash water, re-pulped, combined with other hydrometallurgical residues and pumped to the hydrometallurgical residue facility. The solution neutralization thickener overflow would go to the copper solvent extraction circuit.

Copper Solvent Extraction (Copper SX)

During this phase (Figure 3.1-24), the feed solution from the solution neutralization circuit would be pumped to a pinned bed clarifier, which would use coagulant and flocculent to remove ultra-fine solids that would be returned to the solution neutralization thickener. The clarified solution would be pumped to the copper SX feed tank.

From the copper SX feed tank, solution would be pumped to the copper extraction stages. Each stage would include two mixer tanks where a specialized organic based extractant (a liquid used to remove material from a solution) and the aqueous (water-based) solution containing copper would be mixed. During mixing, copper would be extracted into the organic extractant and removed from the aqueous solution.

The aqueous/organic mixture would flow from the final mixer tank into a reverse flow settler. Here, the two phases would separate and be collected in separate launders. Next, the aqueous and organic streams would be sent to flow countercurrent through the SX circuit. The aqueous solution would enter the first extractions stage and flow sequentially through to the second and third stages. Raffinate leaving the third stage would pass through a residual organic filter and would then be pumped to the copper raffinate tanks.

Flowing in the reverse of the aqueous solution, the organic extractant would be continuously extracting copper until the fully loaded organic would exit the extraction stages. The organic would flow to a coalescer wash stage where the water-based parts of the solutions would be reduced, then would be pumped to the stripping stages. By mixing the copper loaded organic stream with acidic spent electrolyte from the electrowinning plant, the copper loading process would be reversed so that copper would be transferred from the organic to the electrolyte. The unloaded organic would be recycled back to the extraction circuit to mix with copper bearing aqueous feed solution and the cycle would begin again.

Copper rich electrolyte would be discharged from the last stripping stage to the electrolyte filter feed tank and then pumped to a coalescing dual media anthracite/garnet filter. The filter would trap organic droplets and any solids remaining in the electrolyte. Periodically, the filter would be drained and backwashed with water. The backwash solution would be held in a storage tank and bled at a controlled rate to the copper raffinate tank. New organic would be manually added to the circuit to maintain the organic inventory. From the electrolyte filter, clean electrolyte would be discharged into the advance electrolyte tank.

Crud, or the accumulation of solids (dust particles or precipitates) at the organic/aqueous interface in the settlers, is known to inhibit the copper extraction process and contribute to organic loss. Therefore, crud would be routinely removed from the settlers by decanting and draining using a portable air operated crud pump. Crud would be pumped to a crud/spillage holding tank where it would accumulate and then be treated on a batch basis to recover entrained organic. The remaining crud, estimated to be approximately 45 to 65 tpy, would be disposed of in the Hydrometallurgical Residue Facility.

Copper Electrowinning

During this process, copper rich electrolyte would be pumped from the advanced electrolyte tank to the electrolyte recirculating tank. In this tank, electrolyte would be mixed with spent electrolyte recycled from the electrowinning (EW) circuit, demineralized water make-up, spillage (if free of solids), plating agents such as guar gum, and cobalt sulfate (added to maintain a required cobalt concentration in the electrolyte).

Over a period of approximately seven days, metallic copper would be electroplated onto stainless steel cathode blanks. Upon the desired thickness of copper being plated, an overhead traveling gantry crane would remove the cathodes. The cathodes would be water washed to remove the copper-bearing electrolyte and immediately stripped in an automatic stripping machine. Stripped cathodes would be bundled, sampled and weighed in the stripping machine and then removed by forklift to a lay down area prior to shipping.

The majority of the spent electrolyte would be recirculated to the electrowinning cells via the electrolyte recirculation tank with sufficient spent electrolyte being recycled to the SX stripping stage to balance the copper bearing electrolyte flow entering the EW circuit. A small amount of electrolyte would be bled out of the EW circuit to prevent impurity build-up in the electrolytic circuit. The bleed solution would be pumped back to the extraction stages.

Raffinate Neutralization

After the SX/EW process has recovered the copper, the raffinate would be neutralized in four raffinate neutralization tanks (Figure 3.1-24). Limestone would be used to further reduce the acidity produced during the copper extraction process and to precipitate iron and aluminum from solution. The raffinate neutralization circuit would use similar equipment and processes to those in the solution neutralization circuit.

The copper SX raffinate would be pumped to the first of four agitated raffinate neutralization tanks. Limestone slurry would be added to the first tank along with recycled gypsum slurry from the underflow of the raffinate neutralization thickener and stage added to the subsequent precipitation tanks. The neutralized slurry would flow to the thickener, producing a thickened underflow that is predominantly gypsum, iron hydroxide, and aluminum hydroxide.

Approximately 75% of this underflow would be recycled to the first raffinate neutralization tank and the remainder would be pumped to the raffinate neutralization filter.

The filter cake from the filters would be washed with acidified wash water, repulped, combined with other hydrometallurgical residues and pumped to the Hydrometallurgical Residue Facility. Most of the thickener overflow would go to the residual copper removal circuit while some would be returned to the autoclaves as quench water.

Residual Copper Recovery

To begin the residual copper recovery circuit (Figure 3.1-25), solution from the raffinate neutralization thickener overflow tank would be heated to 149°F by indirect contact with autoclave discharge slurry in the autoclave residue heat exchangers. The heated solution would be discharged to the first of two residual copper removal precipitation tanks where sodium hydrosulfide (NaHS) and nitrogen are introduced. Nitrogen gas would keep oxygen from entering the precipitation tanks so that the precipitation of copper sulfide would be maximized and sulfate generation reduced.

Slurry from the final residual copper removal precipitation tank would flow to the residual copper removal thickener. A minimum of 75% of the underflow would be recycled to the first residual copper removal precipitation tank while the remaining 25% would be pumped to the gold and platinum group metals precipitation reactors. Any excess underflow would be returned to the autoclave feed tank for re-processing. The residual copper removal thickener overflow, containing less than 1 part per million (ppm) copper, would go to the mixed hydroxide precipitation circuit.

Mixed Hydroxide Precipitation

During the mixed hydroxide precipitation circuit (Figure 3.1-26), copper-free solution from the residual copper removal thickener overflow tank would be reacted with magnesium hydroxide in a two-stage process with the majority of the nickel, zinc, and cobalt being precipitated in the first stage. The pH would be controlled to limit manganese co-precipitation so that a clean (i.e., low-manganese) precipitate is produced. The resulting discharge from 1st stage mixed nickel/cobalt/zinc (Ni/Co/Zn) hydroxide precipitation tanks would flow to the 1st stage thickener. The underflow containing the precipitated metals would be pumped to a filter feed tank. The slurry from the filter feed tank would be pumped at a controlled rate into the hydroxide filter to produce a filter cake. The filter cake would be washed with raw water to remove entrained process solution. The final mixed hydroxide product would have an approximate composition of 97% nickel, cobalt and zinc hydroxides with the remainder as magnesium hydroxide. The high quality mixed hydroxide filter cake would be packaged for shipment to a third party refiner.

The 1st stage thickener overflow would be pumped to the first of two 2nd stage precipitation tanks. Lime would be added to these tanks to raise the pH, ensuring precipitation of all remaining nickel and cobalt. Slurry from the 2nd stage precipitation tanks would flow to the 2nd stage thickener. Flocculant would be added to settle the hydroxide precipitates. The underflow product would be recycled to the autoclave residue tank where the higher acidity would ensure that the metals contained in the precipitate were redissolved. The 2nd stage thickener overflow would then be pumped to the magnesium removal circuit.

Magnesium Removal

During the magnesium removal phase, solution from the mixed hydroxide precipitation circuit would be pumped to the first of the magnesium removal tanks. Lime slurry would be added to each tank to facilitate magnesium precipitation. The resulting slurry would be pumped to the Hydrometallurgical Residue Facility along with other residues as described in Section 3.1.5.3 Hydrometallurgical residue management, where the solids would settle to be stored permanently while the clear water would be reclaimed continuously to the Hydrometallurgical Plant process water system. This would result in approximately 50% of the remaining magnesium being precipitated to produce recycled process water containing minimal metal concentrations.

Process Consumables

The raw materials described below as well as those summarized in Table 3.1-12 would be consumed by the Hydrometallurgical Plant processes. Table 3.1-12 provides additional information regarding processing reagents deliveries, capacity, and nominal use at the site. Locomotive fueling and routine inspection facilities used by LTVSMC would be reactivated, while locomotives needing major repair would be sent off-site. The ore cars would be maintained at the General Shop facility used by LTVSMC.

Table 3.1-12 Materials Consumed by the Hydrometallurgical Plant Processes

Consumable	Quantity[1]	Mode of Delivery	Delivery Condition	Storage Location	Containment
Sulfuric acid	2,998 tpy	Rail (3 tank cars/ mo)	Bulk	Adjacent to General Shop Building	78,700 gallon storage tank with secondary containment
Hydrochloric acid	6,173 tpy	Rail (6 tank cars/mo)	Bulk	Adjacent to General Shop Building	59,500 gallon storage tank with secondary containment
SX Extractant	24 tpy	Freight (1 delivery/mo)	265 gallon tanks	General Shop Building	265 gallon tanks
SX Diluent	130 tpy	Freight (1 delivery/2 mo)	Bulk	General Shop Building	7,400 gallon storage tank
Cobalt Sulfate	35 tpy	Freight (1 delivery/mo)	67 lb bags in powder form	General Shop Building	In bags and batch mixed when needed
Guar Gum (Galactosol)	9 tpy	Freight (1 delivery/mo)	70 lb bags in powder form	General Shop Building	Batch mixed on a daily basis (0.5% solution w/w)
Liquid Sulfur Dioxide	2,866 tpy	Rail (3 tank cars/mo)	Bulk	Adjacent to General Shop Building	30,000 gallon pressurized storage tank with secondary containment
Sodium Hydrosulfide	847 tpy	Tanker Truck (3-4 tankers/mo)	Bulk as a 45% solution with water (w/w)	Adjacent to General Shop Building	52,600 gallon storage tank
Limestone	250,000 tpy	Rail (2 100-car trains/week from April to October)	Bulk	Stockpiled on site	Berms/ditches around outdoor stockpile with water that has contacted limestone collected and added to the plant process water.
Lime	58,100 tpy	Freight (150 loads/mo)	Bulk	Adjacent to General Shop Building	Lime Silo
Magnesium	17,500 tpy	Rail	60% w/w	Adjacent to General	Magnesium Hydroxide

Consumable	Quantity[1]	Mode of Delivery	Delivery Condition	Storage Location	Containment
Hydroxide		(11 tank cars/mo)	magnesium hydroxide slurry	Shop Building	Storage Tank
Caustic (NaOH)	66 tpy	Tanker Truck (1 load/mo)	50% w/w solution	General Shop Building	1,100 gallon storage tank
Flocculant (MagnaFloc 342)	26 tpy	Freight	1,875 lb bulk bags of powder	Main Warehouse	In bags and batch mixed regularly as 0.5% w/w solution
Flocculant (MagnaFloc 351)	180 tpy	Freight	1,875 lb bulk bags of powder	Main Warehouse	In bags and batch mixed regularly as 0.5% w/w solution
Nitrogen (used in Hydrometallurgical Plant)[2]	17,673 tpy	NA	NA	NA	NA

1 Since the July 2007 PD, PolyMet updated some of these quantities in comments they provided on the PDEIS (Scott 2009, Personal Communication)

2 Nitrogen used in the Hydrometallurgical Plant is produced as a byproduct in the Oxygen Plant and no shipping or storage is required (Scott 2009, Personal Communication)

Hydrometallurgical Process Water

A separate Hydrometallurgical Plant process water system would be required due to the different nature of the process solutions involved in the hydrometallurgical and beneficiation processes. Hydrometallurgical process water would contain significant levels of chloride relative to the water in the milling and flotation circuits. The system would distribute water to various water addition points throughout the Hydrometallurgical Plant and would receive water from the Hydrometallurgical Residue Facility (water that was used to transport hydrometallurgical residue to the facility). Make-up water would come from flotation concentrate water and raw water.

Required Process Services

The Plant Site would require various services to perform its functions. These services are in addition to plant switching and site infrastructure needs that are described in Sections 3.1.5.3 and 3.1.5.4, respectively. These services are summarized in Table 3.1-13.

Table 3.1-13 Plant Site Services

Service	Source	Source Location	Needed for
Compressed Air	Duty/standby arrangement of rotary screw type compressors	General Shop Building	Provide air at a pressure of 100 psig for plant services
Instrument Air	Air withdrawn from the plant air receiver to an instrument air accumulator and dried in a duty/standby arrangement of driers and air filters	General Shop Building	Provide air for instruments
Steam	Natural gas-fired boiler	Hydrometallurgical Facility	Generates heat needed for start up of the autoclaves
Diesel Fuel Storage	Existing Locomotive Fuel Oil facility (storage is discussed in more detail in Section 3.1.2.8)	Area 2 Shop	Diesel for locomotives
Gasoline Storage	Existing storage facility – two 6,000 gallon tanks	Main Gate	Gasoline for vehicles
Raw Water	Water from Colby Lake via an existing pumping station and pipeline (see Section 4.1)	Stored in the Plant Reservoir	Plant fire protections systems, plant potable water systems, make up water for grinding and flotation process water, and

Service	Source	Source Location	Needed for
			hydrometallurgical plant process water (see Sections 3.1.7.1.8 and 3.1.7.2.10)
Potable Water	Existing Process Plant potable water treatment plant would be refurbished and reactivated	Near the Plant Reservoir	Potable water distribution system includes the Area 1 and Area 2 Shops
Fire Protection	Existing fire protection system would be refurbished, reactivated and extended to new buildings	Plant Reservoir	Area 1 and Area 2 Shops have independent fire protection systems
Oxygen	770 tpd Oxygen Plant. Plant process takes in ambient air, compresses it, and separates the oxygen from nitrogen and other trace atmospheric gases. Oxygen is transported via pipeline to plant processes and nitrogen and trace gases are returned to the atmosphere.	Adjacent to Concentrator (Figure 3.1-17a)	Plant processes

3.1.5.3 Management of Process Waste Products

Flotation Tailings

During the DEIS process, the design of the Tailings Basin evolved, primarily in response to geotechnical and water quality concerns with the initial design as was first proposed in the June 2005 Scoping EAW. To correct geotechnical issues with the original proposed design, PolyMet proposed a Tailings Basin – Mitigation Design (RS13B, Barr 2008; Barr 2008, Preliminary Geotechnical Evaluation; Barr 2009, FTMP Draft 02). This design is described below. As of June 2009, the Proposed Action – Mitigation Design (referred to as Geotechnical Mitigation in Jim Scott June 16, 2009 email, “PolyMet Proposed Action and Alternative”) became the Proposed Action and will be referenced as such throughout the DEIS.

Under the Proposed Action, flotation tailings would be placed in Cells 1E and 2E of the former LTVSMC tailings basin (Figure 3.1-27). The existing former LTVSMC tailings basin is unlined and was constructed in stages beginning in the 1950’s. It was configured as a combination of three adjacent cells, identified as Cell 1E, Cell 2E, and Cell 2W and was developed by constructing perimeter embankments (starter dams) and placing tailings from the iron-ore process directly on native material. Perimeter embankments were initially constructed from coarse tailings or rock using upstream construction methods. The LTVSMC tailings basin operations were shut down in January 2001 and have been inactive since then except for Closure and reclamation activities consistent with a MnDNR approved Closure plan (Barr 2009, FTMP Draft 02).

The Tailings Basin dams (Figure 3.1-28) would be constructed using LTVSMC bulk tailings that consist primarily of coarse tailings with limited amounts of LTVSMC fines and slimes mixed in. The LTVSMC bulk tailings would be removed from the existing LTVSMC dams to the north and east of Cell 2W, from the southeast dam of Cell 1E and from the south dam of Cell 2E. The LTVSMC tailings would then be mechanically placed and compacted to specification The

Proposed Action also includes a mid-slope setback and construction of buttresses which would be constructed from LTVSMC Area 5 material

The tailings would also be deposited in slurry form through a system of pumps and moveable pipelines. However, tailings would go into Cell 2E for the first seven years of operation, then into both Cells 1E and 2E, thereafter. Tailings would be deposited to allow operations within the basin to be by gravity flow over discharge beaches when necessary and subaqueous via diffusers throughout the pond. The small and fairly uniform grind size of the tailings would allow for a fairly consistent particle size distribution to be achieved, minimizing segregation of coarse and fine portions. When a discharge point is moved to a different location, the dam would be raised using the LTVSMC bulk tailings. Tailings beaches would exist along the northern and northeastern dams of Cell 2E and the southern and eastern dams of Cell 1E.

The tailings would settle out of the slurry in the cells and the decanted water would be allowed to pond and be collected using a barge pump back system. The barge system would consist of a primary pump barge in Cell 1E, an auxiliary pump barge in Cell 2E, piping from the primary pump barge to the Beneficiations Plant, and piping from the auxiliary pump barge to Cell 1E. The auxiliary pump barge would not be needed once the cells combine to form one cell after the first seven years of operations. The return water pipelines would be moved as dams are raised to keep the pipeline at or near the top of the dam. The return water pipes would be fitted with a relief drain valve to allow for water to be drained back to ponds in case of shutdown during winter operations to avoid damage to the pipes from freezing or suction. Pumps would also be fitted with deicing mechanisms to avoid freezing.

Hydrometallurgical Residue Management

The hydrometallurgical process would generate residues from five sources:

- Autoclave residue from the leach residue filter;
- High purity gypsum from the gypsum filter (depending on the market, this may become a saleable product, but is currently planned to be managed as a waste);
- Gypsum, iron and aluminum hydroxide from the raffinate neutralization filter;
- Magnesium hydroxide precipitate from the magnesium removal tank; and
- Crud and other minor plant spillage sources.

In addition to the above listed sources, solid wastes from the WWTF would be recycled directly into the Hydrometallurgical Plant to recover metals. The WWTF solids would be similar to the Hydrometallurgical Residue Facility materials, consisting primarily of gypsum, metal hydroxides, and calcite (CP02, Barr 2008, Wastewater Treatment – Response to Comments in RS52). The projected hydrometallurgical residue generation rate would be 794,000 tons annually. This includes 261,000 tons of gypsum filter cake (gypsum), which would be produced annually in the solution neutralization circuit.

These hydrometallurgical residues, along with the solid wastes from the WWTF, would be combined and disposed of in the Hydrometallurgical Residue Facility as described below.

Hydrometallurgical Residue Cell Design and Operations

The Hydrometallurgical Residue Facility would consist of four cells located within the southern and central portions of Cell 2W of the former LTVSMC tailings basin (Figure 3.1-29). Cells would be irregular in shape and vary slightly in capacity. Final capacities of each cell would be determined as part of the SDS permit application (RS 28T Memo 01, Barr 2008).

The first hydrometallurgical residue cell would be developed over a two year period. Most of the earthwork and placing the liner in the cell would occur in the first year of construction. The remaining earthwork and completion of the liner installation would occur in the second year of construction. Subsequent cells would be developed in a similar fashion. Cell layout and cross-sections are shown in Figures 3.1-29 through 3.1-32. Hydrometallurgical residue cells would be lined to minimize release of water that has contacted the residue. The liner would consist of a composite liner system utilizing a geomembrane liner above a geosynthetic clay liner. It is the position of the tribal cooperators that this section should describe expected leakage rates during operations as well as the long-term effectiveness of the liner system. Given that the applicant has not proposed any long-term maintenance of this system, these parameters should be described in this section and taken into account in sections of the EIS that predict long term surface and ground water quality.

Each cell would be filled by pumping the hydrometallurgical residue as slurry from the Hydrometallurgical Plant. A pond would be maintained within the operating cell so that the solids in the slurry would settle out within the cell, while the majority of the liquid would be recovered by a pump system and returned to the plant for reuse. The solid and liquid levels in the cell would increase incrementally over time. The residue discharge point into the cell would be relocated as needed to distribute the residue throughout the cell. The current Cell 1 residue discharge piping and water return piping layout is shown in Figure 3.1-33.

The initial hydrometallurgical residue cell is planned to have sufficient capacity for approximately five years of service. Construction of subsequent cells is anticipated on a 5-year cycle through the operating life of the facility. Once a cell becomes full, it would be dewatered by an initial decanting of ponded water and then drainage from the residue would be collected using a geocomposite drainage net and system of sidewall riser and pump systems as shown in Figure 3.1-34.

Hydrometallurgical Residue Cell Closure

Cell Closure would begin once a cell's capacity was fully utilized, and the cell has been drained and has become trafficable. During each cell's Closure activities, PolyMet flotation tailings or LTVSMC coarse tailings would be placed immediately above the hydrometallurgical residue with geotextile reinforcing placed in-between the residue and tailings if a working surface for the geomembrane barrier layer is needed. A 40-mil low density polyethylene (LDPE) or similar agency-approved geomembrane barrier layer would be placed, then an additional LTVSMC coarse tailings layer would be placed to create the covered surface on which vegetation could be sustained (Figure 3.1-35; CP04, Barr 2008, Proposed Hydrometallurgical Residue Cell Closure Approach).

It is the position of the tribal cooperators that this section should describe expected leakage rates during operations as well as the long-term effectiveness of the cover system. Given that the applicant has not proposed any long-term maintenance of this system, these parameters should be described in this section and taken into account in sections of the EIS that predict long-term surface and ground water quality.

3.1.5.4 Plant Site Water Management

Water would be consumed at the Plant Site in both the Beneficiation Plant and the Hydrometallurgical Plant. For the most part, water operations within these two plants would operate independently. The only exception would be the exchange of the concentrate from the Beneficiation Plant to the Hydrometallurgical Plant.

Hydrometallurgical Plant

All water that enters the Hydrometallurgical Plant would be consumed within the hydrometallurgical process, exiting as steam or becoming entrained within the solid waste residues or products generated through the hydrometallurgical process. The average annual water demand rate for the Hydrometallurgical Plant would be 370 gpm, but varying from 0 to 660 gpm monthly as operating and climatological variations occur (RS 29T, Barr 2007). At the same time, hydrometallurgical process residues would be disposed in the Hydrometallurgical Residue Facility, where the solids would settle out and the water would pond on the cells. During operations, the ponded water would be pumped out of the Hydrometallurgical Residue Facility then returned to the Hydrometallurgical Plant by gravity flow.

In addition, water that is contained in process fluids, should spillage of these fluids occur, would remain within the Hydrometallurgical Plant buildings and be returned to the appropriate process streams.

Beneficiation Plant

Within the Beneficiation Plant, water would be used to carry the ore through the grinding and separation steps, then to transport the tailings to the Tailings Basin. To the extent possible, water that would be used to transport tailings to the basin would be returned to the Beneficiation Plant, however some losses would occur through evaporation, storage within the pores of the deposited tailings, or seepage to groundwater under the Tailings Basin.

In addition, water that is contained in process fluids, should spillage of these fluids occur, would remain within the Beneficiation Plant buildings and be returned to the appropriate process streams.

Tailings Basin

The Tailings Basin would be the final collection and equalization basin for process water that flows through the Beneficiation Plant. Direct precipitation and run-off from the process areas at the Plant Site would also be directed to the Tailings Basin.

Under the Proposed Action, water that seeps from the toe around the perimeter of the Tailings Basin would be collected through a series of header pipes, seepage recovery trenches, and vertical extraction wells connected to pipes that would discharge to sump and pump systems and from there be returned to the Tailings Basin. For the existing seepage that discharges into Knox Creek from the south end of Cell 1E, a cutoff berm and trench, coupled with a seep collection sump, and pump and pipe system would be used to route the seepage back into Cell 1E (Barr 2009, FTMP Draft-02). This seepage recovery system would be placed approximately 200 to 250 feet downstream of the seepage face. While this seepage recovery system would collect seepage from the toe of the perimeter of the Tailings Basin, some seepage would also occur downward, through the NorthMet tailings, through the underlying LTVSMC tailings, and into the groundwater. The details of this seepage are described in greater detail in Section 4.1.

Should additional Plant Site make-up water be needed, treated water piped from the Mine Site, via the Tailings Basin, could be piped to the Plant Site. Process water needs above and beyond that would be pumped from Colby Lake.

These water management methods would result in no surface discharge of process water at the Plant Site or Mine Site and would minimize water needed via water appropriation from Colby Lake.

3.1.6 Transport of Products

A 1,500 to 2,000 hp GenSet locomotive, similar to the locomotives that would be hauling ore from the Mine Site to the Plant Site, would transfer loaded and empty cars carrying process consumables and concentrates to and from the interchange location with the Canadian National Railroad and the Plant Site. Cars carrying process consumables and concentrate would meet rail common carrier requirements.

3.1.7 Project Closure

The Project is expected to complete mining approximately 20 years after operations begin. PolyMet has developed a conceptual Closure Plan that would be updated as part of its application for the Permit to Mine (RS52, Barr 2007). It is the position of the tribal cooperating agencies that the existing Closure Plan is insufficient to allow an adequate assessment of post-closure impacts. The Proposed Action has changed significantly since the development of the Closure Plan, and additional detail is needed to appropriately inform post closure impacts, since those impacts depend on the specific plans and methods used to close the mine. For example, the conclusions of the West Pit Lake Uncertainty Analysis indicate that "some of the waste rock stockpiles have the potential to leach solutes to groundwater for long periods (i.e., at least 2000 years)." Water quality of the leachate would "exceed USEPA primary MCL's and MDH Health Risk Limits." In order to adequately assess the environmental impacts of the Proposed Action, additional detail on the specific environmental impacts of this leachate and information about the remediation activities that would be needed to avoid damage to surrounding waters should be included in the Closure Plan.

The Closure Plan would be finalized to provide details for the final Closure of the actual as-built facilities during Project operations. In addition, PolyMet would also submit an annual contingency reclamation plan, per *Minnesota Rules,* part 6132.1300 subpart 4 to identify activities that would be implemented if operations cease in that upcoming year.

In general, Project facilities have been designed and would be operated to allow for progressive reclamation, or "mining in a manner that creates areas that can be reclaimed soon after initiation of the operation as practical and as continuously as practical throughout the life of operation" (*Minnesota Rules*, part 6132.0100). This would leave a smaller portion of the Project area needing to be reclaimed at Closure. The primary Project features that lend themselves best to this are the stockpile and pit areas at the Mine Site and the Hydrometallurgical Residue Facility cells at the Plant Site.

Closure activities at the Mine Site are shown in Figure 3.1-37, with features that would remain at the Mine Site during the Closure and Post-Closure period shown in Figure 3.1-38. Closure activities at the Plant Site are shown in Figure 3.1-39.

3.1.7.1 Building and Structure Demolition and Equipment Removal

Within three years after Closure begins, all buildings and structures would be removed and foundations razed and covered with a minimum of two feet of soil and vegetated according to the applicable *Minnesota Rules,* part 6132.2700 and chapter 3200. Demolition waste from structure removal would be disposed in the existing on-site demolition landfill (SW-619) located northwest of the Area 1 Shops. Concrete from demolition would be placed in the basements of the coarse crusher, fine crusher, and concentrator.

Most roads, parking areas, or storage pads built to access these facilities would be demolished during the three year schedule. Utility tunnels would be sealed and closed in place. Asphalt from paved surfaces would be removed and recycled and the disturbed areas reclaimed and vegetated according to *Minnesota Rules*, part 6132.2700. Railroad track and ties that were not used by common carriers would be removed and recycled. Any roads, which include mine pit access roads (*Minnesota Rules*, part 6132.3200) that may develop into unofficial off-road vehicle trails, would require a variance from MnDNR reclamation rules to allow a 15-foot-wide unpaved, unvegetated track down the centerline of the road. Such approvals would also be coordinated with the St. Louis County Mine Inspector's Office.

All mine, railroad, service, and electrical equipment would be moved from the pit to ensure they are above pit water elevations until they can be scrapped, decommissioned, or sold. Removal of the debris and equipment would be removed from the Mine and Plant Sites within one year unless the equipment would be used for reclamation or approval is received from the MnDNR commissioner.

Rail Transfer Hopper Demolition and Reclamation

At Closure, it is possible that the Rail Transfer Hopper would contain ore residuals, which would have acid and metal leaching potential. Therefore, PolyMet developed a specific plan for handling the demolition and reclamation of this structure (RS 52, Barr 2007). Above-ground concrete and steel structures would be razed within three years after Closure begins and the area covered with at least two feet of soil and vegetated according to *Minnesota Rules*, part 6132.2700 and chapter 3200. If constructed with Category 1 and 2 waste rock, the rock platform from which trucks dumped into the hopper would be sloped and covered in the same manner as the Category 1 and 2 waste rock stockpile. If constructed of inert material, the platform would be sloped and vegetated according to *Minnesota Rules*, part 6132.2700 and chapter 3200 (RS 52, Barr 2007).

Any ore remaining in the hopper, the direct ore loadout area, the Lean Ore Surge Pile, or anywhere else in the vicinity of the Rail Transfer Hopper as well as sediment removed from ditches and process water ponds in the Ore Handling Area, would be placed in the Category 4 waste rock stockpile. Any remaining material located at the top of the rail loading platform would be tested and placed in an appropriate waste disposal location (e.g., the Category 3 or 4 waste rock stockpile, returned to the mine pits, or covered with at least two feet of soil and vegetated according to *Minnesota Rules*, part 6132.2700 and chapter 3200).

Special Material Disposal

Special materials on-site at the time of Closure would be disposed of as follows:

- Asbestos-Containing Materials (ACMs) – detailed survey of ACMs (e.g., pipe and electrical insulation in existing LTVSMC utility tunnels, siding, hot water heating system insulation, lube system insulation, floor tile) would be conducted prior to demolition. Appropriate controls would be put in place or ACMs would be removed intact, properly packaged, and disposed in the on-site demolition landfill. ACM locations in the landfill would be noted on the property deed. Any ACMs found in utility tunnels would be sealed before the utility tunnel is sealed.

- *Nuclear sources* (i.e., nuclear density gages used to measure slurry density during processing) – these sources would be removed and properly disposed.

- *Partially used paint, chemical, and petroleum products* – these materials would be collected and properly disposed.

Product and Product Tank Disposal

The reagent suppliers, which would be under contract to PolyMet, would remove any reagents remaining at Closure. In many cases, the suppliers of chemicals and equipment would be responsible for furnishing tanks and would therefore be required to remove and dispose of those tanks during Closure. Those tanks for which PolyMet would be responsible would be demolished as follows:

- Clean tanks to remove remaining materials and sludge;
- Send remaining materials and sludges and wash materials to an appropriate recycling or waste disposal facility;
- Test large above-ground storage tanks for lead paint prior to demolition and, where found, disposal/recycling would be modified to accommodate the lead content;
- Disassemble all tanks for disposal or recycling, as appropriate;
- Leave below-grade foundations in place and buried; and
- Clean smaller ASTs tanks and remove without disassembly.

Other Closure Details

There are several places where concentrate having up to 20% S could accumulate (e.g., dry concentrate storage bins, froth launders/sumps, concentrate thickeners, concentrate filters). Because this would be a high value material, there would be an effort to ship as much as can be recovered. However, material remaining in the equipment and process piping would be properly disposed in the hydrometallurgical residue cells or other MnDNR/MPCA-approved locations.

PolyMet would also close on-site sewer and water systems, powerlines, pipelines (including hydrometallurgical residue pipelines), and culverts according to proper regulatory requirements.

3.1.7.2 Reclamation of Mine Site

Mine Pit - Removal of Dewatering System

Prior to Closure, the East/Central Pit would be backfilled with Category 1 and 2 waste rock. The primary dewatering systems, including power lines, substations, pumps, hoses, pipes and appurtenances, would be removed from both pits and the pits would be allowed to fill with water. All areas disturbed during pipe removal would be graded and revegetated. Some temporary pumps may remain in the pits for selected dewatering that would be performed during pit flooding.

In addition, the following piping would remain:

- The water pipe between the WWTF and the East Pit could be used during Closure to convey treated water to the East Pit if insufficient water was otherwise available to maintain water levels;
- The water pipe from the West Pit to the WWTF could be used in Closure to convey treated water from the WWTF to the West Pit if insufficient water was otherwise available to maintain water levels; and

- The pipes used for stockpile drainage collection and conveyance to the WWTF would remain until water quality discharge limits at compliance locations would be met.

Mine Pit – East and West Pit Overflows and Outlet Control Structures

The East and West pits are expected to fill and have a net outflow of surface water. Outlet structures would establish the steady-state water levels in the East/Central and West pits after Closure. Overflows from the East/Central Pit would flow to the West Pit through a new ditch (Figure 3.1-40). The East/Central Pit outlet structure would be formed out of bedrock or a reinforced concrete weir that is cast-in-place.

The West Pit outlet structure would be constructed on the southeastern side of the West Pit near the natural overflow. The structure would be formed out of bedrock or a reinforced concrete weir that is cast-in-place. The West Pit outlet structure would direct overflows into an existing wetland (Figure 3.1-40) that flows toward Dunka Road at Outlet Structure OS-5 and eventually into the Partridge River through an existing channel.

West Pit Filling

Upon completion of mining operations and removal of pit dewatering systems as described above, the West Pit would begin to fill naturally with groundwater, precipitation, and surface runoff from the tributary watershed. This is projected to result in filling the West Pit around Year 65 and subsequent overflow to the Partridge River (RS 74A, Barr 2008). It is the position of the tribal cooperating agencies that this section should acknowledge that the pit lake will remain at the site in perpetuity and will exceed water quality standards, and should discuss its status as a “water of the state.”

Mine Pit – Mine Wall Sloping and Revegetation

In accordance with *Minnesota Rules*, part 6132.2300, the toe of the overburden portion of all pit walls should be set back at least 20 feet from the crest of the rock portion of the pit wall. Lift heights would be no higher than 60 feet and would be selected based on the need to protect public safety, the location of the pitwall in relation to the surrounding land uses, the soil types and their erosion characteristics, the variability of overburden thickness, and the potential uses of the pit following mining. Finally, the overburden portions of the pit walls would be sloped and graded at no greater than 2.5H:1V and would be vegetated to conform to Minnesota Rules.

Mine Pit – East/Central Pit Category 4 Foot-Wall Cover

Upon completion of mining, approximately 5,000 linear feet of the north wall of the East Pit is expected to consist of Virginia Formation or other Category 4-type rock material.[6] If left exposed to the air, oxidation of this surface would occur, resulting in elevated concentrations of

6 While the mitigation is targeting the Virginia Formation, the Virginia Formation is not continuous along the wall and there are some Duluth Complex Category 4 portions that would also be covered.

dissolved salts (sulfate) and metals entering the East/Central Pit surface water. To mitigate this potential impact to surface water quality, a geosynthetic membrane cover system would be placed over the Virginia Formation and other Category 4-type rock surfaces as shown in Figure 3.1-41. The cover system would be similar to the membrane cover system that would be placed over the Category 4 waste rock stockpile.

Prior to backfilling with overburden or general fill, a layer of approximately four inches of limestone would be applied against the face of the Virginia Formation to help neutralize the acidity of the rock face (CP03, Barr 2008, Overburden Information – Response to Comments in RS52). Next, the overburden would be placed to approximately one foot above the top of the bedrock. The slope of the fill material would be 3.5H:1V on the surface entering the backfilled pit. Overburden fill would be used for the core of the membrane cover system, followed by a select bedding layer used to prepare the core-fill surface for installation of a textured geo-membrane. The geomembrane would be keyed into both the upper and lower limits of the fill. A vegetative soil layer would be placed above the geomembrane cover. The toe of the slope would include additional fill for the establishment of wetland vegetation that would help to further stabilize the slope cover system.

It is the position of the tribal cooperating agencies that this section should describe the long-term effectiveness of the geosynthetic membrane that is proposed to cover the Virginia formation rock wall. Given that the applicant has not proposed any long-term maintenance of this system, expected long-term leaching rates should be described in this section and taken into account in sections of the EIS that predict long term surface and ground water quality.

Mine Pit - Pit Fencing and Access

A pit perimeter fencing system would be installed that would consist of fences, rock barricades, ditches, stockpiles, and berms. The fencing system plan would be submitted to and approved by the St. Louis County mine inspector before installation. Fencing would consist of five strands of barbed wire in most locations and five foot non-climbable mesh fencing with two strands of barbed wire at the top in areas where roads would remain adjacent to the fences unless other means are agreed to with the mine inspector.

Safe access would be provided to the bottom of each mine pit (*Minnesota Rules*, part 6132.3200) via selected original haul roads built during pit development. The access road would be selected such that, as pit water level rises, there would always be a clear path to the water surface. A gated entrance would be placed at each of the pit access locations.

Stockpiles - Waste Rock Stockpile Design and Cover

Throughout the mine life, stockpiles would have been reclaimed progressively, so that during Closure, much of the permanent waste rock stockpiles would have been covered. Areas not fully reclaimed during operations would be covered within three years after the cessation of operations. To provide an adequate base for sloping of cover materials, waste rock stockpile side slopes would be no steeper than 2.5H:1V, and the outermost layer would consist of local till soils (also known as “surface overburden” per *Minnesota Rules*, part 6132.2400, subpart 2, item C) adequate for vegetation growth. To provide erosion control, catch benches at least 30 feet in width would remain on all waste rock stockpiles.

Vegetated soil cover systems are proposed for some stockpiles. Based on the limited preliminary geotechnical investigation (RS49, Golder 2007), the soils at the Mine Site are predicted to perform favorably as soil cover materials. The soil cover would be designed to promote runoff with minimal erosion and provide storage of moisture during the period when the vegetation is dormant. The specific cover methods planned for each type of waste rock stockpile are described in Section 3.1.2.10 and summarized in Table 3.1-9.

It is the position of the tribal cooperating agencies that in order to adequately assess the potentially significant environmental impacts of a stockpile failure, a slope stability analysis must be performed and included in the DEIS. For more information, see section 4.13 of this document.

Stockpiles - Pump and Pipeline Removal and Rerouting

During mining operations, pumps would convey process water collected from stockpile liners to the WWTF. In Closure, some modifications would be made to these systems.

If stockpile drainage ceases or meets water quality discharge limits via treatment through the East Pit wetland treatment system, the drainage would not be collected for treatment at the WWTF. However, as long as there is drainage that does not meet discharge limits after wetland treatment, that drainage would be conveyed to the WWTF. Effluent from the WWTF would then be pumped to the East Pit wetland treatment system.

As illustrated on Figure 3.1-42, the pump and pipeline configuration used for stockpile drainage collection and conveyance from the stockpiles to the WWTF would remain in place through Closure and Post-Closure until water quality analyses show the drainage water quality meets water discharge limits at compliance locations or unless other sufficient treatment means are provided (RS 52, Barr 2007).

The pump and pipeline design proposed for the Lean Ore Surge Pile and Overburden Storage Area would be removed during Closure with the removal and reclamation of these areas. The Lean Ore Surge Pile, Overburden Storage Area, and all associated appurtenances, including the pumps and drainage systems that would no longer be required, would be removed and the area restored during Closure. This includes removal of Sumps S-6 and S-7 and the pumps and drainage systems from all six process water Sedimentation Ponds (PW-1 through PW-6). The overburden portion of the Category 1 and 2 waste rock stockpile would be entirely reclaimed, so that all surface runoff would only be non-contact stormwater.

Stockpiles - Runoff and Drainage during Closure

All waste rock stockpiles would be reclaimed by the final year of operations. Once the stockpile has a final cover or established vegetation, runoff from the tops and sides of the reclaimed stockpiles would be classified as non-contact stormwater and would be routed through a system of ditches prior to being discharged into the natural drainage system. Ditches on the stockpile surface would direct stormwater flows into channels that would route flows down the sides of the stockpile.

Water draining from stockpile liners and water collected in the stockpile foundation underdrains after Closure would be monitored, returned to the WWTF for treatment if necessary, and ultimately discharged to the East Pit treatment wetlands (RS 22, Barr 2008).

The Lean Ore Surge Pile and the Overburden Storage and Laydown Area southeast of the West Pit would be depleted during Year 20. Once this occurs, the liner of the Lean Ore Surge Pile would be removed. The Lean Ore Surge Pile and Overburden Storage and Laydown Area would be reclaimed.

Watershed Restoration

During mining operations, stormwater runoff from reclaimed stockpile areas and natural (undisturbed) areas would be routed through use of a network of dikes and ditches to stormwater sedimentation ponds. During and after Closure, PolyMet would modify these water management systems as described below.

Dike Removal

Once the stockpiles are reclaimed, perimeter dikes that are no longer needed to provide access or separation from the areas outside the Mine Site would be removed during Closure (Figure 3.1-43). The dike located north of the East/Central Pit would remain in place with the purpose of minimizing mixing of the Partridge River flows with the East/Central Pit water and preventing gully development on the northern side of the pit in the segments not protected by the ditches that would be maintained during Closure (Figure 3.1-40). In addition, the dike located north of the Category 1 and 2 waste rock stockpile and along the east boundary of the Mine Site would remain in place to allow access to groundwater monitoring locations.

During Closure, surface runoff inflows would be routed to the mine pits using a combination of existing and new ditches (Figure 3.1-40). Some portions of the pit rim dikes may be left in place after Closure if they were needed to prevent an uncontrolled flow to or from the pits and potential erosion (head cutting) of the pits walls. A more detailed evaluation of this requirement would be conducted prior to Closure.

In all cases of dike removal, material from the main body of the dikes would be removed and used at the site for restoration of disturbed surfaces. To minimize disturbance of subsurface soils, the subsurface seepage control component of the dikes would remain in place.

As part of the dike removal work, typical construction erosion control measures would be used. These might include installing silt fencing on the down slope side of disturbed areas and controlling surface water runoff. The reclaimed surface would then be scarified, topsoil placed, and the area revegetated with native species within three years as specified in the Permit to Mine rules.

Ditch Filling/Rerouting and Pond Filling

During mine development, ditches would have been constructed to divert non-contact stormwater runoff from undisturbed (natural) and reclaimed areas away from process areas (stockpiles, pits, haul roads, etc.). Figure 3.1-16 shows the alignment of the proposed ditches and the location of seven sedimentation ponds and outlet structures that would convey stormwater runoff collected in the ditches to the Partridge River.

In contrast, Figure 3.1-43 shows the ditches that would be rerouted or filled during the Closure period and the alignment of ditches that would be maintained during Closure to direct non-contact stormwater into the West Pit for filling. Use of existing ditches would be maximized, but several new ditches would need to be constructed to direct stormwater runoff from the Mine Site into the East/Central or West Pits during Closure.

During Closure, all seven stormwater ponds and all six process water ponds would be filled, covered with topsoil, and revegetated, or turned into wetlands. If the process water ponds are converted into wetlands, any sedimentation that occurred within the pond would be evaluated to determine if removal or covering is necessary prior to restoration.

As shown in Figure 3.1-40, outlet control structures OS-1, OS-3, and OS-6 would be removed to restore the drainage flow paths to their natural conditions, where possible. Outlet control structure OS-2 would remain in place along with the dike located north of the East/Central Pit with the purpose of minimizing the mixing of the Partridge River flows with the East/Central Pit water and preventing gully development on the northern side of the pit in the segments not protected by the ditches that would be maintained during Closure. Outlet control structures OS-4, OS-5, and OS-7 would remain in-place to direct water under Dunka Road and the railroad to the Partridge River along natural drainage paths. As a requirement of the NPDES permit and/or Closure Plan for the facility, discharges from these outlet control structures would be monitored as necessary to ensure that runoff to the Partridge River would meet water quality discharge limits.

PolyMet would develop a final Mine Closure and Reclamation Plan as part of the Permit to Mine, which would include sections on watercourse restoration, mine and plant site reclamation, structure demolition, site remediation, and ongoing maintenance/water treatment. An estimate for all Closure costs would be included. The final Closure and reclamation plan would be updated annually to reflect changes in costs and integration with area mine reclamation/reuse strategies. As previously discussed, it is the position of the tribal cooperating agencies that the existing Closure Plan is insufficient to allow an adequate assessment of post-closure impacts.

3.1.7.3 Reclamation of Plant Site

Flotation Tailings Basin

During Closure of the Tailings Basin, fugitive dust would be controlled by mulching and temporary vegetation. The seepage collection system that would have been implemented during operations is expected to have continued use into Closure, although seepage collection would be occurring at progressively reduced rates. It is the position of the tribal cooperating agencies that in order to adequately assess post closure impacts, this section should estimate the length of time that seepage collection would be required at the tailings basin.

Reclamation – Tailings Basin

Upon Closure of the Tailings Basin the following strategies would be applied (Barr, 2009, Flotation Tailings Management Plan (FTMP), Draft-02):

- Bentonite augmentation of the upper surface of the tailings to minimize surface water infiltration and facilitate the formation of a pond and wetlands at Closure;

- Control of fugitive dust on upland areas by mulching and establishment of permanent vegetation; and

- Periodic evaluation of dam stability by a qualified geotechnical engineer.

In addition, emergency overflow channels and/or outfall structures would be constructed to carry excess stromwater from the basin to the adjacent wetland only when needed during extreme precipitation events. The channels and/or outfall structures would be sized and designed to safely discharge the design discharge and minimize surface erosion. These channels and/or outfall structures would be lined with vegetation or rip rap to protect the channel from erosion or would consist of clog-resistant inlet structures and discharge pipes. A rip rap delta would be installed where the drainage channel or pipe enters the wetland to distribute the stromwater. Sediment control and energy dissipation structures would be incorporated at channel/outfall structure discharge points if needed based on final design determinations. The conceptual location of the emergency spillway from the combined Cell 1E and Cell 2E to the adjoining land is shown in Figure 3.1-44.

Dewatering/Drainage

At Closure, several sources of water from the Tailings Basin would require management. The sources and a summary of the type of management needed are described as follows:

- Ponded water within the basin – a pond would remain in the tailings basin in Closure. Water would continue to be pumped from Colby Lake as needed to maintain the pond. The pond would also receive surface water runoff from the crest and beaches of the basin. The pond would continue to lose water via seepage during Closure.

- Stored water held in the void spaces of the Tailings Basin – a portion of this water would be released as the pond level within the basin stabilizes at a lower elevation during Closure. The volume of water that would drain from the tailings would depend on climatic conditions and the rate of drainage through the tailings perimeter embankments and to the foundation. It would also depend on the volume of water permanently retained in the tailings.

- Surface water runoff from the crest and beaches and precipitation falling on the basin - most of this water would flow into the pond (see 1st bullet above). Some of this water would be collected through a series of horizontal drain pipes and lateral headers located in the northern basin dam and by the seepage barrier located south of the basin at the headwaters of Knox Creek. This water would be recycled back into the pond water (see 1st bullet above). As the pond reduces in size during Closure to about ¼ of its size during operations, the rate of drainage would be expected to decrease over time so that in the long term, the volume of water requiring handling would decline. Therefore, the remaining Closure activity would consist of periodic inspection of the closed dams and water collection systems to ensure continuing integrity. Additionally channels and/or outfall structures would be constructed to carry excess stormwater, due to an extreme precipitation event, from the basin to the adjacent wetland.

Cover and Revegetation

In order to achieve a closure system at the Tailings Basin that is largely maintenance-free as required by MnNDR rules, the closure surface would be graded to provide a gently sloping surface that effectively routes surface water runoff to the interior of the basin, accommodates future differential settlement of the underlying tailings, and maximizes ponding of water in the closed Tailings Basin pond for the development of constructed wetlands.

Once the entire facility is closed, any water collected by the seepage collection systems would be returned to the pond until it can be demonstrated by water quality that it is no longer necessary to actively manage Tailings Basin seepage.

Emergency Basin

An existing 35-acre Emergency Basin is located south of the existing LTVSMC tailings basin (proposed Hydrometallurgical Residue Facility) and contains material that overflowed from sumps in the concentrator during LTVSMC operations (Figure 3.1-44).

As part of the LTVSMC Closure process, the Emergency Basin was identified as an Area of Concern under the MPCA's Voluntary Investigation and Cleanup (VIC) program. Based on a Sampling and Analysis Plan submitted to the MPCA, PolyMet plans to collect multiple samples from the sediments and the groundwater in the Emergency Basin for analysis. These samples would determine if any further work would be required to identify possible contamination. If no contamination requiring cleanup is found, the area would be contoured to create wetlands and vegetated according to *Minnesota Rules*, part 6132.2700. If contamination requiring cleanup is found, a Corrective Action Plan to address the contamination would be developed and submitted to the MPCA for approval. PolyMet's concept for the plan would be to minimize the amount of stormwater reaching the contaminated soil and, therefore, reduce the potential for contamination to be transported out of the Emergency Basin area.

Regardless of whether contamination is found, detailed plans for any required drainage channels and/or outfall structure would be based on relevant hydrologic data and would be submitted to the MPCA for approval. The Emergency Basin stormwater outflow would be monitored and inspected as approved by the MPCA or as defined in the SDS permit for the Hydrometallurgical Residue Facility.

The Emergency Basin currently overflows through a culvert which is used to prevent any petroleum products floating on the surface of the basin water from escaping the basin. The Emergency Basin would be reclaimed to create wetlands, and therefore an earthen overflow spillway berm would be constructed near the existing outlet to maintain water levels in the created wetlands and reduce long-term maintenance costs associated with a T culvert.

Hydrometallurgical Residue Facility Reclamation

At the time of Mine Site and Plant Site Closure, one of the four hydrometallurgical residue cells would still require Closure. The other three cells would have been closed as part of routine operations at the site as described in Section 3.1.5.3. Reclamation of the remaining open hydrometallurgical residue cell would include removal of ponded water from the cell surface, removal of pore water from the residue, construction of the cell cover system, and establishment of vegetation and surface water runoff controls.

Ponded Water

As described earlier, the hydrometallurgical residue facility would be developed in 5-year increments over the 20-year operating life of the ore processing operations. Each increment would include construction of individually lined cells. A portion of each cell would be reserved for ponded water that would be used to facilitate settling of the hydrometallurgical residue solids discharged into the operating cell and would help clarify the water before it was returned to the plant for reuse. This ponded water from the final cell Closure would need to be removed and treated.

Ponded water removed from the cell would be pumped or hauled by tanker truck to the Mine Site WWTF for treatment and subsequent discharge to the East Pit wetland treatment system, or the water would be treated using a mobile temporary water treatment plant temporarily stationed at the hydrometallurgical residue facility and discharged to the flotation tailings basin pond. Once the majority of ponded water was removed so that it was no longer reasonable to maintain transport of the water to the Mine Site WWTF or to an on-site temporary treatment facility, the remaining water would be collected by tanker truck for off-site treatment and discharge at a permitted wastewater treatment plant.

Drainage

At Closure, the residue void spaces in the one open cell would be full of water, a portion of which would be retained in the residue (stored water) while the other portion would drain from the residue (drainage). Drainage would be collected from the base of the cells at the geocomposite drainage system and managed as noted previously for ponded water.

The rate of drainage would decrease over time as the pore water within the hydrometallurgical residue was collected and removed. Once the entire facility was closed, the volume of water draining from the drainage collection systems would decline and continued operation of the pipeline to the WWTF may no longer be justified, if it was initially used for this purpose. In the long term, the volume of water requiring treatment would decline to the point that the remaining

Closure activity may consist of periodic pumping of remaining drainage into tank trucks for transport, treatment and disposal as appropriate, and of inspection of the closed cells to verify integrity of the closure systems. It is the position of the tribal cooperating agencies that these pumping and water treatment activities would have to be conducted in perpetuity, and that the cover and liner would require perpetual maintenance.

Cover and Surface Water Runoff Control

The closure surface of the hydrometallurgical facility would be graded into a gently sloping surface. The cover used at Closure would consist of a layer of NorthMet flotation tailings or LTVSMC tailings immediately above the drained hydrometallurgical residue. This would be topped, if necessary, with a non-woven needle-punched geotextile fabric. Next, a geosynthetic clay barrier layer and 40-mil low density polyethylene (LDPE) or similar agency-approved geo-membrane barrier layer system would be placed (Barr 2009, Hydrometallurgical Residue Management Plan). If LTVSMC tailings particle size and angularity make it necessary to protect the geo-membrane from puncture, another geotextile layer would be placed on top of the geo-membrane. Finally, additional LTVSMC tailings and local till soils would be placed to create a surface capable of sustaining a vegetated cover.

The cover would slope gently toward the site perimeter to accommodate natural drainage of the runoff. Final cover slopes on the cell interior would be relatively shallow to minimize surface water runoff flow velocity and the associated erosion. Runoff that becomes channeled along the cell perimeter would be routed down-slope via rip-rapped drainage swales or plug-resistant inlet structures and piping systems. Once runoff is moved down the cell embankment, it would be routed to the flotation tailings basin pond.

Cover and Revegetation of the Building Area

After demolition of Plant Site buildings, these areas would be reclaimed and vegetated according to *Minnesota Rules*, part 6132.2700. All areas would be stabilized as required for stormwater management. Roads and parking lots would be reclaimed and vegetated according to *Minnesota Rules*, part 6132.2700. Asphalt pavement would be recycled or properly disposed.

Closure Cost Estimate

In PolyMet's January 2007 PD, a preliminary Closure Cost Estimate was included and is summarized in Table 3.1-14 below. The preliminary Closure Cost Estimate assumed that the facility would be closed at the end of the 20-year proposed mine life. The estimate also included remediation obligations PolyMet acquired with the acquisition of the Cliffs Erie property although these obligations would likely be completed during the mine life. The costs provided were primarily intended only to provide an indication of the scale of the task and therefore were very rough estimates. In addition, the estimates have not been updated to reflect changes to the Project per the July 2007 Supplemental PD or any of the changes thereafter.

Table 3.1-14 NorthMet Project Preliminary Closure Cost Estimate Summary

Closure Task Category	Proposed Cost
Reclamation and Vegetation	$6,437,447
Remediation	$4,488,328
Structure Removal	$21,729,956
Watershed Restoration	$2,897,200
Monitoring and Maintenance	$9,067,040
Total	**$44,619,971**

Source: PolyMet January 2007 PD

This Closure Cost Estimate differs from the Contingency Reclamation Cost Estimate that would be submitted with the Permit to Mine application according to *Minnesota Rules*, part 6132.1200, in that the Contingency Closure Estimate would assume that the facility closes one year after operations begin. The Contingency Closure Estimate would be updated annually as part of the Permit to Mine annual report and would be the basis for computing financial assurance requirements for the Project.

Any additional detail regarding the amount of financial assurance associated with reclamation actions cannot be estimated until these actions are understood at a deeper level of design detail. This detail is more typically made available during the permitting process. Therefore, further discussion of financial assurance figures and instruments are not included in the DEIS. However, the DEIS does recognize that Minnesota regulations require that financial assurance requirements be determined at the permitting phase. It is the position of the tribal cooperators that financial assurance should be fully explored in the DEIS. This is particularly important given the potential for very long-term/perpetual treatment, maintenance and monitoring that may be needed for the Proposed Action. Because of its experience in expensive cleanups of contamination from many defunct or bankrupt sulfide mines, EPA Region 9 has strongly urged other Regions over the past two years to require financial assurance disclosure in the NEPA process. New national rules for financial assurance are under development by EPA, because "Given the history of adverse environmental effects resulting from some hard rock mines, and the expenditure of public funds used in some cases to address environmental problems caused by mining, EPA believes it is necessary to analyze these factors in the DEIS." (from *InsideEPA.com*, Tuesday, August 25, 2009).

3.1.8 Post-Closure Activities

Inspection, maintenance, and reporting activities would be required at the Mine Site and Plant Site after the Closure activities are complete. For example, Mine Site process water and pore water from the Hydrometallurgical Residue Facility at the Plant Site would be treated using the existing WWTF as the primary treatment mechanism, and the constructed wetland in the East Pit as the secondary treatment mechanism. It is the position of the tribal cooperating agencies that the applicant has not demonstrated the effectiveness of the secondary wetland treatment system. The effluent from the WWTF would be monitored on a daily and monthly basis as described in RS 52 – Mine Closure Plan Report, Tables 7-14 .6 and 7-14.7 and as required by relevant permits. In addition, the chemical precipitates generated from wastewater treatment operations would be characterized and disposed in an off-site, licensed solid waste disposal facility. These Post-Closure and reclamation activities would be expected to be ongoing for many years until such time as the various facility features are deemed environmentally acceptable, in a self-sustaining and stable condition. It is the position of the tribal cooperating agencies that the characterization of post closure activities as "occurring for many years" significantly underestimates the potential long term impacts of the project and the potential need for post closure activities to continue for hundreds or thousands of years.

Other continued maintenance activities that would continue throughout Post-Closure would include repair of stockpile slope erosion, tree removal on stockpiles and hydrometallurgical cells with membranes, and seepage collection from the Tailings Basin. Tribal cooperating agencies note that these activities would also have to be conducted in perpetuity.

When PolyMet has completed all reclamation required by the Permit to Mine, they may submit a Request for Release per *Minnesota Rules*, part 6132.1400. This request would provide the Commissioner of the MnDNR with detailed information on the final reclamation status of the Mine Site. Removal of the debris and equipment would be removed within one year, unless it would be used for reclamation or approval was received from the commissioner for it to remain longer. It is the position of the tribal cooperating agencies that if this project would require perpetual maintenance, it cannot be deemed to be "reclaimed" and would violate the stated goal of Minnesota's reclamation statute.

3.2 PROJECT ALTERNATIVES

The purpose of an alternatives analysis is to compare and contrast the impacts of reasonable alternatives to the Proposed Action, so as to better inform decision makers and the public about opportunities to reduce impacts. During preparation of this DEIS, many alternatives were considered in order to determine if impacts affected environment could be reduced, while still meeting the purpose and need of the Project. Some were alternatives considered as required by regulations, others were identified during scoping, and still others were identified after determining the Proposed Action would cause potentially significant adverse impacts. Tribal cooperators note that the scooping period for a federal EIS continues until the release of the DEIS. Therefore, new issues that have been identified during the review of the three PDEIS documents must be considered for the DEIS.

MEQB statutes and rules (*Minnesota Statutes*, chapter 116D, sections 04 and 045; and *Minnesota Rules*, part 4410, subpart 0200 through 7500) require that an EIS include at least one alternative in each of several categories, or provide an explanation as to why no alternative is provided for that category in the EIS. The categories are: alternative sites, alternative technologies, modified designs or layouts, modified scale or magnitude, alternatives incorporating reasonable mitigation measures identified during EIS scoping and DEIS comment periods, along with the No Action Alternative (if the NorthMet Project were not built).

NEPA requires that a "range of alternatives" must be discussed in the environmental documents prepared for a proposed action (§ 40 CFR 1505.1(e)). This includes all reasonable alternatives, which must be rigorously explored and objectively evaluated, as well as those other alternatives, which are eliminated from detailed study with a brief discussion of the reasons for eliminating them (§ 40 CFR 1502.14). In determining the scope of alternatives to be considered, the emphasis is on what is "reasonable" rather than on whether a proponent or applicant likes or is itself capable of carrying out a particular alternative.

Reasonable alternatives are those that are practical or feasible from technical and economic standpoints and using common sense, rather than simply desirable from the standpoint of the applicant. The Purpose and Need statement for the Project (see Section 1.2) serves as a basis for identifying the reasonable alternatives available to the agency. The agency must objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their elimination. The range of reasonable alternatives covers those that substantially meet the agency's purpose and need. Furthermore, reasonable alternatives are to be evaluated in enough detail so that the reader can compare and contrast the environmental effects of the various alternatives. The range of alternatives is guided, not controlled, by the goals of an applicant's proposal.

3.2.1 No Action Alternative

Under the No Action Alternative, the Project would not be constructed and open pit mining operations would not occur. The Mine Site would continue to be managed largely in its current state; however, the Plant Site would continue to be reclaimed according to the previous LTVSMC Closure plan. This alternative would avoid the environmental impacts associated with the Proposed Action; however, the social and economic benefits from the Project would not occur. Tribal cooperating agencies disagree with the assumption that the proposed project would only result in social and economic benefits. The environmental impacts of the project on the 100 Mile Swamp, an undisturbed and very high quality wetland complex, would constitute a social impact. Furthermore, economic development that is not centered on heavy industry (tourism for example) would be adversely impacted by the project. At the end of the project life, there would also be negative economic impacts as the surrounding communities deal with the loss of primary employment and economic revenue streams that were dependent on the Project. Local employment and economic revenue would not increase as a result of this alternative, but the negative post-closure impacts would be avoided. This alternative would not meet the Purpose and Need of the Project, but may still be a reasonable alternative if the overall adverse impacts of the Project outweigh its benefits.

At the greenfield Mine Site, PolyMet would be required under exploration approvals to reclaim surface disturbance associated with exploratory and development drilling activities. Other existing surface uses such as logging would continue under current USFS management plans.

No further upgrades or new segments would be constructed along the existing power transmission line, railroad, and Dunka Road, which would continue to be used by their private owners.

At the brownfield Plant Site, Cliffs-Erie LLC and PolyMet would be required to complete Closure and reclamation activities required under an existing MnDNR- and MPCA- approved Closure program. This would include completing activities for the localized petroleum and other contaminant impacted areas under the VIC program (voluntary investigation and cleanup), former Plant Site building removal, and Tailings Basin embankment seep management. Additional Tailings Basin water quality impact measures may be required but have not been fully determined as of this time.

3.2.2 Mine Site Alternative

This alternative consists of a modified design or layout at the Mine Site to reduce the Project's potential impacts to surface and ground water quality by subaqueous storage of the higher sulfur waste rock in the East Pit. This differs from the Proposed Action which would place lower sulfur waste rock subaqueously in the East Pit, and store the higher sulfur waste rock in surface stockpiles which would result in higher constituent concentrations in leachate and seepage.

Under this alternative, no changes would be made to the transportation/utility corridor or the Plant Site.

This alternative would subaqueously dispose of the most-reactive waste rock (all Category 2, 3, and 4) in the East/Central Pit instead of the least reactive waste rock (Category 1 and 2). Since Category 3 and 4 waste rock is more reactive, it may be preferable to dispose of this rock subaqueously (to prevent oxidation) and to process the Category 3 lean ore (removing sulfur) to the extent project economics will allow. Temporary surface stockpiles (Figure 3.2-1) constructed with enhanced liner systems would be temporarily used to store the Category 2, 3, and 4 waste rock until mining of the East/Central Pit is completed and it becomes available for subaqueous waste rock disposal. To the extent that Category 2, 3, and 4 waste rock is mined, it is beneficial to minimize the stockpile exposure time by mining as quickly as possible to accelerate the subaqueous disposal. Limestone or lime may also be added to the temporary stockpiles to neutralize acid formation. The Category 4 lean ore would be processed as it is mined and the Category 3 lean ore would be either processed or disposed in the East/Central Pit as waste rock as it is mined. Temporary stockpiling would allow for additional waste rock processing during transfer to the East/Central Pit, pending market conditions. The backfilling design capacity of the East/Central Pit would be 125 M tons. Therefore, this pit can accommodate all the Category 3 and 4 waste rock, Category 3 lean ore, if necessary (99.3 M tons in total or 57.8 M tons without Category 3 lean ore); and to the greatest extent possible, Category 2 waste rock.

3.2.3 Tailings Basin Alternative

This alternative consists of a modified design or layout at the Tailings Basin to reduce the Project's potential impacts to surface and ground water quality by capturing most of the seepage from the existing LTVSMC tailings and the proposed NorthMet tailings by a series of ground water pumping wells that would be installed on the lower most benches of the tailings facility (Anderson 2009 ERM Memo). Captured seepage would be pumped and directly discharged to the Partridge River (Figure 3.2-3). If it were determined upon further analysis during permitting, or during operational monitoring, that pretreatment were necessary prior to discharge, a water treatment facility could be installed. It is the position of the tribal cooperators that water treatment of the discharge would be required to comply with the wild rice water quality standard. The Partridge River contains several wild rice beds immediately downstream of the proposed discharge point. Passive treatment of the unrecovered seepage would also be tested during operations along the northern toe of the Tailings Basin, to determine the viability of installing a full-scale system during Closure designed to replace the seepage capture with an *in-situ* long-term water quality treatment method. Geotechnical stability enhancement would be achieved by increasing the size of the rock buttress along the northern toe of the Tailings Basin.

This alternative resulted from the comprehensive mitigation planning effort by the co-lead agencies, and included input from all Cooperating Agencies and consulting tribes. Tribal cooperating agencies note that although they participated in the identification of potential mitigation measures for the tailings basin, they did not participate in the development of the tailings basin mitigation design. In addition, it is the position of the tribal cooperators that an untreated discharge of contaminated tailings basin water to the Partridge River in order to dilute and dispose of tailings basin water would have environmental impacts that must be avoided in order to adequately protect the environment. The planning process identified the alternative from combination of several potentially viable individual mitigation measures, collectively referred to as Combination 9F (Table 3.2-1). Preliminary, semi-quantitative impact assessments indicated this alternative would reduce the adverse environmental impacts and would likely be technically, regulatorily, and economically feasible, in addition to meeting the Project Purpose and Need.

Table 3.2-1 NorthMet Tailings Basin Mitigation Measures

IDEA		ISSUES IT ADDRESSES				PRACTICABILITY			
#	**Potential Mitigation Measure**	**Issue 1: Contaminant Sorption**	**Issue 2: Sulfate / Wild Rice**	**Issue 3: Sulfate/ Methyl mercury**	**Issue 4: Geotech Stability**	**Meets "Project Purpose and Need"**	**Technical Feasibility (H,M,L)**	**Economic Feasibility (H,M,L)**	**Regulatory Feasibility (H,M,L)**
Alternative to be Evaluated in DEIS									
C-9F	**During Operations:** Vertical Wells pump seepage from embankment locations back into pond - Permeable Reactive Barrier demonstration test +/- contingency water treatment plant; **During Post-Closure:** if PRB test showed it was effective, install PRB at north of TB, if PRB test showed not effective, vertical wells may pump collected seepage to Partridge River downstream of Colby Lake +/- water treatment plant; Plus Rock Buttress	Y	N - little effect	Y	Y	Y	H (assuming contingent water treatment plant)	M	M
Less Effective/Viable Options									
C-2B	Partial Liner (TBM-11), Partial Dry Cap (TBM-7), Groundwater flows to wetlands, plus Rock Buttresses (TBM-6)	Y	N	N	Y	Y	H	M	L for MPCA at Post-Closure due to the minimal improvement in methyl mercury and wild rice standard
TBM-3	Full Liner	Y	Y	Y	Y	Y	M	L	H
TBM-1	Groundwater Pumping	Y	Y	Y	Y	Y	H	M	H
TBM-2	Physical Barrier at Toe (2E seeps or beyond)	Y	Y	Y	N	Y	M	M	H
TBM-20	Collection ditch around toe	Y	Y	Y	N?	Y	M	M	H
TBM-4	Thickened or Paste Tails	Y	Y	Y	Y	Y	M	L	H
TBM-8	Chemical Modification to NorthMet Tailings	Y	Y	Y	N	Y	M	M	H
TBM-17	Permeable reactive barrier downgradient of toe	Y	Y	Y	N	Y	M	M	H
TBM-6	Increase Rock Buttress	N	N	N	Y	Y	H	H	H
C-5	Physical Barrier (TBM-2), Dry Cap (TBM-7), Pump to Area 5 Pit, PRB test at RR Crossing, Discharge to Embarrass R.; plus Rock Buttresses (TBM-6)	Y	Y	Y	Y	Y	H	M	L

IDEA		ISSUES IT ADDRESSES				PRACTICABILITY			
#	**Potential Mitigation Measure**	**Issue 1: Contaminant Sorption**	**Issue 2: Sulfate / Wild Rice**	**Issue 3: Sulfate/ Methyl mercury**	**Issue 4: Geotech Stability**	**Meets "Project Purpose and Need"**	**Technical Feasibility (H,M,L)**	**Economic Feasibility (H,M,L)**	**Regulatory Feasibility (H,M,L)**
C-7	Permeable Reactive Barrier (TBM-17), Dry Cap (TBM-7), Groundwater flows to wetlands; plus Rock Buttresses (TBM-6)	Y	Y	Y	Y	Y	L	M	L
C-9B	Vertical Wells at toe (during operations & possibly Post-Closure), Dry Cap (TBM-7), Pump to Area 5 Pit, PRB test, Discharge to Embarrass R.; plus Rock Buttresses (TBM-6)	Y	N	N - to lakes downstream, Y - to wetlands	Y	Y	Unknown	M	H - for reducing methyl mercury risk in wetlands, but L since no change to methyl mercury in lakes
C-4	Physical Barrier (TBM-2), Wet Cap (PA), Water Treatment, Direct Pipe to Surface Water (TBM-9)	Y	Y	Y	N	Y	L	H	L
C-8	Paste or Thickened Tails (TBM-4), Vegetative Cover, GW Flows to wetland N. of TB	Y	Y	Y	N	Y	M	L	M
C-9E	Vertical Wells at toe (during operations), Dry Cap (TBM-7), Pump to Area 5 Pit, PRB test at RR crossing, Discharge to Embarrass R., PRB north of TB (during Post Closure) and groundwater flow north to wetlands; plus Rock Buttress (TBM-6)	Y	Y	N	Y	Y	H	M	L
TBM-11	Partial Liner (cover of LTV coarse tailings)	Y	Y	Y	Y	Y	M	M	M
TBM-7	Dry Closure Cap (organics, paper mill res, soil, etc.)	Y (during Closure)	Y (during Closure)	Y (during Closure)	Y (during Closure)	Y	M	M	H
TBM-5	Reduce Sulfate (from mine site waste rock collection) via Mine WWTF	N	Y	Y	N	Y	M	H	H
TBM-16	Partial treatment of pond water	Y (but not Closure)	Y	Y	N	Y	H	M	H
TBM-18	Use of another embankment source material	Y	Y	Y	Y	Y	M	M	M
TBM-19	Angled drain system, TBM-19a drains go into and pull from tailings; TBM-19b drains go into and draw from till below TB	Y	Y	Y	Y	Y	M	M	H
TBM-15	Timed release of sulfate water to Embarrass River	N	N	Y	N	Y	M	M	M

IDEA		ISSUES IT ADDRESSES				PRACTICABILITY			
#	**Potential Mitigation Measure**	**Issue 1: Contaminant Sorption**	**Issue 2: Sulfate / Wild Rice**	**Issue 3: Sulfate/ Methyl mercury**	**Issue 4: Geotech Stability**	**Meets "Project Purpose and Need"**	**Technical Feasibility (H,M,L)**	**Economic Feasibility (H,M,L)**	**Regulatory Feasibility (H,M,L)**
TBM-9	Direct piping of leachate from TB to Partridge R. watershed	Y (gw) N (sw)	N	Y	N	Y	H	H	H
TBM-24	Lining of Cell 2W and disposing NorthMet tailings there (5-20 years capacity)	Y	Y	Y	Y	Y	L	L	M
Considered but Eliminated									
C-1	Partial Liner (TBM-11), Wet Cap (PA), Water Treatment (long term), Direct Pipe Surface Water (TBM-9)	Y	Y	Y	N	Y	H	M	L
C-3	Physical Barrier (TBM-2), Wet Cap (PA), Direct Pipe to Surface Water (TBM-9)	N	N	Y	N	Y	H	H	L
C-6	PRB (TBM-17), Wet Cap (PA), GW Flows to wetlands; plus Rock Buttresses (TBM-6)	Y	Y	?	Y	Y	L	M	L
TBM-21	Alternative location of a new basin (off LTV tails)	Y	Y	Y	Y	Y	M	L	M
TBM-13	Induced consolidation of LTV toe slimes	N	N	N	Y	Y	M	M	H
TBM-12	Modified embankment w/ only LTV Cell 2W tails (from embankment of Cell 2W)	N	N	N	Y	Y	M	H	H
TBM-22	Manage sulfate loading from LTV waste rock sites (not PolyMet)	N	N	Y	N	N/A	M	M	M
TBM-23	Off-site in-pit subaqueous disposal of tailings	Y	Y	Y	Y	Y	M	M	M
TBM-25	Redesign NorthMet to underground mine and use as home for tailings storage	Y	Y	Y	Y	Y	M	L	M
TBM-26	Groundwater discharge of treated water	Y	Y	Y	N	Y	M	M	M
TBM-27	Co-disposal of tailings in surface and subaqueous waste rock facilities at Mine Site	Y	Y	Y	Y	Y	M	M	M
TBM-28	Chemical Modification of Hydromet cell sulfate	N	Y	Y	N	Y	M	H	H
TBM-14	Collection/incorporation of LTV Pit 5 water into NMet process	N	Y	N	N	Y	H	M	M

The basic components of this alternative are as follows:

(1) ***Vertical wells (to capture and pump Tailings Basin seepage)*** would be constructed on existing benches of the northern embankment of LTVSMC Cells 2E and 2W prior to operating the NorthMet Tailings Basin. These wells may ultimately be extended around the eastern side of Cell 2E and the western side of Cell 2W embankments, depending on testing performed during the first several years of operations. During operations, these wells would pump some water back into the Tailings Basin to be beneficially reused as make up water for mineral processing. The remainder of pumped water would be discharged directly to the Partridge River downstream of the Colby Lake Outlet Structure. During Closure and Post-Closure, all water would be pumped directly to the Partridge River (since no mineral processing would be occurring). The pumping wells would be operated long term and until no longer needed when water quantity, water quality, passive treatment, or other conditions allow. [For additional information see Tina Pint June 16, 2009 memo, *Tailings Basin – Alternative Pump-Out Well Locations*; PolyMet/Barr's Combination 9F write-up, received May 31, 2009; and PolyMet/Barr's TBM-1A write-up, received May 20, 2009.]

(2) ***Permeable Reactive Barrier (PRB) demonstration testing*** would be conducted in a representative location north of the NorthMet Tailings Basin during operations to assess whether such a passive treatment method would be effective in reducing constituents of concern in Tailings Basin seepage. Should the PRB test be successful, a permanent PRB could be built as a vertical unit through the flow path of the seepage from the Tailings Basin and/or a horizontal surface unit (i.e. constructed wetland). Both the horizontal and vertical options would allow sulfate reduction and antimony and arsenic precipitation to occur within the reactive material (i.e., organic matter, iron filings, etc) so that any groundwater that flows to the surface would have lower concentrations of the chemicals of concern. The PRB, if built, may require periodic recharging. [For additional information see PolyMet/Barr TBM-17 write-up, received May 20, 2009.] It is the position of the tribal cooperating agencies that the DEIS should include explicit estimates of how often "periodic recharging" would need to occur.

(3) ***Partial dry capping*** of the NorthMet Tailings Basin upon Closure. This cap would be constructed of either a bentonite clay amended or geomembrane plastic. The cap would be placed over the crest of the perimeter dams (LTVSMC coarse tailings) and the inner beach areas (NorthMet bulk tailings). The interior of the basin would receive bentonite augmentation in both scenarios to reduce infiltration and to maintain a pond (a partial wet cap). Surface water runoff from the partial dry cap would flow to the central area of the basin to help maintain the pond and to dilute the pond water. Emergency overflows would be constructed to limit the pond to desired maximum pond elevations. [For additional information see Tom Radue, June 11, 2009 email, "June 10 Conference Call Follow-up Items 4 and 15," and PolyMet/Barr TBM-7A write-up, received May 20, 2009]

(4) ***Increased rock buttress material*** would be placed along the toe of the northern embankment of Cell 2E. It is assumed that raising the height of this buttress can be accomplished without additional wetland impacts beyond that of the Proposed Action.

> Buttress construction material will consist of screened overburden material and waste rock from existing stockpiles from nearby taconite mine sources. [For additional information see PolyMet/Barr TBM-6 write-up, received May 9, 2009.]

Under this alternative, no changes would be made to the Mine Site or transportation/utility facilities.

3.2.4 Alternative Considered But Eliminated

Minnesota Rules, part 4410.2300, subpart G states that an alternative may be excluded if "it would not meet the underlying need for or purpose of the Project, it would likely not have any significant environmental benefit compared to the Project as proposed, or another alternative, of any type, that will be analyzed in the DEIS would likely have similar environmental benefits but substantially less adverse economic, employment, or sociological impacts." In accordance with the requirements of subpart G, Table 3.2-2 describes the alternatives previously considered, but subsequently eliminated from detailed analysis and the rationale for their elimination.

3.2.4.1 Alternative Sites

As determined in the Final SDD, the DEIS does not evaluate alternative sites to the Proposed Action. The ore deposit is found at the NorthMet Mine Site so consideration of alternative mine sites would not satisfy the Project purpose. Alternative greenfield plant or tailings basin sites were not carried forward in the analysis since the PolyMet proposal of using a Brownfield site avoids disturbance of a new area. Off-site subaqueous disposal of waste rock was considered; however, the proposed on-site subaqueous disposal would provide the same environmental benefit and avoid the environmental impact of transporting the waste rock off-site. Therefore, no off-site alternatives will be evaluated. The Final SDD also stated that in-pit tailings disposal was to be evaluated. The only available location for this was determined to be the LTVSMC Area 5 pit. However, the Area 5 pit would not have capacity enough for all tailings produced, therefore a basin would be required even if this alternative was used. Finally, the Final SDD stated that off-site disposal of non-reactive waste rock would be considered. However, through the DEIS process, it was determined that the Project would not produce non-reactive waste rock, therefore this alternative does not apply to the Project.

Table 3.2-2 Alternatives Considered but Eliminated

Alternative Number	Potential Alternative	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Available	Potentially Offer Significant Environmental or Socioeconomic Benefits	Rationale
Alternative Sites							
Eliminated Alternative 1 (E1)	Off-site non-reactive waste rock disposal	Yes	Yes	Yes	Yes	No	This alternative was eliminated from consideration because the on-site subaqueous disposal alternative (Mine Site Alternative) offered all the benefits of off-site disposal without the added impacts associated with transporting the waste rock off-site (e.g., noise and emissions from the trucks). In addition, further waste rock characterization shows there may be no “non-reactive rock.”
E2	Offsite, in-pit sub-aqueous reactive waste rock (preferably Category 3 and 4) disposal in the LTVSMC Area 3 pit or other previously disturbed land (including Area 2, 2W, 2WX, 5S, 5N, 5NW, and Dunka pits)	Yes	Yes	Yes	Partially	No	Area 2E, 2W, and 3 pits have 216, 136, and 90 million tons of proven taconite crude ore reserves, respectively, and have been recently sold to another developer. Area 2WX pit has over 383 million tons of known mineral reserves and is optioned to Mesabi Nugget. The Dunka Pit is under contract to another developer. Therefore it is concluded that these pits are unavailable and have mineral reserves that would be lost if the pits were used for waste rock disposal. The Area 5 pits are available; however, they were eliminated from consideration because the on-site subaqueous disposal alternative offered most of the benefits of off-site disposal without the impacts associated with transporting the waste rock off-site (e.g., noise and emissions from the trucks).
E3	Alternative mine pit	No	No	No	No	Uncertain	An alternative mine site would not meet the underlying need or purpose of the Project. The mineralization of the desired elements within a geologic deposit dictates the location of the mine. Eliminated in Final SDD.
E4	Alternative Processing Plant site	Yes	Uncertain	No	Uncertain	No	An alternative Processing Plant site would not likely have significant environmental benefits over using existing mining industry infrastructure. Eliminated in Final SDD.
E5	Off-site sub-aqueous in-pit tailings disposal (consider LTVSMC Area 2, Area 2W, Area 2WX, Area 3, Area 5S, Area 5N, and Area 5NW)	Yes	Yes, but insufficient disposal volume	Uncertain	Only Area 5 pits, thus insufficient volume of disposal capacity	No	Area 2E, 2W, and 3 pits have 216, 136, and 90 million tons of proven taconite crude ore reserves, respectively, and have been recently sold to another developer. Area 2WX has over 383 million tons of known mineral reserves and is optioned to Mesabi Nugget. Therefore we conclude these pits are unavailable and have mineral reserves that would be lost if the pits were used for waste rock disposal. The Area 5 pits are available; however, they were eliminated from consideration because they do not provide the required disposal capacity for tailings.

Alternative Number	Potential Alternative	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Available	Potentially Offer Significant Environmental or Socioeconomic Benefits	Rationale
E6	Off-site subaqueous in-pit co-disposal of reactive waste rock, tailings, and/or overburden	Yes	Yes, but insufficient disposal volume	Uncertain	Only Pits 5S and 5N, thus insufficient volume of disposal capacity	No	Area 2E, 2W, and 3 pits have 216, 136, and 90 million tons of proven taconite crude ore reserves, respectively, and have been recently sold to another developer. Area 2WX has over 383 million tons of known mineral reserves and is optioned to Mesabi Nugget. Therefore we conclude these pits are unavailable and have mineral reserves that would be lost if the pits were used for waste rock disposal. The Area 5 pits are available; however, they were eliminated from consideration because they do not provide the required disposal capacity for tailings.
Alternative Technologies							
E7	Underground mining	No	Yes	No	Yes	Possibly	Not economically viable. The rate of ore production of an underground mine would not support the processing rate necessary to economically process the low grade ore, and therefore would not meet the Purpose and Need of the Project. This reduced scale of production ties into the elimination of the modified scale or magnitude alternative discussed below. Additionally, the ore deposit is shallow and broadly distributed throughout the Mine Site; which increases the safety hazards due to the risk of the mine ceiling collapse unless a sizable amount of ore was left in place and not recovered. It is the position of the tribal cooperating agencies that this alternative was eliminated prematurely and without sufficient consideration. They note that analysis of unquantified environmental impacts, values, and amenities have not be en evaluated as required by CEQ regulations. A study of this particular deposit was performed by U.S. Steel that recommended underground mining. By examining cross-sections showing the distribution of ore by depth, it appears that there are substantial ore reserves at depths that likely could not be accessed by the proposed open-pit mine. The ecological costs of open-pit mining and above-ground disposal of tailings and waste rock are immense. This ecological cost, combined with the most current understanding of deposit ore grades and reasonably possible metals prices, must be evaluated to determine the viability of this alternative.

Alternative Number	Potential Alternative	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Available	Potentially Offer Significant Environmental or Socioeconomic Benefits	Rationale
E8	Other Hydrometallurgical technologies	Yes	Yes	Uncertain	Yes	No	The Project uses a hydrometallurgical technology that does not include cyanide leach or other technologies that may have significant environmental effects. Although there are impacts that are analyzed for the proposed hydrometallurgical process, other processing technologies would have no significant environmental benefit over the proposed technology. Eliminated in the Final SDD.
E9	Concentrate-only operations mode	No	Yes	No	Yes	Possibly	PolyMet has proposed as an alternative operating scenario in limited circumstances, such as pre-hydromet startup and during maintenance and periods of high energy costs. Normal operation in concentrate-only mode cannot sustain successful levels of metal recovery.
Modified Designs or Layouts							
E10	Process the Category 3 and 4 lean ore and waste rock through the Processing Plant	Yes	Uncertain	No	Uncertain	No	While this alternative eliminates high sulfur waste at the Mine Site, thus reducing the potential for long term impact from the Mine Site, this alternative would increase the mass of tailings which would require increased storage volume and could increase groundwater impacts from the Tailings Basin. In addition, the Plant's ability to process very low metal content rock is unknown.
E11	Alternative designs and layouts for the ore Processing Plant.	Yes	Yes	Uncertain	Yes	No	Alternative designs and layouts of the ore Processing Plant would not likely provide significant environmental benefits over the Project. Eliminated in Final SDD.
E12	Alternative ore transportation from the mine to the Processing Plant (e.g., conveyor belt)	Yes	Uncertain	Uncertain	Yes	No	The Project includes using existing railroads with construction of a short railroad spur from the mine to the Processing Plant. Alternative designs and layouts would not likely provide significant environmental benefits over the Project. Eliminated in Final SDD.
E13	Alternative ore transport from pit to surface (conveyors vs. trucks)	Yes	Possibly, but may require less steep pit.	Possibly, would require a mobile in-pit crusher	Yes	Possibly would reduce mobile source air emissions	Conveying ore from pit to surface will require a mobile in-pit crusher and likely a less steep pit, which would increase land disturbance and wetland impacts. Although using a conveyor system could allow separation of large diameter rocks, which if used for construction purposes might produce drainage that would meet water quality discharge limits, practically these larger rocks are not useful for construction and would need to be further crushed. Air quality benefits are not believed to be significant.
E14	Co-disposal of reactive waste rock and tailings on a lined tailing basin	Yes	No	Uncertain	Yes	Possibly	The current Project description does not propose lining of the Tailings Basin, therefore this alternative is not feasible as a stand alone alternative.

Alternative Number	Potential Alternative	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Available	Potentially Offer Significant Environmental or Socioeconomic Benefits	Rationale
E15	Pretreatment of Mine Site reactive runoff and discharge to City of Babbitt or Hoyt Lakes POTW	Yes	Uncertain	Uncertain	Uncertain	No	The current Project description no longer proposes a surface water discharge, but rather collects this water for beneficial reuse at the Processing Plant.
E16	Pretreatment of tailings basin process water and discharge to the City of Hoyt Lakes POTW	Yes	Yes	Uncertain	Uncertain	No	The current Project no longer proposes a surface water discharge, but rather collects this water for use at the Processing Plant.
E17	Use of Mine Site reactive runoff as make-up water for Processing Plant with single wastewater treatment at the Processing Plant. Could include pretreatment and discharge to a POTW	Yes	Yes	Uncertain	Uncertain	No	The current Project includes use of Mine Site reactive runoff as make-up water for the Processing Plant. However, a single wastewater treatment facility is located at the Mine Site. Inclusion of pretreatment and discharge to one of the nearest POTW's (Babbit or Hoyt Lakes) is not feasible as the POTW capacities would not accept this additional load (flow).
E18	Use of low sulfur waste rock as construction material	Yes	Yes	Yes	Yes	No	This alternative was eliminated because the low sulfur waste rock (Category 1) has been determined to be reactive.
E19	Use non-contact stromwater from detention pond at Mine Site as process water to reduce withdrawals from Colby Lake and fluctuations in Whitewater Reservoir	Yes	Yes	Yes	Yes	No	MnDNR fisheries staff indicate that they would prefer maintaining the base flow in the Partridge River (to which the non-contact stromwater would otherwise flow) over reducing water level fluctuations in Whitewater Reservoir.
E20	Dispose of waste rock and/or tailings in West Pit	Yes	Yes	Possibly	Yes	No	There are additional mineral resources in the West Pit that would effectively be lost if the pit was used for waste rock and/or tailings disposal. This alternative does not appear to offer significant benefits over the Mine Stie alternative already under consideration that would still allow future ore recovery in West Pit.
Modified Scale or Magnitude							

Alternative Number	Potential Alternative	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Available	Potentially Offer Significant Environmental or Socioeconomic Benefits	Rationale
E21	Operating a smaller mine and ore processing facility	No	Yes	No	Yes	No	Although there may be environmental benefits from a smaller scale project, such as a smaller impact footprint (for wetlands, wildlife, vegetation, etc.), the cost of operating a smaller mine and ore processing facility for the low grade ore body will adversely affect the feasibility of the Project. An 18,000 tpd operation was determined not to be feasible. There may be some smaller scale of the operation than the proposed 32,000 tpd scale that would still be economically feasible, but the environmental benefits associated with this smaller scale of operation not produce significant environmental benefits. Eliminated in Final SDD.

3.2.4.2 Alternative Technologies

Evaluating alternative processing technologies to the Proposed Action was not carried forward in the DEIS since it was determined during the Final SDD process that alternative hydrometallurgy technologies would not have significant environmental benefits over the proposed hydrometallurgy technology. The Final SDD stated that underground mining would not meet the purpose and need of the Project, "If the cost of developing an underground mine were so high that the proposer could not develop the Project." The following analysis is included in response to public inquiries regarding the feasibility of underground mining the NorthMet deposit. Tribal cooperating agencies disagree with the rationale used to eliminate underground mining as an alternative. See table 3.2-2 for details.

The minability and extraction rate of underground mining is largely dependent on the geometry of the deposit. Standard underground mining practices for shallow-dipping ore bodies (such as NorthMet) require that pillars of rock be left in place to stabilize the mining areas against collapse (minimize human safety risks) and prevent craters, or sink holes, at the surface following extraction (minimize environmental risks). The pillars result in abandonment of large quantities of ore as large segments of rock are left unmined, thereby reducing the overall minable tonnage of the deposit. For homogenous (uniformly-distributed) mineral deposits such as NorthMet, the abandonment rate associated with such pillars is up to approximately 50 percent of the in-place ore (PEG Mining Consultants memo, July 2009). The extraction rate associated with underground mining would be lower relative to bulk surface mining (e.g. 5,000 tons per day, compared to 32,000 tons per day, respectively) because large-scale equipment cannot access the deposit efficiently and the ore must be extracted with smaller equipment at a lower daily production rate. Effectively, underground mining reduces the scale of the Project as there is less available ore and the daily extraction rate would decrease relative to bulk surface mining.

During scoping a reduced ore processing rate alternative (approximately 56 percent of the Proposed Action) was evaluated and it was determined that daily production rates at that scale would not be economically feasible (the Final SDD stated that an alternative scale or magnitude would not feasibly meet the purpose of the Project - see below for alternative scale and magnitude discussions). This reduced scale is within the range of the potential pillar ore that would not be mined if the NorthMet deposit were mined by underground technologies.

Preliminary and approximate capital costs and unit operating cost per ton to extract the ore through both surface and underground mining methods are presented in Table 3.2-3.

***Table 3.2-3 Comparison of Surface and Underground Mining Costs for the NorthMet* Deposit**

	Surface Mining	Underground Mining	Cost Difference to use Underground Mining
Capital Cost	$18.5 million	$120 to $180 million	6 to 10 times greater
Unit Cost (per ton)	$3.26	$20 to $50	6 to 15 times greater

Sources: PolyMet's January 2007 NorthMet PD; and PEG Mining Consultants memo July 2009

The capital start-up costs for mining the NorthMet deposit using underground methods would be six to ten times the cost of surface mining and the unit operating cost per ton would be six to fifteen times greater than if the deposit was mined from the surface. Underground mining would reduce the minable ore tonnage of the deposit by a significant amount (pillars of ore left in place for geotechnical stability) and by increased economic ore cut off grade, while at the same time requiring a substantial increase in both start-up and unit production costs.

During the Scoping EAW and Final SDD process, it was determined that if the cost for developing an underground mine were found to be so high that the proposer could not develop the Project, this alternative would not meet the Purpose and Need of the Project. The economic imbalance between increased capital costs and decreased production rates (modified scale and magnitude) would increase the overall costs and payback period such that the rate of return is not economically viable. Therefore, this alternative would not meet the Purpose and Need of the Project and this technology alternative was not carried forward for further consideration.

3.2.4.3 Modified Designs or Layouts

During the Final SDD process, alternative designs and layouts for ore transportation from the mine to the Processing Plant were eliminated from further evaluation since the Proposed Action primarily includes use of existing railroads, requiring new construction only of a new railroad spur at the Mine Site and approximately one mile of new railroad between the railroad that serves the Mine Site and the railroad that serves the Processing Plant. Therefore, it was determined that alternative designs and layouts would not likely provide significant environmental benefit over the Project.

Under the Proposed Action, the Processing Plant is sited on a brownfield site, where the LTVSMC Processing Plant existed previously. Therefore, during the Final SDD process, alternative designs or layouts for the ore Processing Plant were eliminated from further evaluation as it was determined that they would disturb greenfield space and therefore would not provide a significant environmental benefit over the Proposed Action .

The Final SDD stated that the EIS would evaluate the feasibility and environmental impacts of mining the NorthMet deposits as two mine pits, with one pit being completely mined out before the beginning of the second pit. This evaluation was to consider the placement of the waste rock from the second pit into the first pit that was mined so that final pit lake and waste rock stockpiles would be considerably smaller. In addition, this evaluation would consider the issue of encumbering resources and the feasibility of backfilling the pits with both reactive and non-reactive waste rock. Through the EIS process, it was realized that the two pit layout (West Pit and East/Central Pit) and backfilling of the first pit to be mined (East Pit) with the least reactive (Category 1 and 2) waste rock from the later mined pit (West Pit) would render fewer environmental impacts and was therefore integrated by PolyMet into the Proposed Action as described throughout this DEIS.

The Final SDD also stated that the EIS would evaluate the chemical modification of reactive waste rock stockpiles and the co-disposal of reactive waste rock and tailings on a lined tailings basin. The chemical modification of reactive waste rock stockpiles is listed in Table 3.2-2 Alternatives Considered But Eliminated (E14). The co-disposal of reactive waste rock and tailings on a lined tailings basin was carried forward in the analysis as a mitigation measure (Table 3.2-1).

Finally, the Final SDD stated that the EIS would consider several options for management of wastewater:

- Pretreatment of Mine Site reactive runoff and discharge to POTW, considering the cities of Babbitt and Hoyt Lakes POTW's;

- Pretreatment of Tailings Basin process water and discharge to the City of Hoyt Lakes POTW; and

- Use of Mine Site reactive runoff as make-up water for Processing Plant with single wastewater treatment at the Processing Plant. This option could also include pretreatment and discharge to a POTW.

These three options were considered but eliminated as alternatives E15, E16, and E17 in Table 3.2-2.

3.2.4.4 Modified Scale or Magnitude

As discussed in Section 2.2.4, multiple ore processing rates were analyzed to determine the economic feasibility of the Project at various scales. It was determined during the Final SDD process that although there may be environmental benefits from smaller amounts of mine waste associated with a smaller scale project, the cost of operating a smaller mine and facility would adversely effect the feasibility of the Project. As part of the Project development, various mill feed rates (32,000 tpd and 18,000 tpd) were evaluated to estimate the economic feasibility of the Project. The reduced scale operations (e.g., processing ore at 18,000 tpd) offered environmental benefits relative to the Proposed Action but the return on investment for the smaller operation was not economically feasible and therefore did not meet the Purpose and Need for the Project. It was also determined during the Final SDD process that some smaller variability around the Proposed Action (32,000 tpd) scale could still be economically feasible; however, these smaller changes to the processing rate did not offer significant environmental benefits compared to the Proposed Action. Therefore, no alternative scale or magnitude alternatives were carried forward for further consideration in accordance with the Final SDD.

4.0 EXISTING CONDITIONS AND ENVIRONMENTAL CONSEQUENCES

4.1 WATER RESOURCES

This Water Resources section primarily focuses on water inputs to (e.g., surface water withdrawals) and outputs from (e.g., releases to surface or groundwater) Project operations through Post-Closure to evaluate Project effects on both surface and groundwater quantity and quality. We have provided below a "roadmap" to the Water Resources section (Table 4.1-1) that guides the reader to the pages where key water resources topics are discussed.

It is the tribal cooperating agencies position that there are several fatal flaws in the water resources section. These fatal flaws are listed below. Hydrologic characterization and impact prediction at the mine site and the tailings area are not based on strong data:

1. Water Quantity and Flow

Baseline. The baseline data for both the mine site and the tailings basin are sparse. A comparison of hydrologic data that was collected for two other projects in the region (GLIFWC letter to Jon Ahlness and Stuart Arkley, February 6, 2009) demonstrates that the PolyMet project is data-poor in the area of basic hydrology. The use of flow data on the Partridge River from a site twenty years and seventeen miles distant from the proposed project does not provide sufficient information to allow a full assessment of the hydrologic and environmental impacts of the project on the Partridge River. The lack of groundwater level data in the surficial aquifer and in the bedrock, except in the immediate vicinity of the mine pits, does not allow for a full or complete characterization of the watertable or the potentiometric surface in the bedrock or the surficial aquifer. The current bedrock groundwater model calibration to shallow wetland pizometers cannot be justified. The lack of groundwater level data at the tailings area except in the immediate area of the tailings piles prevents complete characterization of water tables, potentiometric surfaces, and groundwater flow direction. The dramatic scarcity of hydrologic data for the PolyMet project, both at the mine site and at the site of the tailings basins has been repeatedly recognized by hydrologists at technical meetings. Limited data collection to fill in the data gaps has recently been conducted and in general not incorporated into hydrologic analysis of the mine or plant site.

Analysis. Hydrologic characterization using MODFLOW models was done for the immediate area of the mine pit and the tailings pile only. There are no groundwater models that were designed to characterize the watertables, the potentiometric surface in the aquifers, fluxes to rivers and streams or to predict impacts to the water tables or surface waters. The MODFLOW groundwater model at the tailings area is restricted to the tailings pile and cannot be used to characterize groundwater flow direction, the watertables, the potentiometric surface in the aquifers, fluxes to rivers and streams or to predict mounding impacts to the water tables or surface waters. Data driven models need to be developed and these impacts need to be predicted and evaluated.

The view that mine pit dewatering impacts will be very limited or non-existent (Adams, John and Michael Liljegren. 2009 “Additional PolyMet peatland data / information.” email communication to Stuart Arkley. February 1, 2009) is based on the assumption that there is little or no connection between the bedrock and surficial aquifers (GLIFWC 2009, Memorandum to Jon Ahlness and Stuart Arkley: Photographic evidence for pit impacts to wetland hydrology. April 24, 2009). However, the scant data that does exist characterizing mine site hydrology suggests that there may be substantial connection between the bedrock and surficial aquifers. Such a connection would mean that dewatering of the mine pits could cause significant drawdown of the watertable in the surficial aquifer. Data presented in RS02 indicates that ammonia can be found in deep boreholes. Section 3.3 Analytical Results, Pg.10 of RS02 states: "The water sample from boring 05-407M exceeded the criteria for ammonia (1,900 ug/l)”; and goes on to state, “The sample from boring 05-401M exceeded criteria for ammonia (610 ug/l)."; and “Water quality criteria were exceeded for ammonia, aluminum, copper, and silver in both boreholes.”; and concluded that, “The presence of ammonia in the deep boreholes may indicate that the water in the borehole came from the shallow surficial deposits. Ammonia is not typically found in deep bedrock systems but is common in wetland environments." Similarly, technical document RS10 concludes: “The presence of ammonia nitrogen in the samples likely indicates that there is a hydraulic connection between the bedrock aquifer and the surficial aquifer; however, the nature of this connection cannot be determined at this time." Furthermore, tritium data also presented in RS10 suggests that deep water is of relatively recent origin.

While professional opinion can be very useful in predicting mine impacts, it must be tempered with site specific knowledge based on quantitative data. Models, using assumptions based on professional judgment, that adequately characterize the hydrology of both the mine site and the tailings site must be developed so that hydrologic data can be integrated into the best characterization of the area’s hydrology possible. Such models depend on the reasonable use of professional judgment but require a significant amount of real, site-specific data. The expertise of both local hydrologists and hydrologists with experience in other settings is needed to develop a plan for hydrologic data collection and for formulating the appropriate models to integrate the hydrologic data.

2. Water Quality.

The old LTV taconite mining and processing site encompasses approximately 60,000 acres. The PolyMet project would use some of the degraded areas of the old LTV site to develop the mine plant site and re-use the tailings basin. Groundwater contamination from the previous mining activities is still an issue near the LTV tailings basin more than twenty years after operations ceased. Because of the limited distribution of monitoring wells, the extent of the contaminant plume is not known. However, recent well data show that the plume extends in some areas at least as far as private wells along the Embarrass River. In the wells that do exist near the tailings basin, pollutants including iron, sulfate, manganese, aluminum, and fluoride exceeded drinking water standards. Recent wells near the northern property line show substantial contamination of the groundwater aquifer (Barr 2009, Memorandum: Results of Tailings Basin Hydrogeological Investigation. June 2, 2009). The baseline data on which to base estimates of the impact of the proposed project on water quality at the mine site and the tailings basins is insufficient. The existing analysis for the PolyMet project calculates the additional constituents that the project will add to groundwater but is unable to realistically estimate what the resulting water quality will be because background water quality has not been incorporated into the estimates. Private domestic wells lie between the tailings basin and the Embarrass River where tailings basin discharge water is expected to ultimately discharge. Some of the sampled private wells have contaminants at levels several times the drinking water standard (Barr 2009, Memorandum: Results of residential well sampling north of LTVSMC tailings basin. January 27, 2009) Samples from these wells show exceedances of manganese and close to exceedances of the arsenic standard. Once a groundwater flow model is developed that would show the direction and rate of groundwater flow, that pattern of flow should be used to plan a groundwater sampling scheme that would map the extent of the existing contaminant plume. This data and analysis should then feed into estimates of how the proposed project would interact with existing contamination. The combination of existing conditions with impacts due to the proposed project would show what groundwater quality can be expected during and post project.

Surface water quality at the project has been poorly characterized or left uncharacterized. The limited data that exist suggest that surface waters are already adversely impacted by mining activity. Mercury, sulfate and specific conductance have exceeded Minnesota surface water criteria in surface water samples collected near the tailings basin proposed for use by PolyMet, at nearby Area Pit 5, and mercury exceeds surface water criteria in the Partridge River downstream of Colby Lake. However, no water samples have been collected from lakes near the tailings basin (Hiekkilla, Mud, Kaunonen, or Hay Lakes) to determine if the pollutants found in the surface and groundwater at the existing tailings pile have caused contamination of those waterbodies. Contaminant transport modeling suggests that the PolyMet project will cause manganese, aluminum and sulfate to exceed standards. Proposals to collect data and monitor groundwater after the issuance of the DEIS would not allow for identification of potentially significant groundwater and surface water impacts or provide this analysis and information to the public during the primary public comment period..

Table 4.1-1 Water Resources Section Page Number Roadmap

Key Topics	Existing Conditions (EC)	Proposed Action (PA)	No Action Alternative (NAA)	Mine Site Alternative (MSA)	Tailings Basin Alternative (TBA)
Groundwater levels at Mine Site	4.1-2	4.1-48	Same as EC	Same as PA	Not applicable
Groundwater quality at Mine Site	4.1-7	4.1-53	Same as EC	4.1-107	Not applicable
Flows in the Upper Partridge River	4.1-19	4.1-77	Same as EC	Same as PA	Not applicable
Water quality in Upper Partridge River	4.1-30	4.1-87	Same as EC	4.1-111	Not applicable
Water levels in Colby Lake	4.1-22	4.1-83	Same as EC	Same as PA	4.1-122
Water quality in Colby Lake	4.1-32	4.1-92	Same as EC		Not applicable
Flows in the Lower Partridge River	4.1-24	4.1-84	Same as EC	Same as PA	4.1-123
Water quality in Lower Partridge River	4.1-35	4.1-93	Same as EC		4.1-124
Groundwater levels at Tailings Basin	4.1-5	4.1-51	4.1-104	Not applicable	4.1-117
Groundwater quality downgradient of the Tailings Basin	4.1-10	4.1-67	4.1-104	Not applicable	4.1-118
Flows in the Embarrass River	4.1-24	4.1-85	Same as EC	Not applicable	4.1-125
Water quality in Embarrass River	4.1-36	4.1-94	4.1-104	Not applicable	4.1-125
Mercury in water	4.1-40	4.1-97	4.1-105	4.1-114	4.1-127
Impact Summary Table	Not applicable	4.1-103	4.1-105	4.1-116	4.1-128

4.1.1 Existing Conditions

4.1.1.1 Meteorological Conditions

The Project is located near the headwaters of the Partridge and Embarrass River watersheds at approximate elevation of 1,600 feet above mean sea level (feet msl). Meteorological data are available for the Project area from two weather stations operated by the National Weather Service (NWS) - Babbitt 2SE (located about five miles from the Mine Site) with 66 years of records and Hoyt Lakes 5N (located about one mile from the Plant Site) with 25 years of records (Figure 4.1-1).

Table 4.1-2 shows the monthly and annual average air temperature and precipitation for the two NWS stations. Precipitation averages approximately 28 inches annually. Snowfall in the Project area typically occurs between October and April. Rainfall statistics from various storm events for this area were obtained from the Rainfall Frequency Atlas of the Midwest (Huff and Angel 1992). Estimates of annual average evaporation for northern Minnesota range from 18 inches (Siegel and Ericson 1980) to 22 inches (Meyer 1942). Pan evaporation measurements indicate no evaporation occurs during the winter months.

Table 4.1-2 Normal Monthly and Annual Average Air Temperature and Precipitation near the NorthMet Project

Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Air Temperature (°F)													
Babbitt 2 SE	6.7	14.4	25.7	40.3	54.6	62.4	66.6	64.5	54.9	43.3	26.5	12.0	39.3
Hoyt Lakes 5N	3.4	8.6	21.8	37.5	52.3	58.9	64.9	61.4	51.8	41.0	25.4	8.7	36.3
Precipitation (inches)													
Babbitt 2 SE	0.83	0.65	0.97	1.49	2.82	3.96	3.61	4.14	3.44	2.90	1.92	0.92	27.65
Hoyt Lakes 5N	0.95	0.81	1.46	1.49	3.01	3.98	3.84	4.38	3.17	3.06	1.21	0.78	28.15

Source: Western Region Climate Center, Reno, NV (www.wrcc.dri.edu/htmlfiles/mn/mn.01.html)
Period of Record: Babbitt = 1920 to 1986; Hoyt Lakes = 1958 to 1983.

4.1.1.2 Groundwater Resources

This section describes the existing geologic and hydrogeologic setting and groundwater resources that could be affected by the Project. Principal groundwater resources are contained in bedrock geologic units and overlying surficial glacial deposits (also referred to as unconsolidated deposits). Saturated conditions exist within the unconsolidated deposits and in the underlying bedrock at the Mine and Plant Sites. Recharge to the bedrock aquifers is by infiltration of precipitation in outcrop areas and leakage from the overlying surficial aquifer (Siegel and Ericson 1980). The water table is primarily located within the surficial aquifer, but is likely located within the bedrock in areas of local bedrock highs.

Hydrogeology

Mine Site

Over 10 copper-nickel-PGE deposits have been identified along the northern margin of the Duluth Complex. The NorthMet deposit is located within the Partridge River intrusion on the southern flank of the Mesabi Iron Range, which hosts large taconite iron ore mines, the closest of which (Peter Mitchell Mine) is about one mile north of the Mine Site. The deposit consists of disseminated copper-nickel-iron sulfides, with minor local massive sulfides, hosted in layered heterogeneous troctolitic (plagioclase and olivine with minor pyroxene) rocks forming the basal unit of the Duluth Complex. Extensive drilling within the Partridge River intrusion (over 1,100 drill holes) has identified seven layered troctolitic igneous rock units dipping southeast in the NorthMet deposit (Figure 4.1-2). Unit 1, which has the most economic sulfide mineralization, is the oldest layer and hosts the Project ore body.

The footwall rocks below the NorthMet deposit consist of Paleoproterozoic sedimentary rocks. The youngest of these sedimentary rocks is the Virginia Formation, which directly underlies Unit 1 across all of the Project (i.e., the Duluth Complex only contacts the Virginia Formation and does not contact the older sedimentary formations below, as shown in Figure 4.1-3). The Virginia Formation consists of a thinly-bedded sequence of argillite and greywacke and contains relatively high sulfur content.

Underlying the Virginia Formation is the Biwabik Iron Formation, which is the source of taconite iron ore and is an important water source for residential and community wells in the region. The NorthMet mine would retain about a 100-foot separation from the Biwabik Formation (RS22, Barr 2007). The oldest of the sedimentary rocks is the Pokegama Quartzite. These sedimentary rocks are underlain by Archean granite of the Giants Ridge batholith.

The Biwabik Formation has a relatively high permeability, whereas the Virginia Formation and Duluth Complex are much less permeable (Siegel and Ericson 1980). PolyMet conducted several aquifer tests to characterize the hydraulic conductivity and specific storage values for the bedrock aquifers underlying the Mine Site, although no testing was done in the Biwabik Iron Formations (Table 4.1-3). As indicated above, the Biwabik Iron Formation is believed to have the highest hydraulic conductivity, followed by the Virginia Formation, with the Duluth Complex having conductivity at least one order of magnitude lower. As part of the aquifer testing, a range of specific storage values for the bedrock aquifer (i.e., 2.3×10^{-5} to 5.5×10^{-7} ft^{-1}) was determined from time-drawdown data at observation wells. The specific capacity tests conducted in two wells indicated that the upper portion of the Virginia Formation is more permeable than the lower portion (RS10A, Barr 2007). This is attributed to the increased amount of fractures and joints in the bedrock closer to the surface. Overall, groundwater flow within the bedrock units is thought to be primarily through fractures and other secondary porosity features because the rocks have low primary hydraulic conductivity. Near the ground surface, groundwater in the bedrock is thought to be hydraulically connected with the overlying surficial aquifers, resulting in similar flow directions (RS22, Barr 2007).

Table 4.1-3 Bedrock and Surficial Aquifer Hydraulic Conductivity Estimates at the Mine Site

		Hydraulic Conductivity		
Aquifer	**Test methods**	**Range**	**Geometric Mean**	**Reference**
Surficial	Lab permeability tests on silty sand samples	$4.3x10^{-4}$ ft/day to $8.1x10^{-3}$ ft/day	NA	Appendix B in RS22B, Draft 03, Barr 2008
	Single-well tests of various unconsolidated deposits	$1.2x10^{-2}$ ft/day to $3.1x10^{1}$ ft/day	NA	Appendix B in RS22B, Draft 03, Barr 2008
Duluth Complex	Single-well aquifer tests on 10 exploratory borings	$2.6x10^{-4}$ ft/day – $4.1x10^{-2}$ ft/day	$2.3x10^{-3}$ ft/day	RS02, Barr 2006
Virginia Formation - Upper Portion	4 pumping wells and 5 observation wells	$2.4x10^{-3}$ ft/day - 1.0 ft/day	0.17 ft/day	RS10, Barr 2006
Virginia Formation - Lower Portion	Single well aquifer tests on 2 wells	NA	0.047 ft/day	RS10A, Barr 2007
Biwabik Formation	Specific capacity tests	0.9 ft/day		Siegal and Ericson, 1980

The overlying surficial sediments at the Mine Site are poorly sorted and range from very dense clay to well-sorted sand with boulders and cobbles (RS02, Barr 2006; RS49, Golder 2007). Shallow borings and test trenches at the Mine Site encountered bedrock at depths ranging from 3.5 to 17 feet below ground surface (bgs), so the surficial aquifer is not very thick. The site exploration drilling database, drilling logs, and geophysics (electrical resistivity) data were used to develop an estimated depth to bedrock isopach map (RS49, Golder 2007). The isopach map indicates that more than 75 percent of the surficial cover at the Mine Site is 20 feet thick or less, and 92 percent is less than or equal to 30 feet in thickness. Although the isopach contouring indicates local depressions in the bedrock where estimated surficial cover thickness reaches 50 feet, no major areas of highly permeable outwash sands and gravel have been reported that might serve as groundwater conduits through the unconsolidated material.

The Mine Site has extensive wetlands overlying the relatively thin surficial till aquifer with bedrock fairly close to the surface. Based on well logs, soil borings, and available soil mapping, the hydrology of these wetlands is characterized by a waterlogged organic soil body perched over dense clayey till or a more localized sandy surficial aquifer and represent bog wetlands (RS 44, Barr 2006). Most of the wetlands are mapped as Rifle mucky peat and Greenwood peat mapping units in the Natural Resources Conservation Service soil survey system. These soils are typically characterized by fibric peat in the upper horizons underlain by mucky peat to a depth of up to five feet or more. These bogs are isolated from the underlying groundwater, receiving virtually all of their water and nutrient input from precipitation. They receive essentially no groundwater inflow and have extremely low seepage rates to the underlying surficial aquifer. Tribal cooperating agencies strongly disagree with this conclusion. It is the tribal cooperating agencies' position that there is no data to substantiate this assumption. This assumption is based on incidental observation and the analysis of aerial photography, which is by its nature imprecise (Adams, John and Micheal Liljegren. 2009 "Additional PolyMet peatland data / information."

email communication to Stuart Arkley. February 1, 2009). Tribal cooperating agencies note that the wetland delineation indicates the presence of several hundred acres of cedar swamps and tamarack wetlands. These vegetation types, by definition, rely on an influx of groundwater to support them. Finally, tribal cooperating agencies note that the wetland delineation does not encompass all wetlands that are likely to be affected by the project. Because no initial determination of the projects area of influence (AOI) on wetlands was made, the site field surveys of wetland and other vegetation was limited to little more than the area within the project fence. The existing characterization of wetland and other vegetation does not cover even one-half the area that might reasonably be expected to be impacted by secondary impacts of the mine due to disruption of the existing hydrology. Around the tailings basin virtually no wetland delineation has taken place although wetland impacts from inundation are likely to occur.

Based on the groundwater elevations within the surficial deposits (Figure 4.1-4), groundwater at the Mine Site generally flows to the south, with the major component from the north-northwest direction to south-southeast (perpendicular to the strike of the bedrock geologic formations) toward the Partridge River, which is the major discharge point for the area. Based on limited MnDNR well records in the Project area, natural groundwater levels in the glacial till vary seasonally between 3 and 10 feet. At the Mine Site, depth to groundwater is generally less than five feet below the ground surface (RS02, Barr 2006). Because of the shallow water table and the generally thin nature of the surficial aquifer, flow paths within the surficial deposits are generally thought to be short, with the recharge areas being very near the discharge areas. Groundwater divides generally coincide with surface water divides. However, groundwater flow is interrupted by bedrock outcrops, which force deviations in the groundwater flow field (Siegel and Ericson 1980).

Based on aquifer testing (see Table 4.1-3), the ability of the surficial sediment to transmit water was found to be highly variable depending upon location and thickness of the sediments, as recognized in other studies (Adams et al 2004; Siegel and Ericson 1980). No data were available regarding the storage parameters for the surficial deposits. It is the tribal cooperating agencies' position that any conclusions based on this aquifer test data have a great deal of uncertainty given the variability in the results.

Plant Site

Bedrock at the Plant Site and Tailings Basin consists of Precambrian crystalline and metamorphic rock. The Giants Ridge batholith represents the uppermost bedrock unit encompassing most of the area, although there are two high exposures of bedrock that abut the southeastern corner of Cell 1E at the Tailings Basin that consist of schist of sedimentary and volcanic origin. Aquifer testing in the bedrock has not been performed in the Tailings Basin area, but the bedrock is believed to have a significantly lower hydraulic conductivity than the overlying drift (Barr 2009, Technical Memorandum: Tailings Basin Area Geologic and Hydrogeologic Setting).

Jennings and Reynolds (2005) map the surficial deposits around and beneath the Tailings Basin as Rainy Lobe till, which functions as the surficial aquifer and is generally a boulder-rich till with high clay content. Data from the eight monitoring wells installed north and west of the

Tailings Basin indicate that the primary lithology in this area is sand with varying amounts of silt and gravel. Layers of sandy silt were encountered in two of the borings (Pint et al 2009). The area northwest of the Tailings Basin is believed to be one of the few areas in the region with significant quantities of outwash (sand and gravel) and thicknesses ranging from 0 to greater than 150 feet (Olcott and Siegel 1978) (Figure 4.1-5). Near the toe of the Tailings Basin, average depth to bedrock is approximately 40 feet as reported in site boring logs (Barr 2009, Technical Memorandum: Results of Tailings Basin Hydrogeological Investigation).

The surficial till is often overlain by wetland/peat deposits. Peat deposits were encountered in some borings, ranging in thickness from less than a foot to several feet, but they are relatively few and discontinuous. Most of the area between the Tailings Basin and the Embarrass River is covered by extensive wetlands and minor surface water features, which are assumed to represent surficial expressions of the water table (Barr 2009, Technical Memorandum: Tailings Basin Area Geologic and Hydrogeologic Setting).

Regionally, groundwater flows primarily northward toward the Embarrass River, although there is a small amount of groundwater flow to the south, which forms the headwaters of Second Creek, a tributary of the Partridge River (Figure 4.1-6). North of the Tailings Basin, site monitoring wells show an average gradient of 0.0039 ft/ft with an average direction of 16 degrees west of north. Recent hydrologic investigations (Barr 2009, Technical Memorandum: Results of Tailings Basin Hydrogeological Investigation) indicate that the average flow through the aquifer downgradient of the Tailings Basin (i.e., flux) may be as low as 155 gpm with a recharge rate of approximately 0.3 inches per year (Barr 2009, Technical Memorandum: Results of Tailings Basin Hydrogeological Investigation). Tribal cooperators note that hydrologic data indicates that this aquifer is saturated by tailings discharge water (see discussion below). It is the tribal cooperating agencies' position that therefore, it is not possible for recharge from precipitation to occur.

The LTVSMC Tailings Basin consists of three cells. Cell 2W is the largest (1,450 acres) and highest (average fill height of 200 feet) of the three cells and has been revegetated. Cell 1E is located east of Cell 2W and covers approximately 980 acres with an average fill height of 60 feet. Cell 2E is located east of Cell 2W and north of Cell 1E, covers approximately 620 acres, and has an average fill height of 60 feet, although at a lower elevation than Cell 1E.

As the LTVSMC Tailings Basin was built up over time, a groundwater mound formed beneath the basin due to seepage from ponds located within the various cells. Surface seeps have been identified on the south, west, and north sides of the Tailings Basin, although the number of seeps and the volume of seepage have declined since January 2001 when LTVSMC terminated tailings deposition in the basin. The east side of the Tailings Basin is bounded by low-permeability bedrock uplands and there is likely little or no water that seeps out in this direction. In addition to these visible surface seeps, groundwater flows out from beneath the Tailing Basin into the surrounding unconsolidated deposits to the south, west, and north. Current seepage to the north toward the Embarrass River from the LTVSMC Tailings Basin is estimated at approximately 1,795 gpm (Hinck 2009, Personal Communication). This seepage volume exceeds the aquifer flux capacity, resulting in upwelling of as much as approximately 1,600 gpm of groundwater to the surface. This upwelling, in conjunction with the surface seeps, has inundated some wetlands immediately downgradient of the Tailings Basin (see Section 4.2). These hydrologic impacts to wetlands diminish to the north with little evidence of impacts north of the transmission line (approximately one mile north of the Tailings Basin, as shown in Figure 4.1-7).

Groundwater elevation data have been collected from 2001, when LTVSMC stopped operations, through 2009 at eight monitoring wells in and around the periphery of the Tailings Basin (Figure 4.1-7). These data show that groundwater levels in the monitoring wells outside the Tailings Basin (i.e., GW-001, 002, 006, 007, and 008) are relatively stable. Wells within the Tailings Basin showed a rapid drop in water levels following cessation of LTVSMC operations (i.e., GW-003 has been dry since April 2003), but water levels appear to be relatively stable since 2007 (i.e., GW-004 and GW-005). Following the cessation of mine operations, the remaining surface water within Cell 2W was either drained into Cell 1E or infiltrated into the underlying tailings such that no pond remains. Cells 1E and 2E still impound water, but at lower levels than during active LTVSMC operations. Pond and piezometer water levels located within the cells indicate that these cells may be at or near steady-state conditions. PolyMet proposes to reuse Cells 1E and 2E for NorthMet flotation tailings disposal and to create the Hydrometallurgical Residue Facility, consisting of four small lined containment cells within the southern portion of Cell 2W.

Estimated hydraulic properties of the native units found near the Tailings Basin vary over several orders of magnitude (RS13B, Barr 2008). Estimated hydraulic conductivities range from approximately 0.0002 ft/day for the Giants Ridge bedrock to approximately 70 ft/day for the glacial till (Barr 2009, Technical Memorandum: Tailings Basin Area Geologic and Hydrogeologic Setting). Single well pumping tests conducted in eight of the monitoring wells located within the glacial till found an average permeability of 14 ft/day within a range of 0.4 to 65 ft/day (Barr 2009, Technical Memorandum: Results of Tailings Basin Hydrogeological Investigation), while slug tests performed in standpipe piezometers located in the glacial till downgradient of Cell 2W found an average permeability of only 1.5 ft/day within a range of 0.25 to 2.1 ft/day (Pint and Dehler 2008). The hydraulic conductivity of the LTVSMC tailings ranges from approximately 0.003 ft/day for the slimes to approximately 7 ft/day for the coarse tailings.

Groundwater Quality

In Minnesota, groundwater is protected for use as an actual or potential source of drinking water (Class 1 Water). Groundwater quality standards are published in *Minnesota Rules*, part 4717.7500, Table of Health Risk Limits (Table 4.1-4). The USEPA has also established National Primary Drinking Water Regulations (40 CFR Part 141) that set mandatory water quality standards for drinking water contaminants. These enforceable standards, called maximum contaminant levels (MCLs), are established to protect the public against consumption of water that present a risk to human health. An MCL is the maximum allowable amount of a contaminant in drinking water that is delivered to the consumer, reflecting required water quality after treatment. The USEPA has also established National Secondary Drinking Water Regulations that set non-mandatory water quality standards for 15 contaminants. These secondary MCLs are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health. We collectively refer to the USEPA primary and secondary MCLs and Minnesota Department of Health (MDH) Health Risk Limits as the groundwater evaluation criteria in this EIS.

It is noted that *Minnesota Rules*, part 7060.0600 also has a provision that states:

> *"The groundwater may in its natural state have some characteristics or properties exceeding the standards for potable water supplies. Where the background level of natural origin is reasonably definable and is higher than the accepted standard for potable water and the hydrology and extent of the aquifer are known, the natural level may be used as the standard."*

Mine Site

Based on once a year monitoring at three wells (MW-05-02, MW-05-08, MW-05-09, as shown in Figure 4.1-8), in 2005 and 2006, groundwater within the surficial aquifer at the Mine Site was generally found to meet groundwater evaluation criteria except for elevated concentrations of total and dissolved aluminum, total beryllium, total iron, and total manganese (Table 4.1-5). Overall pH levels tended toward basic (mean of 7.6) with one sample at 10. Methylmercury was detected in two samples at concentrations of 0.043 – 0.13 nanograms per liter (ng/L). The metals exceeding groundwater evaluation criteria in the surficial aquifer are probably natural levels as background because we are unaware of any historic activities at the Mine Site (other than logging) that could have contributed these contaminants.

The natural presence of some of these constituents is consistent with the findings presented in the Regional Copper-Nickel Study (Siegel and Ericson 1980), which found elevated concentrations (i.e., at or higher than the groundwater evaluation criteria) for aluminum (up to 200 micrograms per liter [µg/L]), iron (up to 3,100 µg/L), and manganese (up to 7,100 µg/L), as well as sulfate, cadmium, cobalt, copper, and nickel in groundwater samples collected from the surficial/glacial till aquifers (Table 4.1-5), although the aluminum and iron concentrations found at the Mine Site were considerably higher than these baseline concentrations. Siegel and Ericson (1980) noted that higher concentrations correlated with proximity to the mineralized contact zone between the Duluth Complex and older rocks, as is the case with the NorthMet Project, and is probably related to the oxidation of sulfide ores.

Table 4.1-4 Groundwater Evaluation Criteria Applicable to the NorthMet Project

Solute[1]	Units	USEPA Primary MCL	MDH Health Risk Limits	USEPA Secondary MCL
General Parameters				
Chloride	mg/L	--	--	250
Fluoride	mg/L	4	--	2
Nitrate as Nitrogen	mg/L	10	10	--
Sulfate	mg/L	--	--	250
Metals				
Aluminum	µg/L		--	50 to 200
Antimony	µg/L	6	6	--
Arsenic	µg/L	10	--	--
Barium	µg/L	2,000	2,000	--
Beryllium	µg/L	4	0.08	--
Boron	µg/L	--	1,000[2]	--
Cadmium	µg/L	5	4	--

Solute[1]	Units	USEPA Primary MCL	MDH Health Risk Limits	USEPA Secondary MCL
Chromium	µg/L	100	--	--
Copper[3]	µg/L	1,300[3]	--	1,000
Iron	µg/L	--	--	300
Lead[3]	µg/L	15[3]	--	--
Manganese	µg/L	--	300[4]	50
Mercury (inorganic)[5]	µg/L	2	--	--
Nickel (soluble salts)[6]	µg/L	--	100	--
Selenium	µg/L	50	30	--
Silver	µg/L	--	30	100
Thallium (salts)[7]	µg/L	2	0.6	--
Vanadium	µg/L	--	50	--
Zinc	µg/L	--	2,000	5,000

Source: Primary MCL (40 CFR 141); secondary MCL (40 CFR 143) and HRLs (*Minnesota Rules*, part 4717.7500)

1 Unless noted otherwise, the criteria applies to total concentrations.

2 See MDH guidance www.health.state.mn.us/divs/eh/risk/guidance/boron.html.

3 Lead and copper enter drinking water primarily through plumbing materials. In 1991, EPA published the Lead and Copper Rule (http://www.epa.gov/safewater/lcrmr/index.html). This rule requires water systems to monitor drinking water at customer taps. The 1,300 µg/L copper concentration and 15 µg/L lead concentration represent action levels that, when exceeded at 10% of customer taps, requires the water system to take additional actions to control corrosion. Therefore, these values reflect concentrations at the customer tap.

4 See MDH guidance www.health.state.mn.us/divs/eh/risk/guidance/manganese.html.

5 Mercury level is based on inorganic mercury, the most common form in water. Organic mercury (e.g., methylmercury) is rarely found in drinking water.

6 The Minnesota standard is based on Human Health Risk, soluble salts being the primary form associated with Human Risk.

7 The EPA and MDH limits are based on the salt form of thallium, which is by far the most prevalent form in surface waters.

Table 4.1-5 Summary of Existing Groundwater Quality Monitoring Data for the NorthMet Mine Site

Constituent	Units	Groundwater Evaluation Criteria	Surficial Aquifer				Surficial Aquifer Northeast MN Baseline	Surficial Aquifer Cu-Ni Study Baseline	Bedrock Aquifer			
			Detection	Mean[1]	Range	# Exceed.	Range	Range	Detection	Mean[1]	Range	# Exceed.
General Parameters												
Ammonia as Nitrogen	mg/L	--	2 of 6	0.18	<0.10 to 0.42	NA	--	--	2 of 16	0.3	<0.1 to 1.9	NA
Calcium	mg/L	--	6 of 6	9.46	0.007 to 30.1	NA	0.155 to 115.508	6.5 to 150	16 of 16	7.9	0.0054 to 38.5	NA
Carbon, total organic	mg/L	--	6 of 6	4.3	1.6 to 8	NA	<0.5 to 21.7	2.1 to 46	16 of 16	3.3	1.5 to 7.6	NA
Chloride	mg/L	250	6 of 6	1.81	0.69 to 5.5	0	--	0.4 to 35	14 of 16	8.2	<0.5 to 93.1	0
Fluoride	mg/L	2	4 of 6	0.13	0.1 to 0.21	0	0.20 to 0.57	--	13 of 16	0.4	<0.1 to 1.1	0
Magnesium	mg/L	--	6 of 6	2,469.8	5.65 to 6,800	NA	0.112 to 326,412	5.1 to 64	15 of 16	3.9	<2 to 15	NA
pH	s.u.	6.5 to 8.5	6 of 6	7.6	6.5 to 10	1	6.0 to 8.4	5.7 to 8.0	16 of 16	7.7	6.6 to 9.0	3
Sulfate	mg/L	250	6 of 6	14.0	10.4 to 21.2	0	<0.3 to 14.2	1.8 – 450	14 of 15	96.8	<37.2 to 1,200	1
Metals - Total												
Aluminum	ug/L	50 to 200	6 of 6	**5,959**	31.6 to 27,100	5	<0.1 to 28	0.0 to 200	9 of 16	**2,759**	<25 to 39,000	9
Antimony	ug/L	6	0 of 6	<3	<3	0	<0.01 to 0.04	--	0 of 16	<3	<3	0
Arsenic	ug/L	10	4 of 6	3.3	<2 to 4.8	0	0.1 to 9.1	--	4 of 16	2.5	<2 to 5.7	0
Barium	ug/L	2,000	4 of 6	64.2	<10 to 214	0	1.6 to 191	--	1 of 16	15.1	<10 to 92.1	0
Beryllium	ug/L	0.08	2 of 6	**0.3**	<0.2 to 0.7	BDL[2]	<0.01 to 0.41	--	3 of 16	0.2	<0.2 to 0.8	BDL[2]
Boron	ug/L	1,000	1 of 6	43.4	<35 to <50	0	<13 to 41	--	11 of 16	133	<35 to 518	0
Cadmium	ug/L	4	0 of 6	<0.2	<0.2	0	<0.02 to 0.2	0.0 to 8.4	3 of 16	0.6	<0.2 to 1.7	0
Cobalt	ug/L	--	3 of 6	3.2	<1 to 8.8	NA	0.05 to 0.63	0.3 to 28.0	3 of 16	2.5	<1 to 19.9	NA
Copper	ug/L	1,000	6 of 6	33.5	2.4 to 99.6	0	<5.5 to 22	0.6 to 190.0	5 of 16	41.9	<2 to 587	0
Iron	ug/L	300	6 of 6	**6,701**	54.3 to 29,800	5	7 to 7,816	0.0 to 3,100	15 of 16	**2,604**	<50 to 24,500	8
Lead	ug/L	15	2 of 6	2.6	<1 to 6.1	0	<0.03 to 2.0	0.1 to 6.4	1 of 16	1.8	<1 to 95	0
Manganese	ug/L	50	6 of 6	**230**	<30 to 584	5	0.9 to 1,248	10.0 to 7,100	12 of 16	**72**	<10 to 383	5
Mercury	ng/L	2,000	3 of 4	3.6	<2.0 to 28.8	0	--	--	2 of 11	1.2	<0.5 to 4.9	0
Mercury, Methyl	ng/L	--	2 of 6	0.07	<0.025 to 0.13	NA	--	--	1 of 15	0.05	<0.025 to 0.07	NA
Molybdenum	ug/L	--	4 of 6	14.4	<5 to 35.6	NA	<4.2 to 12	--	1 of 15	7.0	<5 to 34.5	NA
Nickel	ug/L	100	4 of 6	10.8	<2 to 40.2	0	<6.0 to 16	1.0 to 120.0	5 of 16	21.8	<2 to 172	2
Selenium	ug/L	30	0 of 6	<2	<2	0	<1.0 to 4.7	--	1 of 16	3.8	<2 to <10	0
Silver	ug/L	30	0 of 6	1.3	<1 to <2	0	<0.01 to 0.05	--	2 of 16	1.4	<1 to 7.4	0
Thallium	ug/L	0.6	0 of 6	<2	<2	BDL[2]	<0.0035 to 0.0096	--	0 of 16	<2	<2	BDL[2]
Zinc	ug/L	2,000	2 of 6	21.4	<10 to 46.3	0	<2.7 to 138	3.9 to 170.0	7 of 16	38.8	<10 to 125	0
Dissolved/Filtered Metals												
Aluminum	ug/L	50 to 200	5 of 6	**304**	<25 to 910	4	--	--	3 of 16	35.5	<25 to 126	3
Cadmium	ug/L	4	0 of 6	<0.2	<0.2	0	--	--	1 of 16	0.2	<0.2 to 0.2	0
Copper	ug/L	1,000	4 of 6	7.4	<2 to 18.2	0	--	--	3 of 16	2.0	<2 to 2.3	0
Molybdenum	ug/L	--	3 of 6	11.9	<5 to 34.4	NA	--	--	1 of 16	6.5	<5 to 28.9	NA
Nickel	ug/L	100	1 of 6	2.2	<2 to 3	0	--	--	3 of 16	8.6	<2 to 100	0
Selenium	ug/L	30	0 of 6	<2	<2	0	--	--	0 of 16	<2	<2	0
Silver	ug/L	30	0 of 6	<1	<1	0	--	--	0 of 16	<1	<1	0
Zinc	ug/L	2,000	0 of 6	17.5	<10 to <25	0	--	--	4 of 16	38.0	<10 to 134	0

Source: RS02, Barr 2007; RS10, Barr 2006; RS10A, Barr 2007; MPCA 1999; and Siegel and Ericson 1980.

Notes: mg/L = milligrams per liter, ug/L = micrograms per liter, ng/L = nanograms per liter, < = less than indicated reporting limit, NA = not applicable.

1 Where non-detects occur, the mean was calculated using the detection limit.

2 Below Detection Limit

Groundwater samples have been collected from nine bedrock (i.e., Duluth Complex and Virginia Formation) monitoring wells (i.e., pumping wells P1–P4 and observation wells Ob1–Ob5), one water supply well, and two exploratory boreholes at the Mine Site. The average water quality in the bedrock at the Mine Site was generally found to meet groundwater evaluation criteria except for total aluminum, total iron, and total manganese (Table 4.1-5). Siegel and Ericson (1980) reported iron and manganese concentrations up to 5,000 and 1,800 µg/L, respectively, in the Biwabik Iron Formation. The pH of the bedrock water samples from the Duluth Formation tended toward basic (i.e., >7.0 - 9.0), while samples from the Virginia Formation was more acidic (i.e., <7.0) with only one exception. Occasional exceedances of beryllium, nickel, and dissolved aluminum were detected.

Plant Site

There are eight existing groundwater monitoring wells (i.e., wells GW-001 through GW-008) at the Tailings Basin that have been monitored since 1999 (Figure 4.1-7). GW-002 is considered the background station for the Tailings Basin, as it is located southwest of Cell 2W and distant from the Tailings Basin groundwater flow path. Three of the wells (GW-003, GW-004, and GW-005) are located within Cell 2W and were intended to monitor the high sulfide Virginia Formation hornfels waste rock that was placed in this cell in 1993. The remaining four wells (GW-001, GW-006, GW-007, and GW-008) are located at or very near the toe of the Tailings Basin embankment. Four additional wells, as shown in Figure 4.1-7, were installed in 2009 to better characterize water quality at the toe of the Tailings Basin (GW-012) and downgradient of the Tailings Basin (GW-009, GW-010, and GW-011). Limited water quality data are available from these four new wells.

<u>Background Water Quality</u>

At the background well (GW-002), groundwater within the surficial aquifer has elevated concentrations (i.e., at or higher than the groundwater evaluation criteria) of total aluminum, iron, and manganese (Table 4.1-6). The manganese levels were within the range of baseline concentrations found by MPCA in Northeast Minnesota (MPCA 1999) and in the Regional Copper-Nickel Study (Siegel and Ericson 1980), but the aluminum and iron values were above the baseline concentrations found in these two studies. All other parameters met the groundwater evaluation criteria.

Table 4.1-6 Summary of Groundwater Quality Monitoring Data for the Tailings Basin Area

Constituent	Units	Groundwater Evaluation Criteria	Tailings Basin Background GW-002 Surficial Aquifer				Northeast MN Baseline Surficial Aquifer	Copper-Nickel Baseline Surficial Aquifer
General Parameters			**Detection**	**Mean[1]**	**Range**	**# Exceed.**	**Range**	**Range**
Ammonia as Nitrogen	mg/L	--	0 of 3	<0.10	<0.10	--	--	--
Calcium	mg/L	--	3 of 3	14.3	11.4 to 16.6	--	--	--
Carbon, total organic	mg/L	--	2 of 2	4.7	1.9 to 7.4	--	--	--
Chloride	mg/L	250	23 of 26	2.3	<0.5 to 31.2	0		0.4 to 35
Fluoride	mg/L	2	16 of 26	0.1	<0.1 to 0.5	0	0.2 to 0.6	--
pH	s.u.	6.5 – 8.5	25 of 25	**7.5**	6.2 to 8.9	**2**	6.0 to 8.4	5.7 to 8.0
Sulfate	mg/L	250	26 of 27	11.5	<0.9 to 55.4	0	<0.3 to 14.2	1.8 to 450
Total Dissolved Solids	mg/L	500	24 of 24	**105**	50 to 518	**1**	28 to 482	--
Metals – Total								
Aluminum	ug/L	50 - 200	3 of 3	**10,133**	4,600 to 16,000	**3**	<0.1 to 28	0 to 200
Antimony	ug/L	6	0 of 3	<0.5	<0.5	0	<0.01 to 0.04	--
Arsenic	ug/L	10	1 of 3	4.7	<2 to <10	0	<0.1 to 9.1	--
Barium	ug/L	2,000	3 of 3	72	47 to 110	0	1.6 to 191	--
Beryllium	ug/L	0.08	0 of 3	1.1	<0.2 to <2.0	0[2]	<0.0010 to 0.410	--
Boron	ug/L	1,000	4 of 12	91	<35 to 283	0	<13 to 41	--
Cadmium	ug/L	4	2 of 3	0.36	<0.2 to 0.46	0	<0.02 to 0.18	0 to 8.4
Chromium	ug/L	100	3 of 3	20.5	13.4 to 31	0	0.090 to 4.7	0 to 5.5
Cobalt	ug/L	--	3 of 3	5.0	2.8 to 7.9	0	0.05 to 0.63	0.3 to 28.0
Copper	ug/L	1,000	2 of 2	24.5	17 to 32	0	<5.5 to 22	0.6 to 190
Iron	ug/L	300	3 of 3	**11,723**	5,170 to 18,000	**3**	7 to 7,816	0 to 3,100
Lead	ug/L	15	3 of 3	2.8	1.8 to 4.0	0	<0.03 to 2.0	0.1 to 6.4
Manganese	ug/L	50	12 of 13	**169**	<10 to 1,170	**3**	1 to 1,248	10 to 7,190
Mercury	ng/L	2,000	2 of 2	6	4.2 to 7.7	0	--	--
Mercury, Methyl	ng/L	--	0 of 2	0.08	<0.05 to <0.1	--	--	--
Molybdenum	ug/L	--	5 of 24	4.5	<5 to 6.5	NA	--	--
Nickel	ug/L	100	2 of 2	12.8	10.6 to 15	0	<6.0 to 16	--
Selenium	ug/L	30	0 of 3	2.3	<1.0 to <5.0	0	<1.0 to 4.7	--
Silver	ug/L	30	0 of 3	<0.2	<0.2	0	<0.009 to 0.050	--
Thallium	ug/L	0.6	0 of 3	<0.4	<0.4	0[2]	<0.0035 to 0.0096	--
Zinc	ug/L	2,000	1 of 2	39	<30 to 48	0	<2.7 to 138	3.9 to 170
Dissolved/Filtered Metals								
Aluminum	ug/L	50 - 200	2 of 3	**63.7**	<25 to 110	**2**	--	--
Arsenic	ug/L	10	--	--	--	--	--	--
Boron	ug/L	1,000	0 of 14	41.4	<5 to <50	0	--	--
Cadmium	ug/L	4	0 of 3	<0.20	<0.20	0	--	--
Chromium	ug/L	100	2 of 3	1.7	<2.0 to 1.7	0	--	--
Copper	ug/L	1,000	2 of 3	5.9	<10 to 4.7	0	--	--
Manganese	ug/L	50	11 of 14	**44.7**	<10 to 267	**2**	--	--
Nickel	ug/L	100	2 of 3	2.8	<1.5 to <5	0	--	--
Selenium	ug/L	30	0 of 3	<1.0	<1.0	0	--	--
Silver	ug/L	30	0 of 3	<0.20	<0.20	0	--	--
Zinc	ug/L	2,000	0 of 2	18	<6.0 to <30	0	--	--

Source: Barr 2008, "Plant Site Groundwater Predictions," November 12, 2008; Barr 2009 "Results of Residential Well Sampling North of LTVSMC Tailings Basin, January 27, 2009;" RS64, Barr 2006; Barr 2009, Memorandum: Water Quality Estimates for LTVSMC Tailings Basin Cell 2E and Cell 2W Seepage; NTS 2009; MPCA 1999; and Siegel and Ericson 1980

Notes: mg/L = milligrams per liter, µg/L = micrograms per liter, ng/L = nanograms per liter, < = less than indicated reporting limit, TB = Tailings Basin

Bold (e.g., 0.014) indicates exceeds evaluation criteria.

1 Where non-detects occur, the mean was calculated using the detection limit.

2 Detection limit is greater than water quality standard.

Existing Water Quality within the Tailings Basin Pond and at the Toe of the Tailings Basin

Ponds remain within Cells 1E and 2E of the LTVSMC Tailings Basin (no pond remains in Cell 2W). Based on limited monitoring of pond water quality and interpolation of seepage monitoring data discussed below, PolyMet characterized existing pond water quality (Table 4.1-7). The LTVSMC Tailings Basin is really is a disposal facility and is not a natural surface water body or a point of compliance pursuant to Cliffs Erie’s NPDES/SDS permit, so comparisons of these data with surface or groundwater standards is not appropriate. Nevertheless, it can be instructive to compare existing pond water quality with water quality at the toe of the Tailings Basin to help understand the effect passage through the LTVSMC tailings is having on seepage water quality. It is the tribal cooperating agencies' position that it would be instructive to compare past or existing pond water quality with water quality at the toe of the Tailings Basin to help understand the effect passage through the LTVSMC tailings is having on seepage water quality. However, a comparison of modeled future pond water quality (Table 4.1-7) with existing groundwater quality at the toe of the basins does not provide a useful comparison.

Table 4.1-7 Summary of Predicted Pond Water and Groundwater Quality at the Tailings Basin

Constituent	Units	Toe of Tailings Basin (GW-001,GW-006, GW-007, GW-008, GW-012) Surficial Aquifer					Pond Water Quality
General Parameters		**Groundwater Evaluation Criteria**	**Detection**	**Mean[1]**	**Range**	**# Exceed.**	**Modeled**
Calcium	mg/L	--	16 of 16	72	23 to 132	NA	53
Chloride	mg/L	250	113 to 113	1.7	0.5 to 34	0	32
Fluoride	mg/L	2	93 of 114	1.3	<0.1 to 9.6	30	6.7
pH	s.u.	6.5 – 8.5	117 of 117	7.4	6.2 to 9.1	6	--
Sulfate	mg/L	250	114 of 114	155	13.4 to 555	24	183
Total Dissolved Solids	mg/L	500	97 of 97	576	49 to 1,400	58	--
Metals – Total							
Aluminum	ug/L	50 - 200	11 of 15	1,080	<25 to 6,600	7	157[2]
Antimony	ug/L	6	0 of 15	<0.5	<0.5	0	0.3[2]
Arsenic	ug/L	10	6 of 15	3.0	<0.5 to <10	0	6.7
Barium	ug/L	2,000	13 of 14	116	<10 to 300	0	6.9[2]
Beryllium	ug/L	0.08	0 of 15	0.9	<0.2 to <2.0	0	0.1[2]
Boron	ug/L	1,000	40 of 49	301	<35 to 588	0	42[2]
Cadmium	ug/L	4	1 of 15	0.5	<0.2 to <2.0	0	0.1[2]
Chromium	ug/L	100	2 of 11	2.5	<1.0 to 9.5	0	--
Cobalt	ug/L	--	16 of 16	1.8	0.22 to 5.0	NA	1.3
Copper	ug/L	1,000	12 of 13	3.9	0.7 to 13	0	2.7[2]
Iron	ug/L	300	15 of 15	4,248	72.2 to 14,000	33	78
Lead	ug/L	15	4 of 15	1.1	<0.5 to 5.6	0	0.3[2]
Manganese	ug/L	50	51 of 51	1,192	40 to 4,020	16	44[2]
Mercury	ng/L	2	7 of 8	1.5	0.2 to 4.6	2	3
Mercury, Methyl	ng/L	--	0 of 6	0.07	<0.05 to <0.1	NA	--
Molybdenum	ug/L	--	68 of 89	23.8	<1 to 94.8	NA	0.4[2]
Nickel	ug/L	100	11 of 11	5.9	2.1 to 11	0	2.1[2]
Selenium	ug/L	30	2 of 15	1.6	<1.0 to <10	0	0.5[2]
Silver	ug/L	30	0 of 15	<0.2	<0.2	0	0.1[2]
Thallium	ug/L	0.6	0 of 15	<0.4	<0.4	0	0.3[2]
Zinc	ug/L	2,000	3 of 13	16.8	<6.0 to 33	0	3.0[2]
Dissolved/Filtered Metals							
Aluminum	ug/L	50 - 200	2 of 15	18	<10 to 25	0	--
Arsenic	ug/L	10	0 of 1	2	<2	0	--
Boron	ug/L	1,000	50 of 64	270	<35 to 540	0	--
Cadmium	ug/L	4	0 of 14	0.5	<0.20 to <2.0	0	--
Chromium	ug/L	100	3 of 15	1.5	<1.0 to 2.9	0	--
Copper	ug/L	1,000	11 of 16	61	<0.7 to 913	0	--
Manganese	ug/L	50	58 of 58	913	40 to 2,090	37	--
Nickel	ug/L	100	10 of 17	3.9	<2 to 8.1	0	--
Selenium	ug/L	30	0 of 15	<1.0	<1.0	0	--
Silver	ug/L	30	0 of 15	<0.2	<0.2	0	--
Zinc	ug/L	2,000	6 of 14	13	<6 to <30	0	--

Sources: Porewater – Barr 209, Memorandum: Water Quality Estimates for LTVSMC Tailings Basin Cell 2E and Cell 2W Seepage; Pondwater - Table 7-17, RS54/RS46, SRK 2007; Hornfel Rock, RS64, Barr 2006.

Notes: mg/L = milligrams per liter, ug/L = micrograms per liter, ng/L = nanograms per liter, < = less than indicated reporting limit.

1 Where non-detects occur, the mean was calculated using the detection limit.

2 No pond water quality sampling data available. Values based on 2008 Colby Lake data.

The pond water quality data generally show elevated fluoride, mercury, sulfate, and dissolved aluminum concentrations. The elevated fluoride concentrations may be attributable to the use of wet scrubbers for emission control at the LTVSMC furnaces, which removed highly soluble hydrogen fluoride (HF) gas resulting in elevated fluoride concentrations in the scrubber water, which was disposed of in the Tailings Basin. The elevated mercury concentrations may be attributable to mercury concentrations in meteoric water, which tend to average about 10 ng/L in northern Minnesota.

Groundwater quality monitoring at several wells completed in the surficial aquifer at or near the toe of the Tailings Basin (GW-001, GW-006, GW-007, GW-008, and GW-012) found neutral tending toward basic pH (mean of 7.4), and concentrations for several parameters exceeding some groundwater quality evaluation criteria (Table 4.1-7). As with the background well (GW-002), these wells exhibited elevated aluminum, iron, and manganese concentrations, but also exhibited elevated sulfate, fluoride, molybdenum, and total dissolved solids (TDS) concentrations relative to the background well. Based on these results, NTS (2009) concluded that groundwater has been impacted by the Tailings Basin. NTS noted, however, that there does not appear to be an overall trend, either increasing or decreasing, in concentration of constituents monitored. Potential exceedances for beryllium correspond to situations where the laboratory detection limits (<1.0 µg/L) is greater than the evaluation criteria (0.08 µg/L).

It is the Tribal cooperating agencies' position that the existing LTVSMC tailings are contributing substantially to the level of constituents observed in the groundwater. Unfortunately the modeling of PolyMet contaminants at the basins does not take these or other existing constituents adequately into account (RS74 and TB-14). The result of this oversight is that the contaminant modeling done by PolyMet comes to the illogical conclusion that seepage water from PolyMet, after passing through both LTVSMC and PolyMet tailings, will be cleaner than the existing seepage that is passing only through the LTVSMC tailings. According to PolyMet's consultant "the predicted concentration of seepage from the PolyMet basin is lower than the actual measured concentration of existing seepage".(TB-14, page 9). It is unclear how the addition of mine waste to the basins would cause seepage water quality to improve.

Existing Groundwater Quality Downgradient from the LTVSMC Tailings Basin

PolyMet conducted a single round of groundwater sampling at three monitoring wells located approximately one mile north of the Tailings Basin (Figure 4.1-7) and at 15 residential wells located between 1.6 miles and 3.8 miles north of the Tailings Basin (Figure 4.1-9), as shown in Table 4.1-8 (Barr 2009, Technical Memorandum: Results of Tailings Basin Hydrogeological Investigation; Barr 2009, Results of Residential Well Sampling North of LTVSMC Tailings Basin). As with the background well, the three monitoring wells also exhibited elevated aluminum, iron, and manganese concentrations, although the concentrations were even higher than those found at the toe of the Tailings Basin.

In terms of the residential wells located farther from the Tailings Basin, the samples indicated that several wells exhibited total and dissolved manganese concentrations exceeding the groundwater evaluation criteria (i.e., secondary MCL). Localized high manganese concentrations can occur when carbon dioxide is available under reducing condition (e.g., from anaerobic decay of vegetation, Berndt et al 1999) and these concentrations are within the range found in the Regional

Copper-Nickel Study. One well had total and dissolved aluminum concentrations slightly above the evaluation criteria and four wells had pH concentrations below the minimum of the range (pH of 6.5), but again, these values are within the range found in the Regional Copper-Nickel Study. Although limited, these data suggest little degradation of groundwater quality at the residential well locations from the nearly 50 years of LTVSMC tailings disposal.

Existing Bedrock Aquifer Water Quality at the Plant Site

No bedrock groundwater samples are available from the Plant Site/Tailings Basin. Although some of the residential wells summarized in Table 4.1-8 sample bedrock aquifers based on well completion records, these wells were not constructed as monitoring wells to distinguish the bedrock from the surficial aquifer. Siegel and Ericson (1980) report that iron and manganese concentrations up to 500 µg/L are common in the Giants Ridge batholith.

Table 4.1-8 Summary of Existing Groundwater Quality Monitoring Data Downgradient from the LTVSMC Tailings Basin

Constituent	Units	Groundwater Evaluation Criteria	Downgradient Wells (GW-009, GW-010, GW-011) Surficial Aquifer				Downgradient Residential Wells Bedrock and Surficial Aquifers			
General Parameters			**Detection**	**Mean**	**Range**	**# Exceed.**	**Detection**	**Mean**	**Range**	**# Exceed.**
Ammonia as Nitrogen	mg/L	--	0 of 3	<100	<100 to <100	--	--	--	--	--
Calcium	mg/L	--	3 of 3	47	15.8 to 66	--	15 of 15	25	11.7 to 51.4	--
Carbon, total organic	mg/L	--	3 of 3	8.7	1.4 to 18.4	--	--	--	--	--
Chloride	mg/L	250	3 of 3	11.4	2.8 to 18.4	0	14 of 15	4.2	<0.5 to 12.5	0
Fluoride	mg/L	2	3 of 3	0.2	0.11 to 0.23	0	11 of 15	0.2	<0.1 to 0.6	0
pH	s.u.	6.5 – 8.5	3 of 3	6.6	6.4 to 6.9	**1**	15 of 15	6.9	5.7 to 7.9	**4**
Sulfate	mg/L	250	3 of 3	109	20.8 to 235	0	12 of 15	6.1	<1 to 20.9	0
Total Dissolved Solids	mg/L	500	--	--	--	--	15 of 15	125	83 to 243	0
Metals – Total										
Aluminum	ug/L	50 - 200	3 of 3	2,361	25.3 to 9,140	**3**	2 of 15	30.2	<25 to 83	**1**
Antimony	ug/L	6	0 of 3	<0.5	<0.5	0	0 of 15	<0.5	<0.5	0
Arsenic	ug/L	10	0 of 3	<2	<2	0	3 of 15	2.8	<2 to 7.5	0
Barium	ug/L	2,000	3 of 3	195	37.9 to 442	0	--	--	--	--
Beryllium	ug/L	0.08	1 of 3	0.24	<0.2 to 0.34	**1**	--	--	--	--
Boron	ug/L	1,000	2 of 3	104	<50 to 150	0	3 of 15	79	<50 to 459	0
Cadmium	ug/L	4	0 of 3	0.3	<0.2 to 0.47	0	--	--	--	--
Chromium	ug/L	100	0 of 3	7.6	<1 to 27.3	0	--	--	--	--
Cobalt	ug/L	--	3 of 3	6.2	1.2 to 13.5	--	--	--	--	--
Copper	ug/L	1,000	3 of 3	6.0	1.2 to 17.9	0	13 of 14	38	<0.7 to 86.7	0
Iron	ug/L	300	3 of 3	4,743	63.2 to 14,700	**3**	--	--	--	--
Lead	ug/L	15	1 of 3	1.2	<0.5 to 3	0	--	--	--	--
Manganese	ug/L	50	3 of 3	1,637	226 to 2,990	**4**	15 of 15	579	0.66 to 4,710	**7**
Mercury	ug/L	2	--	--	--	--	--	--	--	--
Mercury, Methyl	ng/L	--	--	--	--	--	--	--	--	--
Molybdenum	ug/L	--	3 of 3	5.1	1.2 to 9.2	--	12 of 15	0.6	<2 to 1.4	--
Nickel	ug/L	100	3 of 3	11.7	4.6 to 28.8	0	14 of 15	1.9	<0.6 to 5.5	0
Selenium	ug/L	30	0 of 3	<1	<1	0	--	--	--	--
Silver	ug/L	30	0 of 3	<0.2	<0.2	0	--	--	--	--
Thallium	ug/L	0.6	0 of 3	<0.4	<0.4	0	--	--	--	--
Zinc	ug/L	2,000	0 of 3	6	<6 to <6	0	--	--	--	--
Dissolved/Filtered Metals										
Aluminum	ug/L	50 - 200	0 of 3	25	<25 to <25	0	2 of 15	28	<25 to 71	**1**
Arsenic	ug/L	10	0 of 3	<2	<2	0	3 of 15	2.7	<2 to 7.5	0
Boron	ug/L	1,000	--	--	--	--	3 of 15	80	<50 to 461	0
Cadmium	ug/L	4	0 of 3	0.2	<0.2	0	--	--	--	--
Chromium	ug/L	100	0 of 3	1	<1	0	--	--	--	--
Copper	ug/L	1,000	2 of 3	2.0	<0.7 to 3.5	0	14 of 15	19.3	<0.7 to 64.5	0
Manganese	ug/L	50	--	--	--	--	15 of 15	579	0.63 to 4,850	**7**
Nickel	ug/L	100	3 of 3	6.7	4.4 to 9.2	0	12 of 15	1.6	<0.6 to 5	0
Selenium	ug/L	30	0 of 3	1	<1	0	--	--	--	--
Silver	ug/L	30	0 of 3	0.2	<0.2	0	--	--	--	--
Zinc	ug/L	2,000	0 of 3	<6	<6 to <6	0	--	--	--	--

<u>Legacy Groundwater Quality Issues at the Plant Site and Tailings Basin</u>

In 2002, Cliffs Erie LLC commissioned a Phase I Environmental Site Assessment (ESA) of the former LTVSMC property and improvements (NTS 2002), which identified 62 potential areas of concern (AOCs). Designation as an area of concern does not necessarily mean that contamination occurred in the past or is currently present, but simply that these are areas requiring further investigation.

As shown in Figure 4.1-10, PolyMet would assume responsibility for 29 of the 62 AOCs upon acquiring the property from Cliffs Erie LLC (RS52, Barr 2007). Five of the AOCs to be acquired by PolyMet have been closed or have received a no further action letter from the MPCA, and two

AOCs are permitted former landfills that require post-closure monitoring pursuant to the Minnesota solid waste landfill requirements. The remaining 22 AOCs require further investigation. Table 4.1-9 summarizes the potential issues and current status of these AOCs. PolyMet indicates that it intends to continue the Voluntary Investigation and Cleanup (VIC) program initiated by Cliffs Erie and will investigate and remediate as necessary these AOCs on a schedule approved by the MPCA. PolyMet plans to reuse some of these AOCs (i.e., AOC 1, 38, 43, 44, 46, 48, and 59). At Closure, all historic and any potential operational AOCs would be investigated and remediated as necessary. MnDNR has indicated that any associated clean up costs for the legacy AOCs would be included in the financial assurance requirements for any Permit-to-Mine issued to PolyMet for the NorthMet Project (Vadis 2009).

Of the remaining 33 AOCs of which PolyMet does not have any responsibility for, 10 sites have been closed through the VIC program; 6 sites are pending closure through the VIC program or awaiting confirmatory sampling; 4 sites have completed initial investigations, provided sampling plans, and are awaiting MPCA review; 3 have not yet been investigated; 8 sites have been transferred and their status is not readily available; 1 site is being managed through the NPDES program; and 1 site will likely require additional remediation (i.e., Pellet Plant). Table 4.1-10 summarizes the potential issues and current status of these AOCs.

In May 2009, Cliffs Erie conducted a detailed assessment of both surface and groundwater quality at the LTVSMC Tailings Basin, including testing for volatile organic compounds (VOCs), semi-volatile compounds (SVOCs), PCBs, and other parameters to determine if there was any organic contamination that could be transported off-site via stormwater runoff or groundwater seepage. The laboratory analyses determined all samples were below the detection limits for all organic parameters (Clark 2009, Personal Communication).

Based on the investigations and laboratory analyses to date, there has not been any documentation of any off-site contamination, and the extent of on-site contamination appears to be limited to localized soils and possibly groundwater. Cliffs Erie LLC did receive a permit (SW-625) in 2006 from MPCA to locate two individual land treatment sites within Cell 2W of the LTVSMC Tailings Basin. This facility is being used to land farm petroleum (i.e., diesel fuel) contaminated soils excavated from AOCs #38 (Area 2 Shops) and #39 (Knox Train Fueling Station).

Tribal cooperating agencies note that additional legacy issues exist. Over the many decades of operations at the tailings basin, thousands of gallons per minute of tailings basin water have been discharged through the bottom of the basin, into groundwater. This water has then moved down gradient and into surrounding wetlands and as stated in the water quality section below, ultimately reaches the Embarrass River. It is the tribal cooperating agencies' position that despite very limited recent groundwater sampling that shows groundwater contamination at the property line and at private wells north of the basin, the full extent of the contaminant plume and the existing contamination to groundwater has not been defined.

Table 4.1-9 PolyMet Area of Concern Summary List for Voluntary Investigation and Cleanup Program

AOC No.	Location	Description	Identified Potential Issues	Status
1	Area 1	Area 1 Shops and Reporting	Domestic septic systems and drain field	A Phase I ESA/SAP has been prepared.
6	Area 1	Oily Waste Disposal Area	Waste from general shop area floor drains	No actions have been taken with regard to this site.
7	Area 1	Bull Gear Disposal Area	One time 1970s disposal of heavy lubricant	No actions have been taken with regard to this site.
8	Area 1	Private Landfill	Permitted industrial waste landfill that operated until 1993. Appears in good conditions.	Permitted Industrial Landfill SW-619. Closed and subject to post-closure monitoring
9	Area 1	Area 1 RR Panel Yard	Railroad tie disposal area comingled with scrap metal, wood and demolition debris	SAP approved by MPCA in 11/08. Implementation scheduled for 2009
10	Area 1	Area 1 Airport	Some areas of soil staining	No actions have been taken with regard to this site.
11	Area 1	Stoker Coal Ash Disposal	Disposal area until 1980s with marginal cover	No actions have been taken with regard to this site.
12	Area 1	Mill Rejects Area	Solid waste from concentrator building	Site closed-No Further Action required.
13	Area 2/2E/3	2001 Storage Area	Some areas of soil staining	No actions have been taken with regard to this site.
14	Area 2/2E/3	Large Equipment Paint Area	Buildup of blasting sand	No actions have been taken with regard to this site.
24	Area 5	Area 5 Reporting	Scrap and salvage area with some stained soils	Site has been closed thru the VIC program in letter dated 7/30/08
25	Area 5	Area 5 Loading Pocket & Storage	Some areas of stained soils along rail siding.	Site has been closed thru the VIC program in letter dated 7/30/08
35	Plant Site	Dunka WTP Sludge Staging Area	Little evidence of any residue remaining	Water treatment plant sludge residue removed.
36	Plant Site	Coal Ash Landfill	Cover appears to be in good condition	Permitted Landfill. Closed and subject to post-closure monitoring.
37	Plant Site	Line 9 Area 5 Petroleum Contaminated Soil	Permitted petroleum land application site with 25,000 cubic yards of soils	The MPCA sent a closure letter for this site on February 24, 2006.
38	Plant Site	Area 2 Shops	Contains a locomotive fueling station and a septic system.	Excavation conducted Summer 2007. Pending MPCA PRP conditional closure. Full closure is contingent on sampling results for the land treated soils.
40	Plant Site	Heavy Duty Garage	Formerly used for equipment maintenance	Building and one UST removed
42	Plant Site	Bunker C Tank Farm	Large AST of #4 and #6 fuel oil.	Remedial excavation completed in 2007. Fuel line removal scheduled for summer 2009
43	Plant Site	Administration Building	One heating oil UST was abandoned in place	Facility still in use.
44	Plant Site	Main Gate Vehicle Fueling Area	Contains several AST used for fueling trucks.	Facility still in use.
46	Plant Site	Plant Site Proper/General Shops	Former taconite processing area – no specific issues identified.	No actions have been taken with regard to this site.
47	Tailings Basin	Tailings Basin Reporting	Septic system remains	Two USTs removed
48	Tailings Basin	Transformers	Several transformers present, but records indicate that do not contain PCBs.	No actions have been taken with regard to this site.
49	Tailings Basin	Coarse Crusher Petroleum Contaminated Soil Stockpile	Contained floor sweepings (containing oil).	All contaminated soil was removed in 1990s.
50	Tailings Basin	Emergency Basin	No additional information available.	SAP approved by MPCA in 10/08. Implementation scheduled for 2009.
51	Tailings Basin	Salvage and Scrap Areas	Some areas of soil staining	No actions have been taken with regard to this site.
52	Tailings Basin	Cell 2W Salvage Area	Several small soil stained areas as well as the remnants of a mobile AST.	No actions have been taken with regard to this site.
53	Tailings Basin	Cell 2W Hornfels waste rock	Sulfide waste rock disposed under a MPCA/MnDNR approved plan.	NPDES monitoring on-going.
59	Colby Lake	Colby Lake Pumping Station	One transformer remaining.	One heating oil AST removed in 1970.

Source: NTS 2008; NTS 2002; Scott 2009, Personal Communication, "Re: Reconciling AOCs"; NTS 2009
UST – underground storage tank; AST – aboveground storage tank; VIC – Voluntary Investigation and Cleanup; WTP – water treatment plant; SAP – Sampling and Analysis Plan

Table 4.1-10 Non-PolyMet Area of Concern Summary List for Voluntary Investigation and Cleanup Program

AOC	Responsible Party	Site Description	Issues	Status
2	Mesabi Nugget	Area 1 petroleum contaminated soil	petroleum contaminated soil	liability transferred
3	Mesabi Nugget	Sludge site	sludge contaminated soil	liability transferred
4	Mesabi Nugget	1004 storage area	soil staining and debris	liability transferred
5	Mesabi Nugget	Roofing disposal site	roofing debris	liability transferred
15	Cliffs Erie	Railroad storage area	Debris	No action to date
16	Cliffs Erie	Area 2 vibratory loading pocket		Phase II submitted November 2008, requested no further action
17	Cliffs Erie	Area 2 truck fueling		Site has been closed through the VIC program
18	Cliffs Erie	Area 2 superpocket		Phase II submitted November 2008, requested no further action
19	Mesabi Nugget	Area 2WX reporting		Site has been closed through the VIC program in letter dated 7/31/08
20	Mesabi Nugget	Area 2WX shovel salvage		Site has been closed through the VIC program in letter dated 7/31/08
21	Mesabi Nugget	Area 2WX truck fueling		Site has been closed through the VIC program
22	Mesabi Nugget	Area 2WX vibratory loading pocket		Site has been closed through the VIC program in letter dated 7/31/08
23	Mesabi Nugget	Area 2WX superpocket		Site has been closed through the VIC program
26	Mesabi Nugget	Area 6 truck fueling		Site has been closed through the VIC program
27	Mesabi Nugget	Area 6 misfired blast		Site has been closed through the VIC program
28	Mesabi Nugget	Area 9S former Aurora dump site	Debris	liability transferred
29	Mesabi Nugget	Stockpile #9021	debris related to Aurora dump site	liability transferred
30	Mesabi Nugget	Pre-taconite plant	Debris	liability transferred
31	Mesabi Nugget	Area 9N vibratory loading pocket	septic tank and drain field	liability transferred
32	Duluth Metals	Dunka shops and reporting	demolition debris, closed leak site	Phase I ESA and SAP complete, but not yet submitted
33	Duluth Metals	North loading pocket – Dunka	abandoned wells and septic system	Phase I ESA and SAP complete, but not yet submitted
34	Duluth Metals	South loading pocket – Dunka	abandoned wells and septic system	Phase I ESA and SAP complete, but not yet submitted
39	Cliffs Erie	Knox Railroad fueling station		Pending closure based on confirmatory sampling
41	Cliffs Erie	Oxygen plant		Pending closure
45	Cliffs Erie	Pellet storage area and load-out	soil staining and petroleum residue	No action to date
54	Cliffs Erie	Taconite Harbor marine fueling ASTs		Pending closure based on confirmatory sampling
55	Cliffs Erie	Taconite Harbor oil track		Pending closure based on confirmatory sampling
56	Cliffs Erie	Coal ash landfill - Taconite Harbor		Managed through NPDES permit, no VIC action
57	Cliffs Erie	Murphy City	soil staining, well and septic system	Phase I ESA and SAP complete, but not yet submitted
58	Cliffs Erie	Rail lubricators	stained soil	No action to date
60	Cliffs Erie	Brick recycling area		Site has been closed through the VIC program
61	Cliffs Erie	PCB ditch investigation (pellet plant)		Site has been closed through the VIC program
62	Cliffs Erie	Pellet plant	soil staining and debris	Phase I ESA and SAP submitted in December 2008, additional action likely

Source: NTS 2008; NTS 2002.
UST – underground storage tank; AST – aboveground storage tank; VIC – Voluntary Investigation and Cleanup; SAP – Sampling and Analysis Plan

Groundwater Use

There are no existing domestic wells between the Mine Site and the Partridge River (Minnesota Department of Health, http://mdh-agua.health.state.mn.us/cwi/). There are, however, 27 known domestic wells between the Tailings Basin and the Embarrass River, with the closest being approximately 1.6 miles from the toe of Cell 2E, as shown in Table 4.1-11 and Figure 4.1-9. In addition, there are several valid Water Appropriation Permits for mine pit dewatering in the Project area, including the Peter Mitchell Mine (Permit #822097), which authorizes Northshore Mining Company to withdraw up to 29,700 gpm (66.2 cfs) of groundwater. This water is discharged to both the Partridge and Dunka rivers pursuant to NPDES/SDS permit MN0046981.

Table 4.1-11 Existing Domestic Wells Located Between the Proposed PolyMet Tailings Area and the Embarrass River

Unique Well No.	Map Number	Direction From Site	Surface Elev. (ft)	Depth (ft)	Depth Cased (ft)	GWL (ft bgs)	Casing Diameter (in)	Aquifer
476480	1	NW	1445	63	63	8	6	Alluvium
584595	2	N	1468	30	30	8.3	6	Alluvium
144818	3	N	1467	45	28	--	6	Bedrock
668955	4	N	1459	50	50	15.3	6	Alluvium
658445	5	N	1436	83	81	-2	6	Bedrock
693384	6	W	1423	325	20	22	6	Bedrock
151880	7	NW	1433	103	96	--	6	Multiple
189325	8	NW	1430	97	97	7	6	Alluvium
519773	9	NW	1417	42	42	5	6	Alluvium
169958	10	NW	1443	223	33	23	6	Bedrock
411142	11	NW	1445	229	34	35	6	Bedrock
409338	12	NW	1429	43	43	25	6	Alluvium
563293	13	N	1459	325	18	--	6	Bedrock
555048	14	NNE	1459	45	29	0	6	Bedrock
620123	15	NNE	1461	65	18	8.2	6	Bedrock
555023	16	NNE	1459	100	19	--	6	Bedrock
716183	17	NNE	--	325	29	20.5	6	Bedrock
174550	18	NE	1445	60	50	8	7	Bedrock
447031	19	N	1451	86	86	15	6	Alluvium
701452	20	N	--	125	40	8	6	Unknown
735554	21	N	--	205	31	14	6	Bedrock
576439	22	NNW	1447	80	80	7.7	6	Alluvium
187853	23	NNW	1465	90	90	--	6	Alluvium
529149	24	NNW	1468	42	42	22	6	Alluvium
620143	25	NNW	1469	61	61	34.4	6	Alluvium
409060	26	NNW	--	100	60	40	6	Unknown
741400	27	NNW	--	41	41	21	6	Unknown

Source: Minnesota County Well Index (http://mdh-agua.health.state.mn.us/cwi/) and Barr 2009, Results of Residential Well Sampling North of LTVSMC Tailings Basin
GWL - groundwater level; bgs – below ground surface

4.1.1.3 Surface Water Resources

The Partridge and Embarrass rivers are the two primary waterbodies draining the Project and both are within the St. Louis River Basin (Figure 4.1-1). This section describes the existing hydrology and water quality of these two rivers and other potentially affected tributaries in the Project area.

Hydrology

Partridge River

The Partridge River forms just south of the Peter Mitchell Mine (although historically it source was further upstream) and flows approximately 32 miles to its confluence with the St. Louis River, draining a total of approximately 161 square miles as measured at Aurora, MN, approximately three miles from the St. Louis River confluence. The Partridge River watershed is primarily a mix of upland forest (47%) and wetlands (43%), with very little development (4%). There are several active and inactive mines within the watershed including the active Peter Mitchell Mine in the headwaters, as well as the former LTVSMC mine. All of the proposed Mine Site and a portion of the Plant Site drain to the Partridge River. Seeps from the southern portion of the LTVSMC Tailings Basin (south side of Cell 1E) flow to Second Creek, a tributary of the Partridge River. The Partridge River varies from sluggish marshy reaches, to large open ponds, to steep boulder rapids.

There are limited flow data available for the Partridge River. Data from four USGS gaging stations within the Partridge River watershed (Figure 4.1-1) are available, but the period of record for each is relatively short and the three that reflect flow from the Project area have all been impacted by mining operations (Table 4.1-12). The Partridge River above Colby Lake (USGS Station #04015475) is the gaging station that best represents flows from the Project area, but only has 10 years of flow records available (1978-1988). As previously indicated, it is the tribal cooperating agencies' position that this data is inadequate. Tribal cooperating agencies have requested that additional data be collected.

The available flow records indicate that streamflow is generally low from late fall through the winter, rises sharply during spring snowmelt, and recedes during the summer, except during occasional heavy storms. This pattern of significantly reduced summer streamflow is characteristic of streams draining extensive bogs (Wright et.al. 1992). Baseflow is low during the winter because little groundwater recharge occurs since most precipitation falls as snow and is not available for infiltration or runoff until it melts (Siegel and Ericson 1980). The discharge statistics for USGS Station above Colby Lake as well as modeled flow at six other upstream locations (SW-001, SW-002, SW-003, SW-004, SW-004a, and SW-005) on the Partridge River (Figure 4.1-11) are presented in Table 4.1-13. As previously discussed, it is the tribal cooperating agencies' position that these patterns are not representative of the Partridge River near the mine site. The gauging station is seventeen miles from the mine site and the data from that station are twenty years old and therefore, unlikely to be representative of current conditions at the mine site.

A Level I Rosgen Geomorphic Survey (Rosgen 1996) was conducted for the Partridge River from its headwaters to Colby Lake, a distance of about 28 miles (RS26, Barr 2005). A Level I Survey is a physical classification of a stream channel to determine its geomorphic characteristics based on the relationship of its physical geometry and hydraulic characteristics.

The purpose of a geomorphic survey is to evaluate the stability of a stream under existing conditions, to determine its sensitivity to change, and to indicate how restoration may be approached if a portion of the stream becomes unstable. This broad level characterization was performed using 2003 aerial photography, USGS 7.5 minute quadrangles with a 10-foot contour interval, available ground photographs, and two site visits.

Table 4.1-12 Monthly Statistical Flow Data for USGS Gaging Stations in the Partridge River Watershed

Station:	04015475 Partridge River Above Colby Lake			04015500 Second Creek Near Aurora			04016000 Partridge River Near Aurora		
Period of Record:	1978-1988			1955-1980			1942 - 1982		
Drainage Area:	103.4 mi^2			29.0 mi^2			161 mi^2		
Contributing Drainage Area:	103.4 mi^2			22.4 mi^2			147.7 mi^2		
Month	**Monthly Average**	**Daily Minimum**	**Daily Maximum**	**Monthly Average**	**Daily Minimum**	**Daily Maximum**	**Monthly Average**	**Daily Minimum**	**Daily Maximum**
October	124[1]	14	775	24	1.2	134	97	3.3	1,140
November	63	13	468	20	4.0	103	71	4.0	308
December	20	4.1	95	12	2.2	35	34	5.7	116
January	7.5	1.4	23	9.2	1.5	30	21	2.3	61
February	6.4	0.96	26	8.9	1.5	28	17	2.3	41
March	16	0.61	209	16	2.0	84	41	3.0	1,560
April	242	4.0	1,960	47	5.0	233	271	6.5	2,580
May	220	11	874	34	1.7	126	333	37	3,190
June	105	5.9	568	29	1.4	95	210	17	2,920
July	104	0.54	866	23	3.1	90	101	11	950
August	55	0.68	480	20	2.6	130	64	5.2	459
September	87	2.0	383	24	1.9	100	81	3.2	438

Source: Statistical data from USGS National Water Information System (http://nwis.waterdata.usgs.gov/nwis)
[1] All values in cfs unless otherwise noted.

Table 4.1-13 Flow Statistics for Various Locations along the Partridge River (1978-1988)

		Location						
Statistic	**Units**	**SW-001[1]**	**SW-002[1]**	**SW-003[1]**	**SW-004[1]**	**SW-004a[1]**	**SW-005[1]**	**USGS Gage**
Mean Annual Flow	cfs	4.7	11	12	19	45	83	88
Max 1-Day Flow	cfs	68	193	246	385	1,163	1,859	1,960
Avg. Max 1-Day Flow	cfs	32	90	107	166	474	722	748
Max 3-Day Flow	cfs	57	173	214	365	1,002	1,753	1,840
Max 7-Day Flow	cfs	42	140	171	291	759	1,380	1,446
Max 30-Day Flow	cfs	30	77	91	148	356	676	710
Max 90-Day Flow	cfs	15	39	46	75	180	344	362
Min 1-Day Flow	cfs	0.01	0.05	0.07	0.09	0.22	0.49	0.54
Avg. Min 1-Day Flow	cfs	0.06	0.32	0.42	0.62	1.6	3.3	3.6
Min 3-Day Flow	cfs	0.01	0.06	0.08	0.11	0.28	0.59	0.65
Min 7-Day Flow	cfs	0.01	0.07	0.09	0.13	0.32	0.68	0.79
Min 30-Day Flow	cfs	0.03	0.12	0.15	0.21	0.55	1.1	1.2
Min 90-Day Flow	cfs	0.11	0.29	0.34	0.52	1.15	2.1	2.2

Source: Table 2, RS73B, Barr 2008.

[1] These values reflect predicted existing flows based on the XP-SWMM model and are not actual monitored flow values.

The survey results indicated that 54 percent of the Partridge River is a Type C channel, 31 percent is a Type E channel, and 13 percent is a Type B channel. Type C channels are characterized as being moderately sinuous (meandering), having a mild slope, a well-developed floodplain, and are fairly shallow relative to their width. Type E channels are similar to Type C, except that they tend to be more sinuous and deeper relative to their width. Type B channels are steeper, straighter, and have less floodplain available than Type C or E channels. Type B channels tend to be less sensitive to impact than Type C or E channels, and on the Partridge River are dominated by boulder material.

The Rosgen field survey found the Partridge River to be stable, with no evidence of erosion problems except in its headwaters. In general, the Partridge River has well vegetated streambanks for nearly its entire length, and a very well-developed floodplain for all but the Type B reaches. There are many beaver dams along the entire length of the Partridge River, particularly at the head of rapids sections, which create wide pools. Because its steep reaches are well-armored and the flatter reaches tend to have well vegetated shorelines, the Partridge River is considered to be a robust stream. The limited erosion and /or channel widening found in the headwaters (Stations 131,000 to 147,600) may be attributable to pit dewatering discharges from the Peter Mitchell Mine (maximum permitted flow rate of 36.3 cfs) and historic straightening of the river channel for construction of a railroad.

There are several mines, the City of Hoyt Lakes Waste Water Treatment Plant (WWTP), and Minnesota Power's Laskin Energy Center (power plant) that have discharged in the past, and/or are currently discharging water that affect flows in the Partridge River (Figure 4.1-12). Table 4.1-14 summarizes the NPDES/SDS discharges to the Partridge River and its tributaries. Most of these outfalls do not discharge continuously, and many, although still "active" in terms of permit status, have not discharged for many years (e.g., various mine pit dewatering discharges). Although mine discharges have occurred at least periodically in the Project area since 1956 when the Peter Mitchell Mine began operations, there are few readily available mine pumping records available prior to 1988 when the state began requiring NPDES/SDS permit holders to report this information. Pumping records for the Peter Mitchell Mine from 1976 to approximately 1986 are available and have an annual average of between 6.8 and 15.1 cfs. Since 1988, the highest reported average monthly discharge from the Peter Mitchell Mine to the Partridge River was 34 cfs (RS74A, Barr 2008). In addition, former LTVSMC Pits 3 and 5S are currently overflowing (RS74A, Barr 2008). The number and volume of these discharges compared to average and especially low flow in the Partridge River indicate that these discharges have the potential to significantly affect flows and the lack of historical information regarding actual dates of discharge complicate interpreting the flow record.

Colby Lake and Whitewater Reservoir

Colby Lake is located approximately eight miles southwest from the Mine Site and about four miles south of the Plant Site on the Partridge River with a surface area of approximately 539 acres and a maximum depth of approximately 30 feet (Figure 4.1-1). The outlet control of Colby Lake is approximately elevation 1,438.5 feet msl. When water levels drop below this level, outflow from the lake stops. Colby Lake is currently used as a potable water source for the city of Hoyt Lakes and as a cooling water source for the Laskin Energy Center coal-fired power plant owned by Minnesota Power. The power plant discharges the once-through non-contact cooling water (SD001) to the downstream portion of the lake (see Figure 4.1-13), but there is up to a 2.7 mgd evaporative loss of water (see Table 4.1-14).

Around 1955, in order to assure a reliable source of water, LTVSMC constructed Whitewater Reservoir and the Diversion Works, which connects Colby Lake and Whitewater Reservoir. Formerly known as Partridge Lake, this impoundment increased the surface area and depth of the original lake and subjected it to greater annual water level fluctuations. Whitewater Reservoir has a surface area of approximately 1,210 acres and a maximum depth of approximately 73 feet. Water losses due to seepage through the northwest dike can be 15 cfs or more, which drain to the Partridge River downstream of Colby Lake (Adams et al. 2004). The city of Hoyt Lakes discharges an annual average of 0.39 cfs of treated wastewater effluent into Whitewater Reservoir (see Table 4.1-14 and Figure 4.1-13).

The Diversion Works contain three 8-foot gates that can be opened to allow the release of water from Colby Lake to Whitewater Reservoir during high flows in the Partridge River. It also contains three high-volume pumps to move water back to Colby Lake during low water levels. During operation by LTVSMC, water would typically flow through the Diversion Works gates from Colby Lake to Whitewater Reservoir during the spring runoff, then be pumped back into Colby Lake when needed, although this system was not used as much as expected. When water levels in Colby Lake fall below 1,439.0 feet msl due to low inflows, the MnDNR Water Appropriation Permit (1949-0135) limits withdrawals of water from Colby Lake to the rate that water can be pumped from Whitewater Reservoir to replace the water withdrawn.

Table 4.1-14 Discharges to and Water Withdrawals from the Partridge River Watershed

NPDES Permit Number	Discharge ID	Outfall Description	Receiving Waters	Volume (mgd) Avg.[1]	Max.
MN0069078 Mesabi Mining LLC	SD-001	Composite SD-018 to SD-021	Colby Lake	NA	NA
	SD-005	Pit 9 dewatering pipe	First Creek	5.0	7.2
	SD-006	Pit 6 dewatering pipe	Second Creek	10.0	14.4
	SD-007	Pit 9S dewatering pipe	First Creek	10.8	14.4
	SD-014	Pit 2WX dewatering pipe	Second Creek (via wetlands)	5.0	7.2
	SD-015	Pit 2WX dewatering pipe	Second Creel (via wetlands)	5.0	7.2
	SD-016	Pit 2WX dewatering pipe	Second Creek (via wetlands)	5.0	7.2
	SD-017	Pit 2WX dewatering pipe	Second Creek (via wetlands)	5.0	7.2
	SD-018	Pit 2WX dewatering pipe	Tributary to Colby Lake	5.0	7.2
	SD-019	Pit 2WX dewatering pipe	Tributary to Colby Lake	5.0	7.2
	SD-020	Pit 2WX dewatering pipe	Tributary to Colby Lake	5.0	7.2
	SD-021	Pit 2WX dewatering pipe	Tributary to Colby Lake	5.0	7.2
	SD-023	Pit 9S dewatering pipe	First Creek	10.8	14.4
	SD-024	Pit 6 dewatering pipe	First Creek	--	7.2
MN0042536 Cliffs Erie LLC	SD-008	Pit 2W dewatering pipe	Second Creek	5.0	7.2
	SD-009	Pit 2W dewatering pipe	Second Creek	5.0	14.4
	SD-010	Pits 2/2E/3 dewatering pipe	Wetland to Wyman Creek	5.0	7.2
	SD-011	Pits 2/2E/3 dewatering pipe	Wetland to Wyman Creek	5.0	7.2
	SD-012	Pit 3 overflow channel	Wyman Creek	5.0	7.2
	SD-013	Pit 2W dewatering pipe	Tributary to Colby Lake	7.2	14.4
	SD-026	Cell 1E seepage/stormwater	Second Creek	0.4	0.9
	SD-030	Pit 5S overflow	Wyman Creek	--	--
		Stormwater from Area/Shops	Second Creek	--	--
		Stormwater from Plant Area	Second Creek	--	--
MN0067687 Mesabi Nugget Delaware	SD-001	Pit 1 overflow	Second Creek	1.5	5.8
	SD-003	Pit 1 dewatering discharge	Second Creek	5.0	14.4
MN0046981 Northshore Mining Co. Peter Mitchell Mine	SD-006	185S pit dewatering	Partridge River headwaters	Inactive	32.8
	SD-007	223S pit dewatering	Partridge River headwaters	Inactive	32.8
	SD-008	258S pit dewatering	Partridge River headwaters	Inactive	32.8
	SD-009	280/292S pit dewatering	Partridge River headwaters	7.4	32.8
	SD-010	360S pit dewatering	Partridge River headwaters	0.17	32.8
	SD-011	380S pit dewatering	Partridge River headwaters	Inactive	32.8
	SD-012	430S pit dewatering	Partridge River headwaters	Inactive	32.8
	SD-013	Crusher 2 sanitary outfall	Partridge River headwaters	Inactive	0.044
	SD-023	Crusher 2 area discharge	Partridge River headwaters	0.0085	0.09
MN0020206 Hoyt Lakes WWTP	SD-002	Main Facility Discharge	Whitewater Reservoir	0.68	--
MN0000990 MN Power Laskin Energy Center	SD-001	Main Discharge	Colby Lake	125.4	136.71
	SD-2	Ash Pond Discharge	Colby Lake	0.368	1.44
Water Appropriation				**Volume (mgd)**	
Permitee	**Permit Number**	**Intake Description**	**Water Source**	**Avg.**	**Max.**
MN Power/Cliffs Erie LLC	1949-0135	Mining process water	Colby Lake	--	21.6[2]
MN Power (Laskin)	1950-0172	Cooling Water	Colby Lake	--	144.7[3]
Hoyt Lakes	1954-0036	Municipal Water Supply	Colby Lake	0.38	1.5[4]

Source: MPCA (http://www.pca.state.mn.us/data/edawater)

[1] Average flow when discharging. Many of these discharges only occur intermittently and may be currently inactive.

[2] Represents instantaneous peak withdrawal, permit also includes a maximum average withdrawal rate of 17.3 mgd for any continuous 60-day period.

[3] Includes a maximum 2.7 mgd consumptive use for evaporative losses.

[4] Represents instantaneous peak withdrawal, permit also includes an annual maximum withdrawal rate of 0.44 mgd.

After closure of the LTVSMC mine and processing plant in 2001, Minnesota Power purchased the Diversion Works and all of LTVSMC's riparian land around Whitewater Reservoir. This land currently is leased as lake-front property. The Water Appropriation Permit is currently jointly held by Minnesota Power and Cliffs Erie LLC. An agreement has been reached, however, whereby PolyMet would replace Cliffs Erie LLC as the co-lessee and enable PolyMet to obtain makeup water from Colby Lake for use at the Plant Site.

In the five-year period after LTVSMC stopped its water withdrawals (i.e., January 2001 to December 2006) under relatively natural flows (e.g., discharges from the Peter Mitchell Mine were occurring periodically), water levels in Colby Lake were higher with less fluctuation than when LTVSMC was withdrawing water for its mining operations (Table 4.1-15). Over the same period, Whitewater Reservoir also experienced less fluctuations and high average water levels.

Table 4.1-15 Comparison of Colby Lake Elevations over Time

Time Period	Represent	Source	Max Annual Fluctuation[1]	% Time below el. 1,439.0
1937-1954	Pre-mining	Actual measurements	4.6 ft	5.0%
1955-1992	During mining (with LTVSMC withdrawals)	Actual measurements	4.1 ft	24.1%
1976-1988	During mining (without LTVSMC withdrawals)	Modeled predictions	5.6 ft	25-27%
2001-2006	During mining (without LTVSMC withdrawals)	Actual measurements	3.7 ft	7.5%

Source: RS73A, Barr 2008; Adams, Leibfried, and Herr 2004.

1 Maximum annual fluctuation is the maximum difference between annual maximum and minimum water elevations for any single year during the indicated time period.

Lower Partridge River Downstream of Colby Lake

Downstream of Colby Lake, the Partridge River flows about four more miles before reaching its confluence with the St. Louis River. Second Creek (also known as Knox Creek) is a tributary of the Partridge River in this segment and currently receives an annual average of 1.2 cfs seepage from the LTVSMC Tailings Basin (refer to Seeps 32 and 33 as shown in Figure 4.1-14) (RS74B, Barr 2008). Second Creek is also currently receiving seepage from Pit 6 as well as dewatering flows from Pit 1 as part of the Mesabi Nugget Project (see Table 4.1-14, Mesabi Nugget, SD-003).

Embarrass River

The Embarrass River originates just south of the City of Babbitt and flows southwest approximately 23.2 miles to its confluence with the St. Louis River, draining 171 square miles as measured at McKinley, near the confluence with the St. Louis River. The Embarrass River watershed is dominated by upland forests (50%), wetlands (35%) and scrub/shrub (8%), with little development. In terms of the Project, most of the Tailings Basin drains to the Embarrass River.

Relatively little flow data are available for the Embarrass River. There are two USGS gaging stations located within the watershed (#04017000 located about three miles northwest of the Tailings Basin and #04018000 located about seven miles southwest of the Tailings Basin), but they only provide flow records for 22 and 9 years respectively. Table 4.1-16 provides flow data for the nearest gaging station at Embarrass (Figure 4.1-1 for location).

Table 4.1-16 Monthly Statistical Flow Data for USGS Embarrass Gaging Stations

Station:	04017000 Embarrass River at Embarrass		
Period of Record:	1942 – 1964		
Drainage Area:	88.3 mi^2		
Month	**Monthly Average (cfs)**	**Daily Minimum (cfs)**	**Daily Maximum (cfs)**
October	46	2.6	453
November	33	4.9	166
December	14	3.4	50
January	6.7	0.90	22
February	5.0	0.90	14
March	22	1.4	774
April	190	2.6	1,490
May	194	21	1,720
June	114	5.2	1,090
July	63	3.6	790
August	31	1.8	284
September	50	2.2	789

Source: USGS National Water Information System (http://nwis.waterdata.usgs.gov/nwis).

The headwaters of the Embarrass River watershed include a portion of the city of Babbitt, but are otherwise relatively undeveloped and unaffected by any mining. The City of Babbitt WWTP has an annual average discharge of approximately 0.33 cfs to the headwaters pursuant to NPDES/SDS Permit MN0020656. PolyMet has established a monitoring station (PM-12), as shown in Figure 4.1-1, above all Project influences with a drainage area of 18.9 square miles. PolyMet estimated low (i.e., average annual 30-day minimum flow), average (i.e., mean annual flow), and high (i.e., annual 1-day maximum flow) flows at this station as 1.19, 13.80, and 144.35 cfs, respectively (Barr 2008, External Memorandum: Changes to the Tailings Basin Flows in the Embarrass River Watershed).

Overflow and seepage from several former mining facilities contributes to the flow in the Embarrass River, as shown in Table 4.1-17 and Figure 4.1-12. Based on bi-monthly flow measurements between 2001 and 2007, an average of approximately 1.99 cfs (893 gpm) overflows from Pit 5NW to Spring Mine Creek where it flows north about five miles before joining the Embarrass River just downstream of monitoring station PM-12 (Figure 4.1-7).

Table 4.1-17 NPDES/SDS Discharges to the Embarrass River Watershed

NPDES/SDS Permit Number	Permit Number	Outfalls ID	Outfall Description	Receiving Waters	Volume (cfs) Avg.[1]	Max.
Mesabi Mining LLC	MN0069078	SD-022	Pit 9 Dewatering Pipe	Wynne Lake	7.7	11.1
Cliffs Erie LLC	MN0042536	SD-033	Pit 5NW overflow	Spring Mine Creek	0.39	
Mesabi Nugget Delaware LLC	MN0067687	SD-004	Pit 1 dewatering discharge	Wynne Lake	8.4	18.3
Cliffs Erie LLC	MN0054089	SD-001	NW seepage collection ditch	Unnamed creek	--	--
		SD-002	NE seepage collection ditch	Trimble Creek	--	--
		SD-004	Tailings Basin Cell 2W Seep A	Unnamed creek	0.28	3.00
		SD-005	Tailings Basin Cell 2W Seep B	Kaunonen Creek	--	0.46
		SD-006	Power line access road culvert	Unnamed creek	5.0	6.2

Source: MPCA (http://www.pca.state.mn.us/data/edawater)
[1] Average flow when discharging. Many of these discharges only occur intermittently and may be currently inactive.

The LTVSMC Tailings Basin, proposed for reuse by PolyMet, was operated from 1953 until it was shutdown in January 2001. The existing Tailings Basin is unlined and the perimeter embankments do not have a clay core or cutoff, which allows for both surface seepage through the embankment and groundwater seepage under the embankment. Shortly after LTVSMC ceased operations, seepage from all cells (Cells 1E/2E and 2W) was estimated as 12.7 cfs (5,710 gpm), of which 11.5 cfs (5,160 gpm) flows toward the Embarrass River, with the remainder (1.2 cfs or 550 gpm) draining to Second Creek, a tributary of the Partridge River (RS74B, Barr 2008). More recent monitoring (October 2008) estimated total seepage from the Tailings Basin as 1.8 cfs (800 gpm) (NTS 2009). Table 4.1-18 summarizes data for 33 LTVSMC seeps as shown in Figure 4.1-14 identified over the period 2002 to 2006 (RS55T, Barr 2007). As the flow monitoring shows, seepage at most locations has declined or stopped since tailings disposal was discontinued in 2001. Only Seep 30, which drains to wetlands north of the Tailings Basin in the Embarrass River watershed, and Seeps 32/33, which drain to Second Creek in the Partridge River watershed, still have any significant flow. PolyMet estimates current groundwater seepage as approximately 4.0 cfs (900 gpm from Cells 1E/2E and 895 gpm from Cell 2W (Hinck 2009, Personal Communication). During low flow conditions, PolyMet estimates the current groundwater flow from the Tailings Basin actually reaching the Embarrass River as only 1.2 cfs (540 gpm) based on calibration of the Embarrass River model (RS74B, Barr 2008).

PolyMet has established a second surface water monitoring station (PM-13), as shown in Figure 4.1-1 along the Embarrass River just downstream of the Heikkila Lake tributary with a drainage area of 111.8 square miles. This station is believed to be downstream of all Tailings Basin seepage and will be used to evaluate Project effects on flow and water quality in the Embarrass River. PolyMet estimated low (i.e., average annual 30-day minimum flow), average (i.e., mean annual flow), and high (i.e., annual 1-day maximum flow) flows at this station as 5.66, 81.53, and 853.08 cfs, respectively (Barr 2008, External Memorandum: Changes to the Tailings Basin Flows in the Embarrass River Watershed).

Table 4.1-18 Summary of Existing Tailings Basin Surface Seeps (Figure 4.1-14)

Seep ID	Description	Range of Flow (gpm)	
		5/02 – 10/06	October 2008[1]
Seep 1	Emergency Basin area seep	0-1	0
Seep 2	Emergency Basin area seep	~0	0
Seep 3	Emergency Basin area seep	0-12	0
Seep 4	Emergency Basin area seep	0-42	0
Culvert	Combined flow of seeps 1-4 (WS-011)	0-21.8	0
Seep 5	Emergency Basin area seep	0-0.8	~0
Seep 6	Emergency Basin area seep	0-1.6	~0
Seep 7	Emergency Basin area seep	0-1.6	~0
Seep 8	Emergency Basin area approx. 4 seeps	0-35	~0
Seep 9	Emergency Basin area seep	~0	~0
Weir	Combined flow of seeps 5 thru 9 (WS-012)	0-94	0
Seep 10	West side of TB	0->750	0
Seep 11	West side of TB	0-0.5	0
Seep 12	West side of TB	0-0.5	0
Seep 13	West side of TB	0-1.5	0
Seeps 14-17	West side of TB	0-0.8	0
Weir	Combined flow of seeps 11 thru 17	0-25	0
Seep 18	West side of TB	0-2	0
Seep 19	West side of TB	0-22	0
Seep 20	Northwest side of TB pipe flow	0-5.0	2.5
Seep 21	Northwest side of TB	0-1.5	0
Seep 22	Northwest side of TB (SD-004)	1.0-7.0	3.0
Seep 23	No pipe present	0-6.0	0
Seep 24	Flow from pipe (North Side seep)	1-21	10
Seep 25	Flow from pipe	2.5-29	0
Seep 26	North Side of TB	0-1.0	0
Seep 27	Flow from pipe	0-<1	0
Seep 28	Flow from pipe	0-0.25	0
Seep 29	Flow from pipe	0-30	0
Seep 30	Three seeps in one small area, no pipe present.	1.5-127	100
Seep 31	Various seeps along northeast side of TB	0->60	0
Seeps 32-33	Drains to Second Creek	0-554	600

Source: Table 2, RS55T, Barr 2007; NTS 2008
[1] Most recent flow data

Surface Water Quality

This section describes the applicable surface water quality evaluation criteria and the ambient water quality conditions for the primary waterbodies in the Project area.

Surface Water Quality Evaluation Criteria

The State of Minnesota classifies surface water bodies according to their designated use and establishes water quality standards to protect those uses. The two water classifications with the most stringent regulatory water-quality standards are Class 1 (domestic consumption) and Class 2 (aquatic life and recreation) (*Minnesota Rules*, chapter 7050). Other classifications include Class 3 (industrial consumption), Class 4 (agriculture and wildlife), Class 5 (aesthetic enjoyment and navigation), Class 6 (other uses), and Class 7 (limited resource value) designations. These classes are further divided into subclasses with letter designations. Water bodies can receive multiple designations. In these cases, the applicable water quality standards usually would be the most restrictive standards from all the water's listed classifications. Applicable surface water criteria for the Project are presented in Table 4.1-19. Discharges must not cause violation of water quality standards in the immediate receiving waters, but also must not cause exceedances in downstream waters that may have more stringent water quality standards.

In the Project area, in-stream surface water quality standards for the Partridge River and Embarrass River correspond to Class 2B (cold or warm water sport or commercial fishing), 3C (industrial cooling and materials transport), 4A (irrigation use), 4B (livestock and wildlife use), 5 and 6 waters, which is the default designation for all waterbodies in Minnesota unless explicitly stated otherwise (*Minnesota Rules*, part 7050.0430). All other streams and lakes in the Project area have the default classification except Colby Lake, which is designated as Class 1B (treated with simple chlorination for domestic consumption) and 2Bd (cool or warm water sportfish and drinking water) waters, because the city of Hoyt Lakes uses it for domestic consumption, as well as Class 3C; and Wyman Creek, which directly drains to Colby Lake and therefore also receives the Class 1B classification, as well as 2A (aquatic life and recreation) and 3B (industrial consumption-moderate treatment) (Minnesota Rules 7050.0470). All Project area waters are also designated Outstanding International Resource Waters (*Minnesota Rules*, part 7050.0460 and 7052.0300), which prohibits any new or expanded point source discharges of bioaccumulative substances of immediate concern (e.g., mercury) unless a nondegradation demonstration is completed and approved by MPCA.

A limited number of "wild rice waters" are designated (WR) in *Minnesota Rules*, part 7050.0470, to which a 10 mg/L sulfate standard is added to the Class 4A standards during periods when the rice may be susceptible to damage by high sulfate levels (i.e., typically during the growing season). The only so designated "wild rice waters" in the Project area is Hay Lake, which flows to the Embarrass River downstream of the Project (Figure 4.1-1). The Wild Rice Legislative Report (MnDNR 2008, Natural Wild Rice in Minnesota) included an inventory of wild rice stands in Minnesota. In addition to Hay Lake, one other wild rice stand with no quantified acreage, was identified within the Embarrass River watershed based on a single harvester survey report. The exact location of this stand is unknown, but was estimated by MnDNR as occurring about 15 miles downstream from the LTVSMC Tailings Basin (Drotts 2009). It is unclear whether other wild rice stands exist along the Embarrass River, and, if they do, how the 10 mg/L standard would apply to them. MPCA has indicated that it will review the applicability of wild rice standards on a case by case basis and has requested that PolyMet provide additional wild rice related information (Clark 2009, Personal Communication). It is the tribal cooperating agencies' position that, as stated in Minn. 7050, the 10 mg/l of sulfate standard for wild rice applies for waterbodies where wild rice is found. The PCA has used this approach in past permitting activities (MINNTAC Schedule of Compliance, 2008). The 10 mg/l sulfate standard also applies to the Partridge River below Colby Lake where several wild rice beds are located. Tribal cooperating agencies note that the Army Corps has not completed consultation on cultural issues with the potentially affected tribes. This delay means that the extent of existing wild rice beds has not been fully characterized.

Because the Project is in the Lake Superior Basin, the Great Lakes Initiative water quality standards also apply (*Minnesota Rules*, chapter 7052). These Lake Superior standards can vary from the water quality standards for the same parameters in *Minnesota Rules*, chapter 7050.

Where different, the 7052 standards supercede the 7050 standards, even if the 7052 rules are less stringent. For parameters not listed in *Minnesota Rules*, chapter 7052, the standards from *Minnesota Rules*, chapter 7050 apply.

Table 4.1-19 Surface Water Quality Evaluation Criteria Applicable to the NorthMet Project

Parameter	**Units**	**Class 1B**	**Class 2B[3]**	**Class 2Bd[3]**	**Class 3B**	**Class 3C[4]**	**Class 4A[5]**	**Class 4B[5]**	**Class 5**	**Class 6**
General										
Ammonia as N	mg/L	--	--	0.04	--	--	--	--	--	--
Chloride	mg/L	250	230	230	100	250	--	--	--	--
Dissolved Oxygen	mg/L	--	> 5.0	>5.0	--	--	--	--	--	--
Fluoride	mg/L	2	--	--	--		--	--	--	--
Hardness	mg/L	--	--	--	250	500	--	--	--	--
Nitrate as N	mg/L	10	--	--	--	--	--	--	--	--
pH	s.u.	6.5-8.5	6.5-9.0	6.5-9.0	6.0-9.0	6.0-9.0	6.0-8.5	6.0-9.0	6.0-9.0	--
Salinity	mg/L	--	--	--	--	--	--	1,000	--	--
Sulfate	mg/L	250	--	--	--	--	--[(2)]	--	--	--
Metals Total[6]										
Aluminum	µg/L	50-200	125	125	--	--	--	--	--	--
Antimony	µg/L	6	31	5.5	--	--	--	--	--	--
Arsenic	µg/L	10	53[(1)]	2.0[1]	--	--	--	--	--	--
Barium	µg/L	2,000	--	--	--	--	--	--	--	--
Beryllium	µg/L	4.0	--	--	--	--	--	--	--	--
Boron	µg/L	--	--	--	--	--	500	--	--	--
Cadmium[5]	µg/L	5	2.5[(1)]	2.5[1]	--	--	--	--	--	--
Cobalt	µg/L	--	5.0	2.8	--	--	--	--	--	--
Copper[5]	µg/L	1,000	9.3[(1)]	9.3[1]	--	--	--	--	--	--
Iron	µg/L	300	--	--	--	--	--	--	--	--
Lead[5]	µg/L	--	3.2	3.2	--	--	--	--	--	--
Manganese	µg/L	50	--	--	--	--	--	--	--	--
Mercury	ng/L	2,000	1.3[(1)]	1.3	--	--	--	--	--	--
Nickel[5]	µg/L	--	52[(1)]	52[1]	--	--	--	--	--	--
Selenium	µg/L	50	5.0[(1)]	5.0[1]	--	--	--	--	--	--
Silver[5]	µg/L	100	1.0	1.0	--	--	--	--	--	--
Thallium	µg/L	2	0.56	0.28	--	--	--	--	--	--
Zinc[(5)]	µg/L	5,000	120[(1)]	120[1]	--	--	--	--	--	--

Source: *Minnesota Rules*, chapters 7050 and 7052

All values represent total concentration unless otherwise noted.

[1] Based on *Minnesota Rule*, part 7052.0100 Water Quality Standards Applicable to Lake Superior Basin, which supersedes standards listed in part 7050. [2] Sulfate standard of 10 mg/L applies if designated wild rice waters are present. [3] *Minnesota Rule*, part 7050.0223. [4] *Minnesota Rule*, part 7050.0224. [5] Water quality standard for this metal is hardness dependent. The listed value assumes a hardness of 100 mg/L. [6] Standards for metals are expressed as total metals, but must be implemented as dissolved metal standards. Factors for converting total to dissolved metals are listed in *Minnesota Rules* 7050.0222 and 7052.0360.

Upper Partridge River

Recent water quality data (collected by PolyMet in 2004 and 2006) and historic water quality data (back to 1956) are available for various constituents in various locations along the Partridge River, which are summarized in Table 4.1-20. Most of these water quality data represent occasional grab samples and do not allow a detailed assessment of water quality trends, seasonal effects, or relationship to flow. Nevertheless, collectively, the data can be used to generally characterize water quality in the watershed and draw some comparisons with surface water quality standards. There are no water quality data available, however, that predate the operation of the Peter Mitchell Mine in 1956 and can be used to characterize relatively "undisturbed" conditions in the Partridge River.

Table 4.1-20 Available Surface Water Quality Monitoring Data in the Partridge River Watershed (Figure 4.1-1)

Sample Location	Source	Sampling Period
Main Stem Partridge River (in progressive downstream order)		
PM-1	PolyMet	2004, 2006
PM-2/S-4	PolyMet/Cominco	1974-1976, 1978, 2001-2002, 2004
PM-3/CN126/S-1	PolyMet/C-N Study/Kennecott	1974-1978, 2001-2004, 2006
PM-16	PolyMet	2004, 2006
PM-4/CN123	PolyMet/C-N Study	1976-1977, 2004, 2006
Colby Lake	C-N Study, USGS, MPCA, MN Power, Barr	1976-1977, 1988, 2001
Whitewater Reservoir	MPCA	1972, 2001
USGS gage #04025500/CN122	C-N Study	1976-1977
USGS gage #04016000	C-N Study	1956-1966, 1973, 1976-1977, 1979
CN127	C-N Study	1976-1977
Tributaries		
S. Branch, USGS gage #04015455	C-N Study	1973-1976
Colvin Creek, CN124	C-N Study	1973-1976
Wymans Creek, PM-5 / PM-6	PolyMet	2004
Second Creek, PM-7, PM-17, PM-18	PolyMet	2004, 2006

Source: RS63, Barr 2007; RS74, Barr 2008; RS76, Barr 2007; Siegel and Ericson 1980; Barr 2009, External Memorandum: Colby Lake Water Quality Samples
C-N Study – Regional Copper-Nickel Study

Section 303(d) of the Clean Water Act requires states to publish a list of waters that are not meeting one or more water quality standards. The list, known as the 303(d) Total Maximum Daily Load (TMDL) list, is updated every two years. The State of Minnesota 303(d) list, which was updated in 2008, contains 1,475 waterbodies requiring TMDLs. The Partridge River is not listed as an impaired waterbody on the 303(d) list, although further downstream several segments of the St. Louis River are listed for "mercury in fish tissue" impairment.

In general, ambient water quality is similar across the watershed, although a few parameters (e.g., aluminum and copper) appear to reflect a slightly increasing trend downstream (Table 4.1-21). Comparing 1970's data from the Regional Copper-Nickel Study with recent (post-2000) PolyMet data collected at three common monitoring stations reveals that some parameters appear to have decreased in concentrations (e.g., sulfate and copper), while others have increased (e.g., iron, manganese, and zinc). Although a few individual samples exceeded surface water quality evaluation criteria, overall water quality meets state water quality standards. The only consistent exceedances of water quality standards were dissolved oxygen (DO) near the headwaters of the Partridge River (PM-2) and possibly aluminum just above Colby Lake (PM-4). We do not have sufficient information to interpret either of these exceedances, but the DO exceedances are localized and are not found at other upstream or downstream locations. In terms of aluminum, the surface water standard applies to dissolved aluminum, whereas the monitoring data reports total aluminum, so it is uncertain whether the aluminum standard is actually exceeded.

Table 4.1-21 Comparison of Historic and Recent Mean Water Quality Data for Selected Parameters at Common Monitoring Stations along the Partridge River

			S-4/PM-2		CN126/PM-3		CN123/PM-4	
General Parameter	**Units**	**Stream Standard**	**1970's**	**2000's**	**1970's**	**2000's**	**1970's**	**2000's**
DO	mg/L	>5.0	6.69	4.95*	9.1	10.0	--	9.2
Hardness	mg/L	250	115	75*	117	81	85	63
pH	s.u.	6.5-9.0	7.0	6.8	7.3	7.4	7.2	7.8
Sulfate	mg/L	--	20.1	7.9*	18.9	8.3	18.9	7.2
Metals – Total								
Aluminum	µg/L	125	44	40*	76	54	123	276
Arsenic	µg/L	53	3.8	1.1*	3.2	1.1	0.8	1.0*
Cobalt	µg/L	5.0	0.6	0.1*	0.5	0.4	0.6*	0.7
Copper	µg/L	9.3[1]	1.3	1.1*	1.3	0.8	2.4	1.3
Iron	µg/L	--	1,085	1,603*	1,365	1,711	1,528	1,997
Lead	µg/L	3.2[1]	0.6	0.2*	0.8	0.2	0.7	0.7
Manganese	µg/L	--	112	168*	153	181	160	200
Nickel	µg/L	52[1]	1.4	0.4*	1.5	0.9	1.0*	1.5
Zinc	µg/L	120[1]	5.6	3.0*	4.4	7.7	2.0	10.2

Source: RS76, Barr 2007
* Based on less than five samples.
() Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.

PolyMet (RS74A, Barr 2008) averaged available ambient water quality data to document existing conditions against which to evaluate impacts from the Project at several locations, as shown in Figure 4.1-11, along the Partridge River (Table 4.1-22).

Table 4.1-22 Average Existing Water Quality Concentrations in the Partridge River[1]

Parameter	Units	Stream Standard	SW-001	SW-002	SW-003	SW-004	SW-005
General							
Ammonia	mg/L	0.04	0.05	0.05	0.05	0.07	0.08
Calcium	mg/L	--	24.5	24.5	20.7	20.7	18.6
Chloride	mg/L	230	1.6	1.8	10.5	9.1	6.2
Fluoride	mg/L	--	0.14	0.11	0.90	0.90	0.90
Hardness	mg/L	500	110	112	101	93	83
Magnesium	mg/L	--	10.5	7.5	9.0	8.3	7.5
Potassium	mg/L	--	2.7	2.0	2.0	1.6	1.0
Sodium	mg/L	--	4.8	3.2	3.8	3.5	2.9
Sulfate	mg/L	--	22.1	6.3	10.9	10.0	9.0
Metals							
Aluminum	µg/L	125	16.9	45.9	60.3	71.3	**275.4**
Antimony[2]	µg/L	31	1.5	1.5	1.5	1.5	1.5
Arsenic	µg/L	53	6.5	1.0	1.0	1.0	1.0
Barium	µg/L	--	5.0	9.6	10.0	5.0	8.8
Beryllium	µg/L	--	0.1	0.1	0.1	0.1	0.1
Boron	µg/L	500	96	58.5	66.1	61.1	37.2
Cadmium	µg/L	2.5[3]	0.1	0.1	0.1	0.1	0.1
Cobalt	µg/L	5.0	0.5	0.5	0.5	0.5	0.8
Copper	µg/L	9.3[3]	1.2	0.5	1.1	2.1	1.7
Iron	µg/L	--	30	1,220	1,630	1,340	1,990
Lead	µg/L	3.2[3]	0.2	0.3	0.2	0.2	0.8
Manganese	µg/L	--	8.6	140	190	130	200
Mercury	ng/L	1.3	--	1.914	2.733	3.380	3.078
Nickel	µg/L	52[3]	0.5	0.8	1.6	1.9	2.1
Selenium	µg/L	5.0	0.5	0.5	0.5	0.5	0.5
Silver	µg/L	1.0[3]	0.1	0.1	0.1	0.1	0.1
Thallium	µg/L	0.56	0.3	0.2	0.2	0.2	0.2
Vanadium[4]	µg/L	--	4.3	0.9	0.9	0.9	0.9
Zinc	µg/L	120[3]	7.3	10.1	6.4	19.2	16.7

Source: Table 5-3, RS74A, Barr 2008; and Table 2-6, RS 74A, Barr 2008.

1 Existing water quality was not measured at location SW-004A.

2 Antimony was not monitored in the Partridge River; groundwater value is assumed.

3 Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.

4 Vanadium was not monitored in the Partridge River. Value assumed from Hem (1992).

Colby Lake

Water quality in Colby Lake is affected by inflow from the upper Partridge River watershed, but also anthropomorphic effects from mine pit dewatering and overflows (e.g., Peter Mitchell Mine in the headwaters; Pits 2/2E/2W/3/5S via Wyman Creek), and two permitted discharges from Minnesota Power's Laskin Energy Center (e.g., cooling water discharge and a clarified ash pond discharge), as well as pumping from Whitewater Reservoir during low flows.

Water quality data are available for Colby Lake from various sources from 1976 to 2008 (Barr 2009, External Memorandum: Colby Lake Water Quality Samples). Based on the most recent monitoring data (November 2008), elevated aluminum, iron, and mercury concentrations were found (Table 4.1-23). Single exceedances of manganese and thallium were also observed, although average concentrations met surface water quality standards. Minnesota Power monitoring (2002-2003) found occasional exceedances of arsenic and copper. Aluminum, iron, and manganese are all secondary MCLs and easily removed in treatment. Colby Lake is on the Minnesota 303(d) TMDL list because of mercury concentrations in fish tissue. A TMDL pollution reduction study has not yet been performed for Colby Lake to address this impairment.

The monitoring data also indicate that Colby Lake stratifies weakly during the summer and fall months, but is generally isothermal during winter and spring. Given the average chlorophyll-a (2.56 μg/L) and total phosphorus (27 μg/L) concentrations in the Colby Lake water column, along with the average Secchi disk depth of 4.2 feet, the lake can be considered to be mesotrophic (i.e., moderately productive).

Whitewater Reservoir

Whitewater Reservoir is on the Minnesota 303(d) list because of mercury concentrations in fish tissue. Whitewater Reservoir was included in the Minnesota Statewide Mercury Total Maximum Daily Load study, which was approved by the USEPA on April 3, 2008. The approved TMDL, including State-wide emission and wastewater discharge reduction measures, is believed to be adequate to bring Whitewater Reservoir back into compliance for mercury.

The City of Hoyt Lakes Wastewater Treatment Plant (WWTP) discharges an annual average of 0.39 cfs of treated secondary effluent into Whitewater Reservoir (RS74A, Barr 2008; Figure 4.1-13). The WWTP discharge most likely affects the water quality of Whitewater Reservoir by the addition of nutrients (e.g., phosphorus and nitrogen).

Very limited water quality data are available for Whitewater Reservoir from the USEPA and MPCA. These data indicate that Whitewater Reservoir stratifies weakly during the summer and fall months, but is generally isothermal during winter and spring. It appears that all constituents meet applicable water quality standards for Whitewater Reservoir, but little or no sampling has been done for metals. Given the average chlorophyll-a (5.48 μg/L) and total phosphorus (33 μg/L) concentrations, along with the average Secchi disk depth of 9.5 ft, Whitewater Reservoir can be considered to be mesotrophic (i.e., moderately productive).

Table 4.1-23 Summary of Colby Lake Water Quality Data

Parameter	Units	Surface Water Evaluation Criteria	C-N Study (1976-1977)		MPCA Data (1976-2007)			Minnesota Power Data (2002-2003)			Barr Data (2008)			
			# Samples	Range	# Samples	Mean	Range	Detection	Mean	Range	Detection	Mean	Range	# Exceed.
General														
Calcium	mg/L	--	4	11to 21	14	57.1	21 to 104	--	--	--	5 of 5	11.6	9.0 to 15.4	--
Chloride	mg/L	230	5	6.3 to 9.4	17	6.1	1.8 to 9.3	--	--	--	5 of 5	2.2	2.0 to 2.3	0
Fluoride	µg/L	--	5	0.1 to 0.7	10	0.3	0.1 to 0.4	--	--	--	3 of 5	108	<100 to 140	--
Hardness	mg/L	500	5	41 to 83	14	91.2	40 to 150	--	--	--	5 of 5	54.8	44.4 to 68.5	0
Magnesium	mg/L	--	5	3.2 to 7.3	14	34.1	19 to 51	12 of 12	11.0	4.4 to 17.5	5 of 5	6.3	5.4 to 7.3	--
pH	s.u.	6.8-8.5	17	6.5 to 7.8	109	7.1	6.3 to 8.8	--	--	--	5 of 5	7.38	7.1 to 7.69	0
Potassium	mg/L	--	4	1.3 to 1.5	10	1.7	1.4 to 2.2	--	--	--	5 of 5	760	840 to 1,040	--
Sodium	mg/L	--	4	3.6 to 4.3	10	6.3	4.7 to 8.0	--	--	--	5 of 5	3,246	2,900 to 3,480	--
Sulfate	mg/L	10	15	8.7 to 140	14	52.9	8.7 to 140	--	--	--	5 of 5	17.1	10.1 to 31.7	**5**
Metals														
Aluminum	µg/L	125	5	180 to 470	10	307	180 to 610	12 of 12	264	61 to 264	5 of 5	208	179 to 243	**5**
Antimony	µg/L	31	--	--	--	--	--	0 of 3	3	<3	0 of 5	0.5	<0.5	0
Arsenic	µg/L	53	3	0.4 to 2.1	4	1.4	<0.5 to 2.1	1 of 3	1.4	<2.0 to 2.3	0 of 5	2.0	<2.0	0
Barium	µg/L	--	--	--	--	--	--	2 of 3	15.7	<10.0 to 29.1	5 of 5	6.9	5.7 to 7.6	--
Beryllium	µg/L	--	--	--	--	--	--	0 of 3	0.2	<0.2	0 of 5	0.2	<0.2	--
Boron	µg/L	500	--	--	--	--	--	3 of 3	79	54 to 100	2 of 5	57	<50 to 72	0
Cadmium[1]	µg/L	2.5	10	0.02 to 0.2	15	0.05	0.02 to 0.20	0 of 3	0.2	<0.2	0 of 5	0.2	<0.2	0
Cobalt	µg/L	5.0	9	<0.3 to 0.5	6	0.4	<0.3 to 1.4	2 of 12	0.7	<1.0 to 1.9	4 of 5	0.3	<0.2 to 0.4	0
Copper[1]	µg/L	9.3	12	1.6 to 7.3	15	4.9	1.6 to 8.0	8 of 12	8.3	<5.0 to 14.5	5 of 5	2.4	1.6 to 3.5	0
Iron	µg/L	--	15	190 to 2,300	15	836	190 to 2,500	3 of 3	2,103	650 to 3,030	5 of 5	1,142	1,050 to 1,250	--
Lead[1]	µg/L	3.2	12	0.2 to 1.7	14	0.5	0.2 to 0.9	0 of 3	1.0	<1.0	0 of 5	0.5	<0.5	0
Manganese	µg/L	--	5	50 to 90	14	282	63 to 2,100	3 of 3	123	30 to 280	5 of 5	44	28 to 64	--
Mercury	ng/L	1.3	10	80 to 400	9	190	<130 to 360	--	--	--	5 of 5	5.4	4.8 to 6.0	**5**
Nickel[1]	µg/L	52	2	--	13	2.7	<1 to 9.0	1 of 3	3.4	<5.0 to 5.3	5 of 5	2.5	2.0 to 3.1	0
Selenium	µg/L	5.0	--	--	2	<0.8	<0.8	0 of 12	2.0	<2.0	0 of 5	1.0	<1	0
Silver[1]	µg/L	1.0	--	--	--	--	--	0 of 2	1.0	<1.0	0 of 5	0.2	<0.2	0
Thallium	µg/L	0.56	--	--	--	--	--	0 of 3	2.0	<2.0	1 of 5	0.41	<0.40 to 0.46	0
Vanadium	µg/L	--	--	--	--	--	--	--	--	--	0 of 5	1.0	<1.0	--
Zinc[1]	µg/L	120	12	1 to 35.3	15	6.9	1.0 to 50	2 of 3	17.5	<10.0 to 36.1	0 of 5	6.0	<6.0	0

Source: Tables 1-7, Barr 2009, External Memorandum: Colby Lake Water Quality Samples.

[1] Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L, which approximates the hardness concentration in Colby Lake.

Lower Partridge River Downstream of Colby Lake

Two seeps from the LTVSMC Tailings Basin (Seeps 32 and 33) drain to Second Creek, a tributary of the Partridge River downstream from Colby Lake (Figure 4.1-14). Water quality monitoring from 2006 to 2008 as part of the NPDES Permit MN0042536 (SD026), as shown in Figure 4.1-14, shows these seeps in compliance with surface water standards (NTS 2009). Table 4.1-24 summarizes the surface water quality monitoring data for Station SD026.

Periodic dewatering discharges from Pits 6/9/9S drain to First Creek. Seepage from Pit 6 has very high sulfate concentrations (>1,000 mg/L). The average sulfate concentration where First and Second Creek join (Figure 4.1-1) is 475 mg/L. This input of sulfate raises the sulfate concentration in the Partridge River from about 17 mg/L as it flows from Colby Lake to approximately 149 mg/L downstream of the confluence of First and Second Creek.

Table 4.1-24 Summary of Surface Water Quality Monitoring Data for Station SD026

Constituent	Units	SD026 Surface Discharge (Seeps 32 and 33)		
General Parameters		**Detection**	**Mean**	**Range**
Ammonia as Nitrogen	mg/L	--	--	--
Calcium	mg/L	3 of 3	80.7	76.1 to 84.3
Carbon, total organic	mg/L	--	--	--
Chloride	mg/L	12 of 12	14.8	12.2 to 16.7
Fluoride	mg/L	33 of 33	3	1.5 to 4.2
Hardness	mg/L	21 of 21	495	175 to 780
Nitrate as Nitrogen	mg/L	--	--	--
pH	s.u.	55 of 55	8.0	7.0 to 8.5
Sulfate	mg/L	12 of 12	192	149 to 216
Metals – Total		--	--	--
Aluminum	ug/L	--	--	--
Antimony	ug/L	--	--	--
Arsenic	ug/L	--	--	--
Barium	ug/L	--	--	--
Beryllium	ug/L	--	--	--
Boron	ug/L	31 of 31	251	158 to 304
Cadmium	ug/L	--	--	--
Cobalt	ug/L	0 of 12	4.1	<1 to <25
Copper	ug/L	--	--	--
Iron	ug/L	--	--	--
Lead	ug/L	--	--	--
Manganese	ug/L	31 of 31	539	110 to 1,520
Mercury	ng/L	7 of 12	1.0	<0.5 to <4
Mercury, Methyl	ng/L			
Molybdenum	ug/L	12 of 12	26.7	14.2 to 38.6
Nickel	ug/L	--	--	--
Selenium	ug/L	--	--	--
Silver	ug/L	--	--	--
Thallium	ug/L	--	--	--
Zinc	ug/L	--	--	--

Source: NTS 2009

Notes: mg/L = milligrams per liter, ug/L = micrograms per liter, ng/L = nanograms per liter, < = less than indicated reporting limit.

Embarrass River

The Embarrass River is not on the 303(d) list of impaired waters, however, several lakes downstream of the Project (referred to as the ‘chain of lakes’) through which the Embarrass River flows are listed for “mercury in fish tissue” impairment, including Sabin, Wynne, Embarrass, and Esquagama Lake (Figure 4.1-1). Further downstream, segments of the St. Louis River are also listed for “mercury in fish tissue” impairment. These lakes and the St. Louis River are not covered by the Statewide Mercury TMDL, but are impaired waters and are still in need of a TMDL pollution reduction study.

Water quality data (ranging from 1955 to 2006) are available for various parameters at three locations along the Embarrass River (Table 4.1-25). As was the case along the Partridge River, these data do not allow a detailed assessment of water quality trends, seasonal effects, or relationship to flow, but collectively can be used to generally characterize water quality in the watershed and draw some comparisons with surface water standards. Limited water quality data are also available for four surface discharge sites and one stream draining from the LTVSMC Tailings Basin.

Table 4.1-25 Available Surface Water Quality Monitoring Data in the Embarrass River Watershed (Figure 4.1-1)

Sample Location	Source	Sampling Period
Main Stem Embarrass River		
PM-12 / CN121 / SW-004	PolyMet / C-N Study / Cliffs Erie	1976, 2001-2005, 2004, 2006
CN120	USGS/C-N Study	1955-1963, 1976-1977
PM-13 / SW-005	PolyMet / Cliffs Erie	2001-2005, 2004, 2006
Tailings Basin		
PM-8 (SD006)	PolyMet	2004, 2006
PM-9 (SD001)	PolyMet	2004, 2006
PM-10 (SD002)	PolyMet	2004, 2006
PM-11	PolyMet	2004, 2006

Source: RS76, Barr 2007
C-N Study – Regional Copper-Nickel Study (Siegel and Ericson 1980)

The Regional Copper-Nickel Study 1980 considered monitoring station CN121 (same station as PM-12) to represent “undisturbed” conditions. Under current conditions, it receives stormwater runoff and wastewater treatment plant discharges (0.33 cfs of predominantly domestic wastewater) from the city of Babbitt, but is otherwise unaffected by mining or other development. Table 4.1-26 compares 1976 data from the Copper-Nickel Study with recent data from PolyMet for monitoring station CN121 / PM-12. The data show that water quality at this monitoring station meets surface water quality standards. Most of the measured parameters exhibit relatively little change over the 30 year period, although iron and zinc concentrations appear to be increasing, while copper and manganese concentrations appear to be decreasing over time.

Table 4.1-26 Comparison of Historic and Recent Mean Water Quality Data for Selected Parameters at PM-12 on the Embarrass River

General Parameter	Units	Stream Standard	1976	2004-2006
DO	mg/L	>5.0	5.9	7.4
Hardness	mg/L	500	50[3]	56
pH	s.u.	6.5-8.5	6.9	7.3
Sulfate	mg/L	-- [1]	6.1	4.7
Metals - Total				
Aluminum	µg/L	125	127	99
Arsenic	µg/L	53	0.9	1.0[2]
Cobalt	µg/L	5	2.3[3]	0.5
Copper	µg/L	5.2[2]	0.9[3]	1.1
Iron	µg/L	--	1,121	1,714
Lead	µg/L	1.3[2]	0.2	0.2
Manganese	µg/L	--	234	163
Nickel	µg/L	29[2]	1.0[3]	1.4
Zinc	µg/L	67[2]	1.1[3]	9.5

Source: RS76, Barr 2007
[1] Sulfate standard of 10 mg/L applies if designated wild rice waters are present
[2] Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 50 mg/L.
[3] Based on less than 5 samples

Barr (RS74B, 2008) averaged available ambient water quality data against which to evaluate impacts from the Project at two locations (PM12 and PM13), as shown in Figure 4.1-1, along the Embarrass River (Table 4.1-27).

Pit 5N (Figure 1.1-2), which drains to the Embarrass River between monitoring station PM-12 and PM-13, is completely flooded and has been overflowing since 2001 with an annual average flow of 1.99 cfs to the Embarrass River via Spring Mine Creek. This discharge contributes significant sulfate concentrations (average of 1,046 mg/L) (Barr 2008, Plant Site Groundwater Impacts Predictions).

The LTVSMC Tailings Basin contributes both groundwater and surface water seepage that ultimately reaches the Embarrass River between monitoring stations PM-12 and PM-13. As discussed above (see Table 4.1-18 and Figure 4.1-14), the LTVSMC Tailings Basin had at least 33 locations where tailings water was seeping through the embankment to surface waters. Several of these seeps are monitored for water quality pursuant to NPDES/SDS permit MN0054089 (Table 4.1-28). The monitoring data indicate that these seeps generally meet surface water quality standards other than for mercury at several stations, although the mercury concentrations are well below those found in local precipitation (approximately 10 µg/L). Sulfate concentrations were relatively high (e.g. averaging 280 mg/L at SD004).

The effects of the Pit 5NW discharge as well as potential surface and groundwater contaminant loadings from the LTVSMC Tailings Basin are reflected in the water quality at the downstream monitoring station PM-13 (Table 4.1-27). Significantly higher concentrations for several parameters, especially aluminum and sulfate are found at PM-13. It is unclear whether any wild rice waters subject to the 10 mg/L standard are present.

Table 4.1-27 Average Existing Water Quality in the Embarrass River

Parameter	Units	Stream Standard	PM-12	PM-13
General				
Calcium	mg/L	--	13.4	19.9
Chloride	mg/L	230	4.5	7.0
Fluoride	mg/L	--	0.1	0.4
Hardness	mg/L	500	62	144
Potassium	mg/L	--	0.8	2.3
Sodium	mg/L	--	3	12.7
Sulfate	mg/L	--[1]	4.6	36.1
Metals				
Aluminum	µg/L	125	98	**192**
Antimony	µg/L	31	1.5	1.5
Arsenic	µg/L	53	1.0	1.0
Barium	µg/L	--	15.5	27.8
Beryllium	µg/L	4.0	0.1	0.1
Boron	µg/L	500	18	44
Cadmium	µg/L	2.5[2]	0.1	0.1
Cobalt	µg/L	5.0	0.6	0.5
Copper	µg/L	9.3[2]	1.5	2.0
Iron	µg/L	--	1,720	1,290
Lead	µg/L	3.2[2]	0.15	0.27
Manganese	µg/L	--	160	110
Mercury	ng/L	1.3	**4.3**	**3.8**
Nickel	µg/L	52[2]	1.9	2.1
Selenium	µg/L	5.0	0.5	0.5
Silver	µg/L	1.0[2]	0.1	0.1
Thallium	µg/L	0.56	0.2	0.2
Zinc	µg/L	120[2]	18.3	12.3

Source: RS74B, Barr 2008.
1 Sulfate standard of 10 mg/L applies if designated wild rice waters are present.
2 Water quality standard for this metal is hardness-dependent. Listed value assumes a concentration of 100 mg/L.

Table 4.1-28 Summary of Surface Water Quality Monitoring Data for the Tailings Basin

Constituent	Units	Surface Water Evaluation Criteria	PM-8 (SD006) Surface Discharge				PM-9 (SD001) Surface Discharge				PM-10 (SD002) Surface Discharge				PM-11 Surface Discharge			
General Parameters			**Detection**	**Mean**	**Range**	**# Exceed.**	**Detection**	**Mean**	**Range**	**# Exceed.**	**Detection**	**Mean**	**Range**	**# Exceed.**	**Detection**	**Mean**	**Range**	**# Exceed.**
Ammonia as Nitrogen	mg/L	--	0 of 4	0.1	<0.1	0	0 of 4	0.1	<0.1	0	0 of 4	0.1	<0.1	0	0 of 4	0.1	<0.1	0
Calcium	mg/L	--	47 of 47	42.4	9.2 to 73.9	--	124 of 124	53.9	33.0 to 98.9	--	132 of 132	66.4	17.5 to 92.4	--	9 of 9	32.6	19.0 to 39.9	--
Carbon, total organic	mg/L	--	8 of 8	5.4	2.6 to 6.9	--	8 of 8	8.4	1.7 to 18.5	--	15 of 15	7.5	5.2 to 9.4	--	7 of 7	11.1	7.4 to 15.4	--
Chloride	mg/L	230	19 of 19	20.3	3.1 to 30	0	122 of 122	28.1	12.6 to 66.5	0	130 of 130	27.7	7.2 to 33.6	0	9 of 9	17.3	9.5 to 25.4	0
Fluoride	mg/L	--	42 of 42	2.9	1.0 to 5.8	--	128 of 128	2.4	0.6 to 5.8	--	136 of 136	2.3	0.5 to 4.8	--	9 of 9	1.5	0.8 to 2.2	--
Hardness	mg/L	500	36 of 36	431.28	230 to 721	**9**	41 of 41	452.07	268 to 818	**11**	48 of 48	438.13	327 to 649	**7**	1 of 1	308	308	0
Nitrate as Nitrogen	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	s.u.	6.5 – 8.5	81 of 81	7.9	6.8 to 8.7	**1**	130 of 130	7.8	6.4 to 8.8	**7**	136 to 136	16.7	6.4 to 8.9	**5**	9 of 9	7.9	7.6 to 8.3	0
Sulfate	mg/L	--[2]	61 of 61	161	27.1 to 312	0	125 of 125	159	56.8 to 344	0	133 of 133	182	8.1 to 473	0	9 of 9	88	45.5 to 147	0
Metals – Total																		
Aluminum	ug/L	125	3 of 5	25.7	<10 to 40.7	0	4 of 5	29.9	<25 to 48.4	0	4 of 12	39.6	<10 to 230	**1**	4 of 4	41.0	21.7 to 72.7	0
Antimony	ug/L	31	0 of 5	3	<3	0	0 of 5	3	<3	0	0 of 5	3	<3	0	0 of 4	3	<3	0
Arsenic	ug/L	53	5 of 12	3.0	<2 to 7.2	0	1 of 12	2.1	<2 to 2.7	0	2 of 12	2.1	<2 to 2.7	0	0 of 4	2.0	<2	0
Barium	ug/L	--	15 of 15	25.6	11 to 76.4	--	15 of 15	41.6	18.3 to 140	--	22 of 22	86.7	39.5 to 148	--	7 of 7	24.2	13.4 to 34.6	--
Beryllium	ug/L	--	0 of 5	1.64	<0.2 to <2	--	0 of 5	1.64	<0.2 to <2	--	0 of 5	1.64	<0.2 to <2	--	0 of 4	2	<2	--
Boron	ug/L	500	37 of 37	351	164 to 483	0	127 of 127	337	115 to 452	0	135 of 135	379	85 to 517	**3**	4 of 4	214	129 to 307	0
Cadmium	ug/L	2.5[3]	0 of 5	1.6	<0.2 to <2	0	0 of 5	1.6	<0.2 to <2	0	0 of 5	1.6	<0.2 to <2	0	0 of 4	2	<2	0
Chromium	ug/L	--	4 of 5	1.3	<1 to 2	--	4 of 5	1.7	<1 to 4.1	0	4 of 5	2.1	<1 to 5.9	--	3 of 4	1.2	<1 to 1.5	--
Cobalt	ug/L	5.0	4 of 43	1.2	<1 to <2.5	0	3 of 81	1.1	<1 to 4.9	0	7 of 82	1.3	<1 to 16.8	**1**	0 of 4	1	<1	0
Copper	ug/L	9.3[3]	5 of 32	2.1	<0.7 to 5.4	0	19 of 84	2.5	<0.7 to 12	**1**	16 of 92	2.3	<1 to 24.2	**1**	4 of 9	2.7	<0.7 to 1.6	0
Iron	ug/L	--	23 of 23	410	<30 to 4,500	--	18 of 19	673	<30 to 5,100	--	23 of 25	501	<30 to 4,020	--	4 of 4	405	220 to 590	--
Lead	ug/L	3.2[3]	9 of 10	0.7	<0.3 to <1	0	9 of 10	0.7	<0.3 to <1	0	10 of 10	1.3	<0.3 to 7.1	**1**	9 of 9	0.6	<0.3 to <1	0
Manganese	ug/L	--	40 of 40	3,039	70 to 110,000	--	95 of 98	631	<10 to 50,000	--	93 of 93	100,192	20 to 2,950,000	--	7 of 7	16,921	40 to 118,000	--
Mercury	ng/L	1.3	17 of 28	2.6	<0.5 to <10	**11**[1]	16 of 28	3.1	<0.5 to <10	**10**[1]	22 of 35	3.6	<2 to <10	**13**[1]	4 of 9	5.5	<4 to <10	**4**[1]
Mercury, Methyl	ng/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	ug/L	--	12 of 12	50.5	13.9 to 81.6	--	110 of 112	43.2	<5 to 96.8	--	119 of 121	21.5	<5 to 47.6	--	7 of 7	21.3	15.8 to 29.3	--
Nickel	ug/L	52[3]	3 of 27	2.5	<2 to <5	0	3 of 64	2.3	<2 to <5	0	11 of 72	2.3	<2 to 5.9	0	0 of 4	5	<5	0
Selenium	ug/L	5.0	0 of 10	2.5	<1.0 to <3.6	0	0 of 10	2.5	<1.0 to <3.6	0	0 of 10	2.5	<1.0 to <3.6	0	0 of 9	2.6	<1.0 to <3.6	0
Silver	ug/L	1.0[3]	0 of 10	0.6	<0.2 to <1	0	0 of 10	0.6	<0.2 to <1	0	0 of 10	0.6	<0.2 to <1	0	0 of 9	0.6	<0.2 to <1	0
Thallium	ug/L	0.56	0 of 10	1.2	<0.4 to <2	0[1]	0 of 10	1.2	<0.4 to <2	0[1]	0 of 10	2.7	<0.4 to <2	0[1]	0 of 9	1.1	<0.4 to <2	0[1]
Zinc	ug/L	120[3]	2 of 27	13.6	<10 to <25	0	2 of 12	10.3	<10 to 12.7	0	3 of 19	16.2	<10 to 32.5	0	0 of 4	10.0	<10	0

Source: RS76, Barr 2007

1 Minimum detection limit exceeds evaluation criteria.

2 Sulfate standard of 10 mg/L applies if designated wild rice waters are present.

3 Water Quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.

Mercury in Water

There is relatively little monitoring data for mercury in the Partridge River. PolyMet estimates that current total mercury concentrations average about 3 ng/L in the Upper Partridge River (RS74A, Barr 2008) and between 4.8 and 6.0 ng/L in Colby Lake, based on limited sampling. Total mercury concentrations are similar in the Embarrass River, averaging 5.1 ng/L at monitoring station PM-12 and 4.5 ng/L at monitoring station PM-13 over the past two years. Methylmercury concentrations in the Embarrass River average 0.6 ng/L at PM-12 and 0.4 ng/L at PM-13 over the same period.

Mercury monitoring has occurred at the LTVSMC Tailings Basin and along the Embarrass River, which generally found mercury concentrations consistent with background levels (Table 4.1-29), generally averaging <2.0 ng/L. All samples were well below average concentrations in precipitation (~10 ng/L). MnDNR (Berndt 2003) found that taconite tailings appear to be a sink for mercury in full-scale actual tailings basins in Northern Minnesota, as evidenced by lower mercury concentrations in tailings basin seepage (specifically at U.S. Steel's Mintac Mine and Northshore Mining's Peter Mitchell Mine) than in either precipitation input or pond water in the tailings basin. This finding is supported by surface water monitoring around the LTVSMC Tailings Basin, which found mercury concentrations consistent with background levels (Table 4.1-29), generally averaging <2.0 ng/L. All samples were less than average concentrations in precipitation, so most mercury appears to be sequestered in the LTVSMC tailings.

Table 4.1-29 Summary of Total Mercury Concentrations at the Tailings Basin

			Mercury Concentrations			
Location*	**Dates**	**# of Detections**	**Mean (ng/L)**	**Range (ng/L)**	**# exceeding 1.3 ng/L[1]**	**# exceeding 10 ng/L[2]**
LTVSMC Tailings Basin Surface Water Seepage						
SD001	2001-2006	12 of 65	1.8	0.7 – 4.1	6	0
SD002	2001-2006	14 of 66	1.4	0.6 – 2.3	7	0
SD004	2001-2006	8 of 15	1.9	0.7 – 4.5	3	0
SD005	2001-2004	2 of 18	1.6	1.2 – 2.0	1	0
SD006	2001-2006	13 of 17	1.7	0.5 – 4.6	7	0
WS013	2001-2005	7 of 29	2.1	0.9 – 6.3	2	0
Cell 1E	2001-2003	2 of 24	1.0	0.9 – 1.0	0	0
Cell 2E	2001-2003	3 of 20	1.8	0.7 – 3.6	1	0
Cell 2W	2001	0 of 8	<0.2	NA	0	0
Emergency Basin	2001-2005	11 of 40	1.8	0.7 – 4.2	5	0
West Seep	2001-2003	1 of 17	0.8	0.8	0	0
Embarrass River						
SW003	2002-2005	7 of 10	2.4	0.8 – 4.3	6	0
SW004	2001	0 of 8	<0.2	<0.2	0	0
Wetlands						
Wetland 003	2002-2005	7 of 12	2.4	1.2 – 4.4	6	0
Wetland North	2002-2005	8 of 11	4.2	2.9 – 6.7	8	0

Source: Table 4, RS63, Barr 2007; RS64, Barr 2006; Table 8-9, RS74B, Barr 2008.
* Figure 4.1-1
[1] Minnesota Class 2B Lake Superior standard for mercury.
[2] Estimated average total mercury concentration in Northern Minnesota (Berndt 2003; NCDC 2008).

Surface Water Use

In terms of surface water withdrawals, the city of Hoyt Lakes uses Colby Lake as its potable water source and Minnesota Power uses Colby Lake as a source of cooling water for its Laskin Power Plant (see Table 4.1-14). Cliffs Erie still holds a valid permit to withdraw make-up water from Colby Lake, but no withdrawals have occurred since the plant closed in 2001. There are no significant surface water withdrawals or Water Appropriation Permits issued for the Embarrass River in the Project area.

4.1.2 Impact Criteria

In general, water resource impact criteria are defined as changes in the existing physical-chemical-biological environment and focuses on protecting over-all stream health.

4.1.2.1 Hydrologic Alteration of Streams, Lakes and Aquifers Impact Criteria

Water resource impact criteria include a comparison of proposed hydrologic changes with historic hydrologic alteration from permitted mining practices, an assessment of present and predicted channel stability, and review of any appropriate physical or biological stream data. Impact criteria for stream flows in the Partridge and Embarrass river watersheds and changes in lake or reservoir levels in the Project area are those developed by Richter and others (1996; 1998) related to alteration of hydrology. The main parameters recommended for this “range of variability” approach include:

- Annual mean daily flow by month;
- Annual maximum 1-day, 3-day, 7-day, 30-day and 90-day flows;
- Annual minimum 1-day, 3-day, 7-day, 30-day and 90-day flows;
- Number of high pulses - the number of times per year the mean daily flow increases above the 75th percentile of all simulated mean daily flows;
- Number of low pulses - the number of times per year the mean daily flow falls below the 25th percentile of all simulated mean daily flows;
- Duration of high pulses - the number of days per year with mean flows above the 75th percentile of all simulated daily mean flows;
- Duration of low pulses - the number of days per year with mean flows below the 25th percentile of all simulated daily mean flows;
- Mean duration of high pulses - the ratio of duration of high pulses to number of high pulses;
- Mean duration of low pulses - the ratio of duration of low pulses to number of low pulses; and

- Annual mean, maximum and minimum lake level changes in Colby Lake and Whitewater Reservoir.

It is the tribal cooperating agencies' position that there is no mechanism to accurately develop the data listed above. Field data collection is spotty or non-existent and the numbers used in this DEIS are derived from the MODFLOW groundwater model and XP-SWMM model. It is important to note that the MODFLOW model was developed to assess the rates of mine pit inflow and as such, the results it gives for areas outside the mine pit footprint are unsupported by data. The XP-SWMM is based on stream gage data that is 17 miles and 20 years distant from the proposed project. Therefore, the above listed parameters calculated for the Partridge River have little data to support them.

The deviation from existing conditions, based on modeling, in the mean values of the hydrologic parameters help determine the degree of impact to stream ecology.

There are currently no impact criteria for change in groundwater levels. It is recognized that groundwater drawdown surrounding the Mine Site in the Partridge River watershed, and groundwater level increase north of the Tailings Basin in the Embarrass River watershed, may potentially affect surface water flows and wetlands (Section 4.2).

4.1.2.2 Water Quality Impact Criteria

Impact criteria for water quality rely on Minnesota water classifications for surface and groundwater. Surface water quality standards are 'in-stream' standards applicable at the surface water in question, which include the Partridge River and its tributaries at the Mine Site and the Embarrass River and its tributaries at the Plant Site. Groundwater quality standards are USEPA primary and secondary drinking water standards and MDH Health Risk Limits, which apply to 'in-situ' groundwater. The approach used in this EIS compares predicted water quality with appropriate Minnesota surface or groundwater quality standards; and with existing conditions as determined by recent water quality monitoring. In groundwater, however, emphasis is placed on exceedances of USEPA primary MCLs and MDH Health Risk Limits, rather than on the USEPA secondary MCLs. These secondary MCLs were established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health.

If numeric standards are not available for selected water quality constituents, a narrative standard is used, such as *Minnesota Rules*, part 7050.0150, subpart 3:

> **Narrative Standards**. *For all Class 2 waters the aquatic habitat, which includes the waters of the state and stream bed, shall not be degraded in any material manner, there shall be no material increase in undesirable slime growths or aquatic plants, including algae, nor shall there be any significant increase in harmful pesticide or other residues in the waters, sediments, and aquatic flora and fauna; the normal fishery and lower aquatic biota upon which it is dependent and the use thereof shall not be seriously impaired or endangered, the species composition shall not be altered materially, and the propagation or migration of the fish and other biota normally present shall not be prevented or hindered by the discharge of any sewage, industrial waste, or other wastes to the waters*.

Also, *Minnesota Rules*, part 7050.0210, subpart 2 has the following:

> **General Standard for Waters of the State:** *Nuisance conditions prohibited. No sewage, industrial waste, or other wastes shall be discharged from either point or nonpoint sources into any waters of the state so as to cause any nuisance conditions, such as the presence of significant amounts of floating solids, scum, visible oil film, excessive suspended solids, material discoloration, obnoxious odors, gas ebullition, deleterious sludge deposits, undesirable slimes or fungus growths, aquatic habitat degradation, excessive growths of aquatic plants, or other offensive or harmful effects.*

4.1.2.3 Mercury Impact Criteria

A numeric standard, a fish consumption advisory, and a narrative standard are used to describe the impact criteria for mercury in the environment. Each of these three mercury impact criteria are presented below (MPCA 2007).

Mercury Numeric Water Quality Standard

Mercury numeric standards are based on total (particulate plus dissolved) concentrations. For the Lake Superior Basin, in which the Project is located, the numeric chronic standard for the water column protective of aquatic organisms and recreation is 1.3 ng/L. There is a relationship, as yet poorly known, between sulfate concentration and the conversion of inorganic mercury by sulfate reducing bacteria into methylmercury, which is the form of mercury that is the most toxic and can bioaccumulate in fish and humans. Currently, neither a methylmercury nor sulfate numeric water quality standard for surface water exists in Minnesota. Until a surface water methylmercury standard is implemented, Minnesota is using fish consumption advisories and/or narrative standards for mercury. In addition, MPCA (2006) developed a *Strategy to Address Indirect Effects of Elevated Sulfate on Methylmercury Production and Phosphorus Availability*, which identifies policies and review procedures for evaluating the potential of proposed projects to produce methylmercury. This strategy includes recommendations to avoid or minimize the discharge of water with elevated sulfate concentrations to methylmercury “high risk” situations.

Fish Consumption Advisory

Minnesota’s target maximum level for mercury in fish tissue is 0.2 mg/kg, which is lower than the USEPA criterion of 0.3 mg/kg (wet weight, per USEPA criteria) to adjust for the higher per capita consumption of wild-caught fish in Minnesota (Table 4.1-30). This criterion uses a conservative assumption that all fish tissue mercury is in the methylmercury form (e.g., the mercury species with the highest human health risk). This concentration allows for one meal per week of wild-caught, top predator fish (e.g., trout, bass, walleye) in Minnesota.

Table 4.1-30 Mercury Fish Consumption Advisory (MFCA) Concentrations

	Mercury Concentration in Fish (mg/kg, wet weight)			
MFCA for Mercury	<0.05	0.05 – 0.2	>0.2 – 1.0	>1.0
Consumption Advice [1]	Unlimited	1 meal/week	1 meal /month	Do not Eat

Source: *Minnesota Rules* 7050.0150
[1] Consumption advice for young children and women of child-bearing age.

Narrative Standards

The basis for assessing mercury contamination in fish tissue is the narrative water quality standards and assessment factors in *Minnesota Rules*, part 7050.0150, subpart 7, which addresses the impairment of water relating to fish for human consumption:

> *"In evaluating whether the narrative standards in subpart 3, which prevent harmful pesticide or other residues in aquatic flora or fauna, are being met, the commissioner will use the residue levels in fish muscle tissue established by the Minnesota Department of Health to identify surface waters supporting fish for which the Minnesota Department of Health recommends a reduced frequency of fish consumption for the protection of public health. A water body will be considered impaired when the recommended consumption frequency is less than one meal per week, such as one meal per month, for any member of the population. That is, a water body will not be considered impaired if the recommended consumption frequency is one meal per week, or any less restrictive recommendation such as two meals per week, for all members of the population. The impaired condition must be supported with measured data on the contaminant levels in the indigenous fish."*

4.1.3 Environmental Consequences

The mining, ore processing, and tailings disposal operations associated with the Project may cause changes to the quantity and quality of ground and surface water in the Project area. In order to evaluate these effects, both ground and surface water modeling using deterministic simulations were conducted for a complete set of applicable water quality parameters. This technique uses single values for input variables to produce a single set of results.

In some cases, especially where there was a high degree of uncertainty regarding key input assumptions to the deterministic models, probabilistic simulations, or Uncertainty Analysis, was also used to test the sensitivity of the input variables or to "double check" the results of the deterministic models. Uncertainty Analysis applies probability distributions around input variables (based on professional judgment and literature values that were approved by the resource agencies) to estimate a range of predicted water quality values, as opposed to the single value predictions from the deterministic simulations. The Uncertainty Analysis was conducted using Monte Carlo simulations, which uses random number generators and a large number of model runs (>1,000) to simulate virtually all possible combinations of input parameter values and their associated likelihood of occurrence. The Uncertainty Analysis was not applied to all water quality parameters, but only to a subset of parameters determined to be the most critical by the resource agencies.

Tribal cooperating agencies take the position that the contaminant modeling for the project has not been adequately vetted and consequently produces results that are illogical. For example, the contaminant modeling for the tailings basins (RS74B and TB-14) proposes that adding PolyMet tailings to the existing LTVSMC tailings will improve the quality of seepage coming from the basins for some parameters.

The assumption (TB-14 of July 2, 2009, page 9) that PolyMet seepage water from the basins will be of better quality than the current seepage water results in an unexpected modeling result. The modeling proposes that the more PolyMet seepage that PolyMet releases from the basins, the better the water quality will be for Al, Mn and Fe in the Embarrass River (see Tables in TB-15 of June 24, 2009). It appears that the modeling at the basins does not appropriately account for leaching from the LTVSMC tailings when predicting future seepage quality.

Potential water quality impacts from the transportation, storage and use of hazardous substances are addressed in the Hazardous Materials section of this EIS (Section 4.12).

4.1.3.1 Proposed Action

Project Water Budget Overview

The Mine Site would generate process water from four sources: groundwater entering the mine pits, direct precipitation into the Mine Pits, infiltration through or runoff from the rock stockpiles, and runoff from other site operations (e.g., ore rail transfer hopper, mine service roads). The quantity of process water generated from these sources would vary greatly on an annual basis (Figure 4.1-15). All process water would be treated at the WWTF, but would not be directly discharged to surface waters. Instead, treated process water would either be pumped to the Tailings Basin or to the East Pit. A brief overview of the Project water budget is provided below by mine phase.

Operations (Years 1 to 20)

During Years 1 to 11, PolyMet would collect process water (e.g., stockpile liner water, pit water, drainage from ore handling areas) from the Mine Site, route it to the on-site WWTF for treatment, and then pump the treated water via the CPS to the Tailings Basin for reuse at the Plant Site (Figure 4.1-16). This process water represents a reduction in surface water drainage and groundwater seepage to the Partridge River. The process water would seep from the Tailings Basin with surface seeps being collected and pumped back to the Tailings Basin, while groundwater seepage would flow toward the Embarrass River. Make-up water would be withdrawn from Colby Lake. Stormwater (i.e., any water that has not contacted waste rock or ore) would be collected, routed through sedimentation ponds, and discharged to natural water courses.

Starting in Year 12, when mining in the East Pit would be completed, process water from the Mine Site would still be collected and routed to the WWTF, but the treated process water from the WWTF would then be pumped to aid in filling the East Pit, or could continue to be routed to the Tailings Basin, depending on the water level in the East Pit (Figure 4.1-17). Make-up process water would continue to be withdrawn from Colby Lake, and stormwater would continue to be collected, routed through sedimentation ponds, and discharged to natural water courses.

Closure (Years 20 to ~65)

Mining would end in approximately Year 20 and all mine dewatering activities would cease (Figure 4.1-18). Water withdrawals from Colby Lake would no longer be needed. All process water would be pumped to the East Pit; water would no longer be pumped to the Tailings Basin. Flooding and backfilling of the East Pit is expected to be completed by Year 20, after which a wetland would be constructed to further treat process water. At this time, a limited amount of process water from the Mine Site (long term flow after Year 30 estimated at 108 gpm) would still be generated (e.g., collected stockpile leachate), routed to the WWTF, treated, and pumped to the East Pit, where it would flow through a passive wetland treatment system before draining to, and helping to fill, the West Pit.

The generation and disposal of tailings in the Tailings Basin would end in Year 20, but PolyMet proposes to retain a permanent pool of water, primarily sourced from precipitation, over a portion of the Tailings Basin for water quality purposes. Hydrometallurgical Residue Cell seepage, which previously was being reused at the Plant Site, would be pumped to the WWTF for treatment until approximately Year 34, when the seepage is expected to end. It is the tribal cooperating agencies' position that this 34 year timeframe is unlikely to be correct. Because all cap and liner systems leak, some pumping of water that enters the hydrometallurgical residue cells would be needed in perpetuity. This would be particularly true as the cap ages and develops additional leaks.

Post-Closure (After Year ~65)

The Post-Closure period is considered to begin once the West Pit fills and begins to overflow and drain to the Partridge River, which is estimated to occur around Year 65 (Figure 4.1-19). The West Pit overflow represents the only true surface discharge of water from the Project and would not occur until several decades after mining ceases. PolyMet would continue to collect and treat leachate from the permanent waste rock stockpiles at the WWTF until monitoring shows that treatment is no longer necessary to meet water quality standards. Tribal cooperators note that stockpile leachate is predicted to not meet water quality standards for thousands of years (Table 4.1-41).

The only hydrologic input to the Tailings Basin would be precipitation. The volume of seepage from the Tailings Basin is expected to decrease slowly over time, but, with no proposed dry cap, long-term seepage would be expected. It is the tribal cooperating agencies' position that water quality and hydrologic impacts to wetlands and the Embarrass River under this proposed alternative would be perpetual.

Groundwater Resources

This section discusses the effects of the Proposed Action on groundwater levels and quality at both the Mine and Plant (Tailings Basin) sites.

Effects on Groundwater Levels

Evaluation Methodology

PolyMet developed groundwater flow models using conventional porous media modeling (MODFLOW, McDonald and Harbaugh 1988; Harbaugh et al. 2000). These models were constructed chiefly to assess operational conditions, specifically dewatering of the proposed mine pits, with the intent of estimating the range of inflow to the pits for water balance purposes and water quality modeling, and determining groundwater mounding and internal flow characteristics at the Tailings Basin. Table 4.1-31 summarizes the assumptions and input for the three different MODFLOW models developed for the Project (i.e., Regional Model, Mine Site Model, Tailings Basin Model).

Table 4.1-31 MODFLOW Model Assumptions/Inputs

Regional Model (Appendix B, RS22, Draft 03, Barr 2008)		
• Horizontal Scale - Approximately 1,000 mi² encompasses area surrounding both Mine Site and Tailings Basin		
• Vertical Descritization - single layer		
• Bottom elevations – 640 ft msl		
• Grid – uniform 500 meter spacing		
• Hydraulic Conductivity		
○ Duluth Complex	0.0014 ft/day	
○ Virginia Formation	0.33 ft/day	
○ Biwabik Iron Formation	0.72 ft/day	
○ Giants Ridge Batholith	0.029 ft/day	
• Recharge Value	0.001 inches/year	
Mine Site Local-Scale Model (Appendix B, RS22, Draft 03, Barr 2008)		
• Horizontal Scale – approximately 100 mi² focused on Mine Site		
• Vertical Descritization – 8 layers (7 bedrock units and single layer surficial deposit)		
• Bottom elevations		
○ Layer 1	1,400 – 1,585 ft msl (approximates bedrock surface elevation)	
○ Layer 2	1,350 ft msl (corresponds to elevation of major mine benches)	
○ Layer 3	1,270 ft msl (corresponds to elevation of major mine benches)	
○ Layer 4	1,050 ft msl (corresponds to elevation of major mine benches)	
○ Layer 5	890 ft msl (corresponds to elevation of major mine benches)	
○ Layer 6	700 ft msl (corresponds to elevation of major mine benches)	
○ Layer 7	330 ft msl (corresponds to elevation of major mine benches)	
○ Layer 8	-65 ft msl (approximates bottom elevation of Biwabik Iron Formation)	
• Grid – 100 to 200 meters outside area of interest/10 to 30 meters at Mine Site		
• Boundary Conditions – extracted from Regional Model as constant head cells		
• Hydraulic Conductivity (Horizontal / Vertical in ft/day)		
○ Wetland Deposits	9.3/0.0000033	
○ Glacial Drift	2.6/0.0000033	
○ Duluth Complex	0.0024/0.0024	
○ Virginia Formation – Upper	0.34/0.34	
○ Virginia Formation – Lower	0.085/0.085	
○ Biwabik Iron Formation	0.98/0.98	
○ Giants Ridge Batholith	0.029/0.029	
• Recharge value – (consistent with surface water (XP-SWMM) model values)		
○ Wetland Deposits	0.3 inches/year	
○ Glacial Deposits	1.5 inches/year	
• Calibration – used traditional trial-and-error and automated MODFLOW calibration methods. Predicted baseflow in the Partridge River at monitoring station SW004 was 1.49 cfs compared with target baseflow of 1.43 cfs.		
Tailings Basin Local-Scale Model (Attachment A-6, RS13, Draft 03, Barr 2007e)		
• Horizontal Scale – approximately 18 mi² including the Embarrass River and the historic LTVSMC pits 1, 2, 3, and 2WX and east of Pits 5S and 5N		
• Vertical Descritization – two layers (Note: baseline calibration model. Predictive models added up to 6 additional layers to represent deposition of PolyMet tailings during Project).		
○ Layer 1	LTVSMC Tailings Basin	
○ Layer 2	Underlying native material	
• Hydraulic Conductivity (Horizontal / Vertical in ft/day)		
○ LTV course tailings	0.14/0.14	(RS39/40, Barr 2007j)
○ LTV fine tailings	0.028/0.028	(RS39/40, Barr 2007j)
○ Native drift	80/8	
○ Bedrock	0.000024/0.000024	
• Boundary Conditions		
○ Internal boundaries were used to represent surface water features		
○ Pools in Cells 1E and 2E were simulated as constant head boundaries		
• Dispersion Coefficient Tailing Basin	Dx – 19.2	Dz – 0.96
• Calibration – used traditional trial-and-error methods and calibrated to hydraulic head targets measured in February 2002, representing period shortly after LTVSMC operations at the tailings basin ceased. Predicted seep rate south of Cell1E (seeps 32, 33, and Knox Creek headwaters was 570 gpm compared with a measured rate of 554 gpm in May 2002.		

Source: RS22, Barr 2008; RS13, Barr 2007

The Regional Model was used to provide boundary conditions for the smaller, local-scale Mine Site Model that was used to make the predictions of groundwater inflow rates into the mine pits. The regional model used a near zero recharge value, which is consistent with regional hydrologic water budgets described by Siegel and Ericson (1980), who state that underflow (i.e., groundwater flow within bedrock moving to a discharge zone outside the regional domain) can be considered to be zero in this terrain. With near zero recharge, groundwater in the Regional Model bedrock must come from or go to surface water features, and heads are established independently of recharge. This allows the local-scale models to have fixed heads at the periphery and to be further calibrated with positive recharge over a smaller domain independent of the Regional Model. The calibrated recharge rate in the Mine Site Model is 1.5 inches per year to the surficial aquifer, locally reduced to 0.3 inches per year in areas of mapped wetlands.

Groundwater levels within fractured bedrock, such as at the Mine Site, can be simulated using MODFLOW if the model scale is sufficiently large and bedrock fractures are sufficiently interconnected such that the fractured rock medium behaves similar to a porous medium. The actual hydrogeologic characteristics of the Project site, however, do not fit the model assumptions of homogeneous porous media flow for the bedrock and till layers. The Virginia Formation is considered a poor aquifer and the Duluth Complex has not been recognized as an aquifer, meaning it is not fractured enough to contain substantial quantities of water normally targeted for production purposes. Instead, most of the water in the Duluth Complex is confined to fracture zones and faults, significantly reducing the lateral extent of connectivity with the overlying till (Adams and Liljegren 2009).

Rather than rely on MODFLOW model predictions to estimate groundwater drawdown due to dewatering, and potential impacts related to drawdown, empirical observations and professional judgment will be used as the basis for generally describing likely impacts (Adams and Liljegren 2009). Therefore, in the following discussion, applicable MODFLOW model results will be described except where they have been superseded by empirical observations. It is the tribal cooperating agencies' position that the MODFLOW model does not provide credible data outside the footprint of the mine pits. As previously indicated, tribal cooperators have reviewed the Adams and Liljegren 2009 email and do not consider the methods used to be adequate (GLIFWC 2009, Memorandum to Jon Ahlness and Stuart Arkley: Photographic evidence for pit impacts to wetland hydrology. April 24, 2009).

Mine Site

PolyMet would affect groundwater levels at the Mine Site during operations by dewatering the active mine pits and pumping water to the WWTF and then to the Tailings Basin (Years 1-11) or the East Pit (Years 12-20). Groundwater inflows to the mine pits for several stages of mine development were predicted using the MODFLOW model (Table 4.1-32). The simulations predict that combined groundwater inflows into the mine pits would increase from 200 to 1,140 gpm during Years 1 through 15 as the pits widen and deepen. Thereafter, the increases in inflows to the West Pit as it continues to expand until Year 20 would be offset by filling of the East and Central pits.

Table 4.1-32 Predicted Groundwater Flow Rates during Mine Operations and Closure

	East Pit		Central Pit		West Pit		
	GW Inflow (gpm)	**GW Outflow (gpm)**	**GW Inflow (gpm)**	**GW Outflow (gpm)**	**GW Inflow (gpm)**	**GW Outflow (gpm)**	**Total Net Inflow (gpm)**
Year 1	180	0	--	--	20	0	200
Year 5	820	0	--	--	80	0	900
Year 10	880	0	--	--	160	0	1,040
Year 11	930	0	--	--	140	0	1,070
Year 12	870	0	--	--	150	0	1,020
Year 15	750	0	70	0	320	0	1,140
Year 20	20	130	20	10	810	0	710
Post-Closure	Surficial[1]		30[a]	10	80	--	80
	Bedrock[1]		20	<5	30	--	>40

Source: Modified from Tables 4-1 and 4-2 in RS22 Appendix B Draft-03, Barr 2008.
[1] Combined flow from the merged East and Central pits

Once mining is completed in each pit and pumping stopped, groundwater would contribute to filling the pits. The East Pit is predicted to fill, coincident with backfilling with waste rock, in approximately eight years (from Year 12 when mining ends to Year 20 when the pit is flooded). The Central Pit would be mined from Years 12 to 13. Starting in Year 14, the Central Pit would be filled with rock and water and dewatering ceased. By Year 20, the East and Central pits would be combined into a single pit.

The West Pit is larger and its flooding is subject to more variables. Uncertainty Analysis of the West Pit flooding was conducted using Monte Carlo simulations (Barr 2008, Uncertainty Analysis Workplan – Pit Flooding Geochemistry). According to the MODFLOW results, the West Pit would fill in approximately 53 years (Year 73) after dewatering ceases (RS52, Barr 2007). The Uncertainty Analysis results estimated the average time to fill the West Pit would be about 45 years after mine closure, which is the value we use in the remainder of this EIS.

Effects on Surrounding Groundwater Levels During Mine Operations

The excavation and dewatering of the mine pits would affect groundwater levels in the area surrounding the pits. The MODFLOW model was not developed to accurately predict drawdown in the surficial aquifer or the impact, if any, such drawdown would have on adjacent wetlands and surface waters. In order to accurately model water table drawdown around the pits, MODFLOW would have to accurately model the bedrock fractures and the connectivity of the fractures in the overlying surficial glacial material, which has highly variable hydraulic conductivities. In this hydrologic setting, however, it is not practical to gather such locally variable input data for a MODFLOW model. Tribal cooperating agencies disagree with this assumption. It is the tribal cooperating agencies' position that in order to adequately predict potentially significant environmental impacts, hydrogeologic data must be collected that can be used as input to a MODFLOW model. Tribal cooperating agencies contracted with the United

States Geological Survey (USGS) to review the uncertainty of the MODFLOW model and provide recommendations on how the model could be improved. The USGS report was submitted to the lead agencies in February of 2009 (USGS 2009, Letter Report reviewing PolyMet ground-water model. January 29, 2009). Tribal cooperating agencies organized meetings between USGS staff and participants in the EIS, including the applicant, to openly discuss all issues related to the USGS report, the MODFLOW model and the implications for the proposed project. The conclusions of the report and the meetings should be implemented so as to produce a useful model of project site hydrology. Tribal cooperating agencies believe that impacts to surface waters, groundwater, and wetlands for a project of this complexity demand a scientific, data driven approach rather than one based solely on professional opinion. Finally, it is the tribal cooperating agencies' position that a robust groundwater model must be developed for this project in order to adequately characterize the potential impacts of various project alternatives to natural resources.

Empirical observations at taconite surface mining operations in the region show only localized indirect impacts to nearby surface water bodies or wetlands from mine dewatering. For example, the Iron, Argo, and Mud lakes are located along the north rim of the nearby Peter Mitchell Mine. Water level monitoring in the Iron and Argo Lakes during the dewatering of the Peter Mitchell Mine detected no apparent impacts from water table drawdown. Visual observation and review of historic aerial photographs for Mud Lake and nearby wetlands show little if any impact from the dewatering of the Peter Mitchell pit. MnDNR has monitored several other lakes across the Mesabi Iron Range over the past several decades and the data show little, if any, effects from mine pit dewatering (Adams 2008; Adams 2009). As previously indicated, the empirical observations in the Adams 2009 email are insufficient to support the conclusions in the paper. Vegetation data suggest that a significant groundwater-surface water connection exists. It is the tribal cooperating agencies' position that a more robust groundwater model must be developed for this project in order to adequately characterize the potential impacts of the various project alternatives to natural resources.

Based on this empirical evidence as well as prior studies (Adams et al. 2004, Siegel and Ericson 1980), it appears that the ability of the poorly sorted surficial glacial sediments in the Project area to transmit water is highly variable and to a large extent surface water features, including wetland bogs, are isolated from, and not affected by, groundwater drawdown from nearby dewatering activities. Measurable impacts would be confined to localized areas where bedrock fracture zones/faults intercept high permeability till which, in turn, has a high hydraulic connectivity with a surface water feature. In other words, a chain of high hydraulic connectivity must exist from the bedrock up to the surface water. The existing information strongly suggests that the probability is very low that extensive hydraulic connectivity exists to allow significant impacts to wetlands and other surface water features at the Mine Site (Adams and Liljegren 2009; Adams 2008; and Adams 2009). As previously indicated, the empirical observations in the Adams 2009 email are insufficient to support the conclusions. The evidence presented in the email can be interpreted to indicate substantial impact of the Peter Mitchell Pits on adjacent lakes. However, it is the tribal cooperating agencies' position that aerial photography, without ground verification or georeference is an exceedingly imprecise method for determining water levels in lakes and wetlands (GLIFWC 2009, Memorandum to Jon Ahlness and Stuart Arkley: Photographic evidence for pit impacts to wetland hydrology. April 24, 2009). In addition, the hydraulic characteristics of wetland bogs, like those found at the Mine Site, are controlled by extremely low vertical hydraulic conductivity, which is assumed to be almost impermeable (Siegel 1992), although discontinuous zones of buried wood or other structural features in the peat can either obstruct or enhance water flow (Chason and Siegel 1986). The controlling influence of low hydraulic conductivity has been demonstrated several times when peat mining operations have attempted to dewater bogs (Adams and Liljegren 2009). Fens, on the other hand, have substantial groundwater inflow and outflow, and their vegetation is a product of inflowing groundwaters flow across the surface/near surface of the fen, as evidenced by distinct "water tracts." Given the lack of water tracks and photographic evidence of impacts to nearby surface water features, the Mine Site peatlands appear to be much more bog-like than fen-like (Adams 2009). As previously stated, it is the tribal cooperating agencies' position that the above referenced email (Adams 2009) used inadequate methods for determining impacts to surface water features.

Regardless, the true magnitude or location of any hydrologic impact would manifest itself slowly over many years of mine operations, such that properly-designed monitoring should be capable of detecting impacts as they develop, thereby enabling the implementation of appropriate mitigation strategies (Adams and Liljegren 2009). Section 4.2 discusses recommended wetland monitoring at the Mine Site. It is the tribal cooperating agencies' position that the DEIS should not rely on future monitoring to detect impacts as a substitute for the development of data and analyses that would reasonably identify and predict those impacts as part of a DEIS.

Mine Closure and Post-Closure

Upon completion of mining operations and after pit dewatering systems are removed, the East Pit would fill naturally, as supplemented by the backfill of waste rock, and begin overflowing into the West Pit in approximately Year 21. The West Pit would also begin to fill naturally with groundwater inflows, precipitation, and stormwater runoff at the completion of mining in Year 20. These sources would fill the West Pit in about 45 years (Hinck and Kearney 2008) after dewatering ceases (Year 65).

The actual steady-state water levels in the East and West pits after Year 20 would be established by outlet structures that would be used to route surface overflows from the East Pit (invert at elevation 1,592 feet msl) into the West Pit, and from the West Pit (invert at elevation 1,581 feet msl) to a final discharge location in the wetlands west of the pit and north of the Partridge River (Figure 4.1-20).

MODFLOW simulations were performed to predict final groundwater conditions in Post-Closure (i.e., once the West Pit has filled). Although the MODFLOW model results do not necessarily accurately reflect drawdown in the surficial aquifer, the model drawdown predictions in Closure and Post-Closure reflect long-term conditions to which groundwater heads must re-equilibrate. The model predictions may thus be useful in planning the geographic extent of recommended wetland monitoring (Section 4.2). Long-term change in surficial aquifer groundwater levels (i.e., permanent drawdown) is due to the fixing of head boundaries to lower surface water levels controlled by outlet structures relative to existing conditions. The simulated drawdown reaches a maximum of about 20 feet surrounding the West Pit lake (i.e., Post-Closure groundwater elevation of 1,581 feet versus existing groundwater elevation of approximately 1,600 feet) and about 10 feet at the area of the East Pit (i.e., Post-Closure groundwater elevation of 1,592 feet versus existing groundwater elevation of approximately 1,600 feet).

In the bedrock aquifer, the MODFLOW model predicts nearly complete recovery of groundwater elevations in the Project area. The exception is at the West Pit where the presence of shallow bedrock results in predicted long-term bedrock groundwater elevation being about 10 to 20 feet lower than existing conditions due to the lowered head boundary at the lake.

Plant Site

As opposed to the Mine Site where mine dewatering would lower groundwater elevation, the potential issue at the Plant Site is groundwater mounding at the Tailings Basin. PolyMet does not propose a liner for the Tailings Basin. As a result, the Project would result in increased seepage from the Tailings Basin relative to existing legacy LTVSMC seepage, including both surface seepage through the Tailings Basin embankment and groundwater seepage through the base of the LTVSMC tailings (Table 4.1-33). Most of this seepage would move north toward the Embarrass River, but a small portion of seepage would move south toward Second Creek in the Partridge River watershed.

Table 4.1-33 Summary of Tailings Basin Groundwater Seepage (gpm)

	Seepage toward Embarrass River						Seepage toward Second Creek		
Mine Year	PolyMet Cell 1E/2E Seepage	PolyMet Hydromet Seepage	LTVSMC Cell 2W Seepage	Total Seepage	Total Recovered Seepage	Total Unrecovered Seepage	Cell 1E Seepage	Total Recovered Seepage	Total Unrecovered Seepage
Existing	900	NA	895	1,795	0	1,795	550	0	550
Year 1	1,600	0.5	895	2,496	0	2,496	455	455	0
Year 5	2,260	6.7	895	3,162	0	3,162	410	410	0
Year 10	2,490	7.7	895	3,393	0	3,393	597	597	0
Year 15	2,700	7.8	895	3,603	0	3,603	671	671	0
Year 20	2,900	8.7	895	3,804	0	3,804	737	737	0
Post-Closure	490	0.7	610	1,101	0	1,100	290	0	290

Source: Hinck 2009.

PolyMet proposes a surface seepage collection system that would intercept and collect virtually all surface seepage (estimated as an average of approximately 100 gpm during mine operations) from the Tailings Basin (Figure 4.1-21). The system includes installation of new horizontal drains located near the toe of the embankment north of Cells 2E and 2W. Additional horizontal drains would be placed along perimeter embankments to intercept and collect seepage. All collected surface seepage would be pumped back into the Tailings Basin until the seeps dry out.

PolyMet would also establish a seepage recovery system in the area south of Cell 1E consisting of a clay barrier to block known seepage at the headwaters of Second Creek and divert it to a seepage collection trench. The groundwater seepage to Second Creek would also be collected and pumped back into the Tailings Basin during operations, but the seepage barrier would be removed during Closure and any remaining seepage (estimated at approximately 290 gpm) would be released to Second Creek.

PolyMet proposes a geomembrane liner overlying a clay liner for the four proposed hydrometallurgical residue cells within the existing Cell 2W. The cells would function as large sedimentation basins, with the slurried residue settling out in the cell, while the excess liquid would be recovered and pumped to the Plant Site for reuse during mine operations. The rate of liner leakage (unrecoverable seepage) from these cells to groundwater is predicted to range from 0.5 gpm (Year 1) to 8.7 gpm (Year 20) (Hinck 2009).

The total unrecovered PolyMet groundwater seepage from the Tailings Basin, however, is expected to range from 1,600 gpm in Year 1 (excluding the 895 gpm of residual LTV seepage from Cell 2W) to approximately 2,909 gpm in Year 20 (again excluding 895 gpm of residual LTV seepage from Cell 2W).

Although PolyMet developed a groundwater flow model for the Tailings Basin, it is not suitable for determining impacts to groundwater elevations outside the tailings embankment because the surrounding wetlands were used as head boundaries and by definition are fixed in the model. This is a reasonable assumption based on examination of the limited groundwater monitoring data in the wetlands north and northwest of the Tailings Basin (Figure 3.1-13), which suggests that groundwater elevations outside the basin are controlled by contact with relatively stable water levels in the adjacent wetlands.

Therefore, future impacts to the hydrology of the aquifer and wetlands downgradient of the Tailings Basin were estimated by comparing predicted seepage rates for the Proposed Action (Hinck 2009) with the estimated groundwater flux capacity of the aquifer (155 gpm)(Technical Memorandum: TB-2 and TB-14: Tailings Basin Seepage Groundwater Quality Impacts Modeling Methodology). The current seepage rate toward the Embarrass River from the Tailings Basin (Cells 1E/2E and 2W) is estimated at 1,795 gpm, which continues to result in the upwelling of seepage water into the wetlands as the seepage rate exceeds the aquifer flux capacity by over 1,600 gpm. Under the Proposed Action, the unrecovered seepage rate is predicted to increase to a maximum of approximately 3,800 gpm in Year 20, over 2,900 gpm of which would be attributable to PolyMet (Hinck 2009). Therefore, under the Proposed Action, a significant increase (>100%) in groundwater upwelling relative to existing conditions would be expected. Some of this seepage water would drain to existing streams, but because of the generally flat topography and extensive wetlands, much of this water would be expected to form ponds and inundate wetlands.

Effects on Groundwater Quality at the Mine Site

The Project could affect groundwater at the Mine Site by leaching principally metals from exposed waste rock and lean ore stockpiles and mine pit sidewalls, which subsequently could seep into the groundwater. PolyMet proposes to construct five waste rock/lean ore stockpiles at the Mine Site segregated based on their potential to generate acid rock drainage and to leach metals. The stockpiles would have different types of bottom liners and top cap systems to minimize the volume of unrecoverable leakage to groundwater (see Table 3.1-9). Most of the leachate would be collected (i.e., recoverable seepage), drained to a total of 11 stockpile sumps, and then pumped to the WWTF.

In addition to the waste rock and lean ore, the Project would also need to stockpile overburden. PolyMet classified the overburden into three types based on its physical and chemical characteristics: saturated, unsaturated, and organic soils (peat) (Kearney and Wenigmann 2009).

PolyMet proposes to extend the Category 1/2 liner system under the overburden material and to compact the overburden material as it is placed to limit oxidation and infiltration (Kearney and Wenigmann 2009). Although the effectiveness of compaction is uncertain, the overburden would also be progressively reclaimed to minimize exposure. Process water from the overburden portion of the stockpile would be sent to the WWTF. PolyMet indicates it may place the peat and unsaturated overburden in the unlined Overburden Storage and Laydown Area for processing and re-use. In Section 4.1.3.5 we discuss potential mitigation measures addressing overburden management.

The mine pits could also affect groundwater quality as solutes would be leached from backfilled waste rock as well as flushed from exposed pit sidewalls. In particular, mining would expose portions of the high sulfide Virginia Formation in the East Pit (Figure 4.1-3). PolyMet proposes applying a limestone treatment to the exposed Virginia Formation walls in the East Pit while the backfill is being placed during pit filling to help neutralize the acidity of the rock face. PolyMet also proposes to place overburden and a low permeability cover against the exposed Virginia Formation high wall in the East Pit when filling reaches the design elevation to reduce long-term oxidation and solute leaching from the wall rock (RS52, Barr 2007), although successful application of the technology has not been demonstrated. The groundwater quality modeling discussed below assumes these mitigation measures are implemented.

Tribal cooperators strongly disagree with the assumptions used in the groundwater quality modeling for the mine site. It is the tribal cooperating agencies' position that relying on the effectiveness of a technology with highly variable outcomes (limestone treatment) in calculating long-term water quality is not a conservative approach. The DEIS should provide a range of water quality results including the groundwater quality under a scenario where lime treatment and covering the Virginia Formation wall is ineffective.

Evaluation Methodology

Project effects on groundwater quality at the Mine Site were evaluated by first estimating solute loading from source areas (e.g., rock stockpiles, mine pit walls) and then using models to simulate solute transport to evaluation points.

Solute Loading from Rock Stockpiles

The mechanism most responsible for the release of soluble chemicals of concern from rock stockpiles is the oxidation of sulfide minerals, primarily the mineral pyrrhotite (FeS). Blasting and excavation increases the oxidation rate by increasing the surface area and porosity of the rock, which allows rapid introduction of atmospheric oxygen and flushing of solutes by water. Oxidation releases soluble metals (e.g., cobalt, copper, iron, and nickel) and sulfuric acid. At very low sulfur content (e.g., ~0.1% sulfur), the acid is neutralized by reaction with host silicate minerals; but at higher sulfide content, the acid production could exceed neutralization capacity producing acidic drainage. Formation of acidic conditions is problematic because this increases metal solubility and can increase oxidation rates driven by bacteria. Metals of concern (e.g., cobalt, copper, and nickel) are bound as sulfides in the rock, so sulfide oxidation would result in the release of soluble metals. Metal mobility can be reduced under neutral conditions as metals are removed from solution by adsorption or precipitation, but these may be leached later if conditions become more acidic with time.

The portion of meteoric water (rain and melting snow) that is not lost to evaporation or runoff would percolate into the rock stockpiles before and after the surface is capped with a vegetated soil layer and/or composite liner. Percolating water would flush metals and other products of oxidation from the rock. This flow through unsaturated rock would take limited flow paths that may vary with flux rate and particle-size distribution. Solutes that are out of water flow paths may remain stored in the stockpiles for many years, while solutes in these flow paths would be flushed out, seeping either down into groundwater or out as toe seepage on the stockpile liner.

Solute dissolution rates (mg/kg/week) for 34 elements as well as chloride, fluoride, and sulfate from the five waste rock/lean ore stockpiles were estimated using an empirical approach where results from humidity cells (conservatively using the 95th percentile release rates) were scaled to estimate solute release from full-size facilities (Table 4.1-34). Final predictions were evaluated against mineral solubility limits ("concentration caps") and analogous mine sites (e.g., MnDNR reactor data) to determine the reasonableness of the prediction against theoretical limits and known conditions (RS 53/42, SRK 2007). The analyses identified the following 16 constituents as being present in the NorthMet waste rock/ore and leaching in sufficient quantities to warrant additional analysis: aluminum, antimony, arsenic, beryllium, cadmium, cobalt, copper, fluoride, iron, lead, manganese, nickel, sulfate, thallium, vanadium, and zinc.

It should be noted that the humidity cell tests for antimony were contaminated by leaching of antimony oxide from PVC components of the cell apparatus (RS53/42, SRK 2007). Therefore, the humidity cell results were not intended to be used in developing dissolution rates for antimony, instead the MnDNR reactor data was to be relied on for use in the deterministic modeling. This was the only parameter for which MnDNR reactor data was used. It was recently determined that the antimony dissolution rates from the humidity cell data, instead of the MnDNR reactor data were inadvertantly used in the deterministic modeling for the West Pit under both the Proposed Action and Mine Site Alternative (Hinck, Pint, and Wong 2009). This error has been corrected in this DEIS. As discussed above, concentration caps were used to establish reasonable upper limits to leachate concentrations. In the case of antimony, the concentration cap based on the contaminated humidity cell testing (80 µg/L) was used in the deterministic modeling for the West Pit and stockpile leachate, while the highest observed antimony concentration in the MnDNR reactor data was only 3 µg/L (Hinck, Pint, and Wong, July 22, 2009). The use of this concentration cap from the contaminated humidity cell results suggests that predicted antimony concentrations in groundwater from the West Pit and waste rock stockpiles at the Mine Site may be overestimated.

Table 4.1-34 Solute Release Scaling Factors

Scaling Factors	Scaling Assumptions
Temperature	0.3 for Category 1 / 2 rock – reduces oxidation rates measured at ~20°C in lab to average air temperature at Mine Site (~2.4°C). 0.0 for Category 3 / 4 rock – assumes heat from oxidation would keep rock near 20°C as observed in lab.
Particle Size	0.2 – estimates the reactive factor assuming that rock larger than ¼ inch (the size in the

	humidity cell tests) makes insignificant contribution to solutes.
Contact	0.5 – fraction of rock flushed by infiltrating water each year.
Acid Onset	Category 3 waste rock – Assumed acid onset at 5 years after exposure based on AMAX stockpile data Category 4 waste rock – Assumed immediate acid onset upon placement.
Solute Release	Assumed to be constant and long term
Concentration Caps	Upper limit concentrations were applied to waste rock seepage based on maximum concentrations observed in a water chemistry database for a given pH. See Table 7-2 in RS53/42.
Acidity Factor	The humidity cell results used had not yet resulted in acidic pH. An acidification factor of 10 was applied to the Category 3 waste rock/lean ore stockpiles and Category 4 lean ore surge pile based on data from the Dunka Pit. Acidic weathering rates for Virginia Formation and sedimentary hornfels were used directly for the Category 4 waste rock stockpile.

Source: RS53/42, SRK 2007

Total water flow was estimated as the infiltration rate (liner yield) into the waste rock surface (m/yr) multiplied by the area of the stockpile top (m^2) to yield the volume of water passing through each stockpile (m^3/yr) (RS21, Barr 2007). The mine plan and schedule was used to determine the size and area of the stockpiles for each mine year. Annual inflow calculations account for progressive reclamation efforts including the placement of evapo-transpiration covers. PolyMet assumed three liner yield scenarios (low, average, and high) based on data from test stockpiles in northeast Minnesota and precipitation records (RS74A, Barr 2008). Solute concentrations (mg/L) in seepage were estimated as the annual solute release (mg/yr) divided by the annual flow (L/yr). Under the assumed uniform solute production throughout the rock, seepage concentrations increase in proportion to the height of the stockpile. All modeling was performed using the lowest liner yield (i.e., low liner yield scenario), which results in the highest solute concentrations because all solutes produced in the stockpiles were conservatively assumed to be flushed out in seepage each year, regardless of the liner yield. Assumptions were also made regarding the rate of liner leakage (low, average, and high), all using the highest solute concentration from the low liner yield scenario.

Solute Loading into the Mine Pits

The estimate of pit lake water quality focuses on sulfide-mineral oxidation in rock that would be leached to the lake. The overall solute load to the pit lakes is the sum of the load from inflowing water (i.e., groundwater, waste rock seepage, non-contact stormwater runoff, and treated water from the WWTF), seepage from aerated wall rock, leachate from backfilled waste rock, and flushing of stored oxidation products from wall rock and backfill as it floods.

Pit-wall geology suggests that the wall rock would probably be an important source of metals and sulfate loading to the East and West pit lakes. Based on the geologic block model of the mine pits, acid generating rocks (ore, and Category 3 and 4 waste rock) comprise ~65% of the wall rock in both the East and West pits (Figure 4.1-22). Mine pit blasting produces fractures, particularly in horizontal pit benches, where blast holes are typically drilled to ~2-meters below the bench top. Observation in pit mines also show frequent formation of talus cones on benches from physical weathering of the steeper walls. The result is a permeable rind in the pit walls with enhanced oxygen diffusion (and thus sulfide mineral oxidation), and greater hydraulic permeability (which facilitates flushing of solutes by percolating rain and snowmelt). Some solutes may remain in the pit walls when held in fractures out of seepage flow paths; but most are assumed to eventually flush out when the rock is inundated by the pit lake.

After inundation, wall-rock oxidation essentially stops due to the low solubility (~10 mg/L) and the slow diffusion rate (i.e., ~1/10,000th as fast as in air) of oxygen in water, so submerged wall rock may be considered essentially inert. The acid generating wall rock, however, extends to the rim of the pits, indicating that some acid-generating wall rock would remain exposed and subject to long-term oxidation even when the pit lakes reach their final elevation, which is 10 to 20 feet below the pit rim. PolyMet proposes to place overburden and a low permeability cover over the exposed Virginia Formation walls above the East Pit lake, which would help mitigate solute dissolution in this area to some extent. Solutes are removed from the pit lakes either as dissolved constituents in groundwater and surface water outflow, or as chemical precipitates that settle to the pit lake bottom, as occurs when acidic water is neutralized. After the pit lakes reach a static water elevation, the long-term water chemistry is controlled by the continued leaching of solutes from pit highwalls that remain above the lake and the load lost in outflow.

Waste rock backfilled to the pit lake has a chemical effect similar to wall rock, with waste rock above the lake surface oxidizing and leaching solutes to the pit lake. When inundated by the pit lake, however, leaching stops and the submerged rock is essentially inert fill. Solute loading to the pits from wall rock was estimated using an empirical scale-up of solute-release rates measured in small-scale kinetic test data. The composition of pit water, either pumped out during mining or present in the pit lake, was based on dividing the solute load into the pit by the volume of receiving water. Table 4.1-35 provides model assumptions and input data.

Table 4.1-35 Mine Pit Solute Loading Assumptions and Input

Assumptions/Input	**Source References**
Solute Loading Sources and Release Rates	Generally see Table 6-3 in RS31
Wall rock composition	RS67
Geochemical performance of wall rocks	RS53/42
Geochemical predictions for other facilities	RS53/42
East Pit wetland overflow	RS29T
Tailings seepage and process pond	RS52/46
Wastewater treatment plant parameters	RS29T
Net precipitation	RS73
Groundwater quality	Based on average from monitoring wells
Stormwater runoff from undisturbed soil	Used Partridge River water quality data
Stormwater runoff from reclaimed surfaces	RS24, RS52
Leakage from stockpile liners	RS42
Physical water inflows	RS22, RS10A
Corrections Factors	
Temperature	0.3 – reduces oxidation rate from ~20°C in lab to ~2.4°C (avg ambient air temperature at Mine Site)
Particle Size (reactive fraction)	0.1 – estimate of wall rock fraction that is smaller than 0.25 inch material in humidity cells
Wall Rock Thickness	Assumes 2 meter thick wall rock reactive rind based on over-drilling of blast holes
Contact Factor	0.5 for backfill when inundated and 0.5 for pit surfaces after Closure
Acid Onset	Solutes released in wall rock are assumed to be loaded into pit lakes when flooded by the lake
Critical Assumptions	
Oxidation Rate	Assumed to be proportional to rates in the humidity cells and the wall rock was assumed to contain oxygen thru the 2 meter reactive zone
Solute Concentration	Upper limits applied to waste rock effluent based on maximum concentrations observed during kinetic tests (see Table 7-2 in RS 53/42)
Solute Release Rates	Assumed to decay exponentially and estimates based on MnDNR's long term kinetic reactors (see Appendix B of RS 53/42.
Upper Solute Limits	Upper limits applied based on neutral pH and assumes chemical precipitation in the lake.
Lake Stratification	Assumes the pit lakes remain entirely mixed with no stratification. If stratification was to occur because of denser saline layer, the quality of discharge from the pits would be better (see RS 31).
Lake Volume	Elevation/Volume relationships (see RS31, Figure 6-1)

Solute Transport

Solute transport was evaluated along six simulated flow paths and at two key evaluation points – the PolyMet property boundary and the Partridge River (Table 4.1-36; Figure 4.1-23).

Tribal cooperating agencies note that the property boundary has not been defined for this project. Therefore, It is the tribal cooperating agencies' position that the Dunka road should be used as an evaluation point. The PCA has agreed to this and figure 4.1-23 indicates that the Dunka road is an evaluation point. Corresponding information for that evaluation point must be included in table 4.1-36.

Table 4.1-36 Solute Transport Flow Paths and Evaluation Points

Flow Path	Solute Sources	Evaluation Points
#1	Category 1/2 and overburden stockpiles	Property boundary
#2	West Pit	Property boundary
#3	Category 4 Lean Ore Surge Pile	Partridge River
#4	East Pit and Category 4 Stockpile	Property boundary, Partridge River
#5	Category 3 Stockpile	Partridge River
#6	Category 3 Lean Ore Stockpile	Partridge River

Source: RS74A, Barr 2008.

Solute transport modeling was conducted using a two step process (RS74A, Barr 2008):

1. Steady State Flow Modeling- a steady-state MODFLOW and MT3DMS cross-sectional transport model (Zheng and Wang 1999) was initially used to identify solutes of potential concern from each source area (i.e., stockpiles and pit lakes) along the six simulated flow paths. At the evaluation points along each flow path, dilution factors were used in a spreadsheet model to determine chemical concentration for all constituents.

2. Transient Flow Modeling - For those constituents that showed potential exceedances of groundwater standards using the steady state model, more detailed transient flow modeling with MODFLOW and MT3DMS was conducted to determine solute concentrations at time scales ranging from short-term Project operations to Post-Closure (beyond approximately Year 65). Because of the heightened concern regarding sulfate concentration, sulfate was carried forward to the next phase of modeling regardless of whether the steady state model predicted groundwater concentrations in excess of criteria.

Key model assumptions and input variables are provided in Tables 4.1-37. In about Year 20, following backfilling of the East Pit, groundwater outflow toward the Partridge River would begin, albeit at low levels (i.e., 10 gpm). Similarly, around Years 65, groundwater outflow from the West Pit toward the Partridge River would begin, again at a low rate (i.e., 18 gpm).

Table 4.1-37 Screening and Transient Solute Transport Model Inputs and Assumptions – Mine Site

Evaluation Points	Property boundary and the Partridge River (Figure 4.1-25) Tribal cooperators note that there is no figure 4.1-25.			
Evaluation Criteria	Primary and secondary USEPA drinking water standards and Minnesota Health Risk Limits (see Table 4.1-17)			
Sources Evaluated	Leakage through the waste rock stockpile liners and groundwater outflow from the mine pits (Figure 4.1-25)			
Dispersion Coefficients		Flow Path (Figure 4.1-25)	Dispersion Coefficients	
			D_x(m)	D_z(m)
	1	Category ½ and Overburden Stockpile	17.3	0.865
	2	West Pit	13.2	0.66
	3	Lean Ore Surge Pile	13.4	0.67
	4	East Pit and Category 4 waste rock stockpile	14.3	0.715
	5	Category 3 waste rock stockpile	12.5	0.625
	6	Category 3 lean ore stockpile	12.2	0.61
Source Flow Inputs	Hydrologic head distribution at Closure as predicted by Mine Site MODFLOW model			
	Maximum predicted leakage rates for the waste rock stockpiles from Table 4.1-30			
	Recharge from precipitation was set at 1.5 inches per year as used in the calibrated Mine Site model			
Source Concentrations	Predicted concentrations of liner seepage under high, average, and low flow conditions from Tables 6-26 thru 6-28 in RS74A, Barr 2008			
Background Concentrations	Used groundwater data from monitoring wells at the Mine Site as presented in Tables 6-26 through 6-28 in RS74A, Barr 2008			
Model Cell Dimensions	Δx – 25 meters Δy – 10 meters Δz – surficial deposits – 1 meter ΔZ – bedrock – 20 meters			
Hydraulic Conductivity	Values were based on those used in the Mine Site groundwater model RS22, Barr 2007			
	Highest values were used to evaluate worst-case scenario (highest values cause less mixing resulting in higher predicted solute concentrations)			
	Surficial deposits	9.3 ft/day	2.83 m/d	
	Bedrock	0.0024 ft/day	7.32×10^{-4} m/d	
Sorption	Transient cross-sectional models were run both with and without any solute sorption. Linear sorption is modeled with a partition coefficient (K_d) that relates the concentration of a sorbed constituent to the concentration of the constituent in solution. Sorption was only simulated in the surficial aquifer; no sorption was assumed to occur in the bedrock aquifer.			
	Values Used in Cross-Section Models: arsenic – 25 L/kg; copper – 22 L/kg; nickel – 16 L/kg; and antimony – 0 L/kg.			

Source: Modified from Table 6-4 in RS74A, Barr 2008

The deterministic modeling conducted at the Mine Site highlighted the importance of two key assumptions: the extent of contaminant leakage through the composite liners and the degree to which sorption would occur and reduce contaminant concentrations as the leachate passes through soil and aquifer solids. We discuss these two assumptions below.

Liner Leakage

The amount of liner leakage from the waste rock and lean ore stockpiles is primarily determined by overliner slope, installation defects (i.e., number of holes or tears in the liner), and subgrade permeability. In order to minimize leakage, PolyMet proposes a 1% overliner slope, a maximum of two installation defects per acre, and a subgrade permeability of 1×10^{-5} cm/sec for the Category 3 waste rock stockpile; and a 2% overliner slope, a maximum of two installation defects per acre, and a subgrade permeability of 1×10^{-6} cm/sec for the Category 3 lean ore, Category 4 waste rock, and the lean ore stockpiles. The USEPA Hydrologic Evaluation of Landfill Performance (HELP) Model was used to estimate a range of potential liner yields

(Golder 2007). For purposes of the deterministic modeling, three scenarios were used involving low, average, and high liner leakage rates to estimate potential groundwater quality impacts. The PolyMet proposed design, if achieved, would result in less leakage than the low liner leakage scenario.

After reviewing the available data, we conclude that the low and average liner leakage rates would not be sufficiently protective of the environment for the Proposed Action. We do believe the liner system could be installed in compliance with the proposed design if rigorous quality control measures are used. Current construction practices and improvements in electrical leak detection surveys should be able to achieve the proposed design criteria (i.e., defects/acre, overliner slope, and subgrade permeability). However, we do have concerns regarding the ability of this liner system to permanently maintain these design criteria (e.g., differential settlement could cause tears in the geomembrane liner), the potential for the geomembrane liner to degrade over time, and the adequacy of the proposed overliner cover thickness (12-18 inches) to protect the liner from accidental tears or rips during waste rock placement given both the size of the waste rock and the equipment necessary to place it properly. Mitigation Measures are further discussed in Section 4.1.3.5.

On the other hand, we believe the high liner leakage rate would result in an unreasonably high leakage rate because it assumes a combined worse case scenario of overliner slope, defects per acre, and subgrade permeability. Since modeling was only conducted for these three scenarios, however, we rely on the high liner leakage rate (at least where this rate results in the highest predicted solute concentrations) in evaluating model results in order to be conservative (i.e., protective of the environment), but recognize that use of this leakage value may over estimate groundwater quality impacts.

Sorption

Many contaminants, including metals, are known to adsorb or absorb (collectively referred to as sorption) to various minerals, organic matter, and other surfaces present in the soil and aquifer solids, which reduces contaminant concentrations and/or mass flow rates as they are transported downgradient from their source (Wilkin 2007; McLean and Bledsoe 1992). The metal partition coefficient (K_d) is the ratio of the sorbed metal concentration (expressed in mg metal per kg sorbing material) to the dissolved metal concentration (expressed in mg metal per L of solution) at equilibrium. Higher K_d values represent higher sorption capacity. The partition coefficient for metals is quite complex and is affected by numerous geochemical parameters and processes, including pH; the presence of clays, organic matter, iron oxides, and other soil constituents; oxidation/reduction conditions; major ion chemistry; and the chemical form of the metal (USEPA 1996).

Literature values are available for estimating metal partition coefficients (USEPA 1996; Allison and Allison 2005). These values have been adopted by MPCA as part of its risk based guidance for State Superfund and VIC program sites (MPCA 1998). A close review of these USEPA guidance documents, however, reveals that there is a wide range of partition coefficients, reflecting the many variables identified above that can affect sorption (USEPA 1996). Further, there is a wide variation in the degree of confidence that USEPA has in these data (Allison and Allison 2005). Table 4.1-38 summarizes the USEPA partition coefficient information for the metals applicable to the NorthMet Project. PolyMet initially proposed using the low end (i.e., least sorption) USEPA K_d Estimated Screening Level Values**.**

Table 4.1-38 USEPA Guidance Regarding Sorption

Metals	K_d Median	K_d Range	USEPA K_d Estimated Screening Level Values	Confidence Level 1=highest, 4=lowest
Antimony	251	1.3 – 501	45	4
Arsenic	2,512	2 – 19,953	25 – 31	2
Copper	501	1.3 – 3,981	NA	1
Nickel	1,259	10 – 6,310	16 – 1,900	1

Source: Allison and Allison 2005; USEPA 1996.

In response to agency concerns regarding the use of literature-based sorption values, PolyMet conducted site specific sorption testing on soil samples collected from the most permeable zone of two borings at the Mine Site. Batch sorption tests were conducted in the laboratory generally using standard ASTM procedures (Barr 2009, Technical Memorandum: Results of Site-Specific Soil Sorption Tests: Mine Site). The batch testing results suggest that sorption at the Mine Site for several metals may actually be considerably greater than the low end of the USEPA screening level values originally proposed for use by PolyMet (Table 4.1-39). The agencies, however, raised some concerns regarding the procedures used for the sorption testing (Blaha 2009). Nevertheless, the site-specific sorption results are compelling enough for us to feel comfortable accepting values no higher than the low end of the USEPA screening levels, except for antimony. Although we do expect that some degree of sorption would occur for antimony, the results of the site-specific testing and our concerns regarding the protocol used for the sampling lead us to assume a K_d value of zero at this time. Table 4.1-39 presents the results of the site specific sorption testing and the values we are accepting for use in evaluating the results of the groundwater modeling at the Mine Site.

Table 4.1-39 Comparison of Site Specific and Literature Sorption Values at the Mine Site

	Literature Sorption Value	Site Specific Sorption Values			K_d Values Accepted for Use in Groundwater Modeling
Parameter	USEPA Screening Value	Boring RS-22	Boring RS- 24	Average	
Antimony	45	1.6	22	12	0
Arsenic	25	>52	590	~320	25
Copper	22	1,047	463	755	22
Nickel	16	73	40	56	16

Source: Modified from Barr 2009, Technical Memorandum: Results of Site-Specific Soil Sorption Tests: Mine Site.

Deterministic Model Results

Using the solute loading estimates from the stockpiles and mine pits, the steady state modeling was initially used to identify solutes that have the potential to exceed groundwater evaluation criteria. Table 4.1-40 summarizes the results of this initial modeling. It should be noted that aluminum, beryllium, thallium, iron (Flow Paths #1 and 2), and manganese (Flow Paths #1 and 2) exceeded the groundwater evaluation criteria in the model; however, this was attributable to high background concentrations and these solutes were not carried forward for detailed transient flow modeling. Sulfate was carried forward in all flow paths, regardless of whether the steady state modeling predicted exceedance of groundwater standards.

Table 4.1-40 Summary of Potential Groundwater Evaluation Criteria Exceedances at the Mine Site Using Steady State Model

Flow Path	Potential Groundwater Evaluation Criteria Exceedences	Additional Constituents for Transient Model
#1 - Category 1/2 – Overburden Stockpile	**Arsenic, antimony, sulfate**, *aluminum, iron, manganese, beryllium, thallium*	--
#2 - West Pit	**Arsenic, antimony,** *aluminum, iron, manganese, beryllium, thallium*	Sulfate
#3 - Lean Ore Surge Pile	**Iron, manganese, nickel, iron, manganese,** *aluminium, beryllium, thallium*	Sulfate
#4 - East Pit and Category 4 Waste Rock Stockpile	**Iron, manganese, nickel, and sulfate.** *aluminum, beryllium, thallium*	Sulfate
#5 - Category 3 Waste Rock Stockpile	**Antimony, arsenic, copper, iron, manganese, nickel, sulfate**, *aluminum, beryllium, thallium,*	--
#6 - Category 3 Lean Ore Stockpile	**Copper**, **iron**, **manganese**, **nickel,** *aluminium, beryllium, thallium*	Sulfate

Source: Modified from Table 6-24 in RS74A, Barr 2008.
Notes: Constituents in **bold** or *italics* exceeded groundwater evaluation criteria. Constituents in *italics* were not carried forward to transient modeling.

Those solutes that were identified as potentially exceeding groundwater evaluation criteria using the initial steady state modeling, as well as sulfate (Table 4.1-40), were then subjected to more detailed analysis using transient flow modeling. Table 4.1-41 provides a summary of the results showing that several solutes are predicted to exceed groundwater evaluation criteria at various locations at the Mine Site. As discussed previously, we accept use of the lower range of the USEPA screening level sorption values based on the results of the site-specific sorption testing. Similarly, we evaluate on a case by case basis those solutes that are predicted only to exceed groundwater evaluation criteria under the conservative high liner leakage conditions. Even with these assumptions, several parameters are predicted to exceed USEPA primary and secondary MCLs and MDH Health Risk Limits at multiple flow paths for various periods and durations. It is important to note that secondary MCLs are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health or aquatic life. Therefore, our evaluation primarily focuses on exceedances of primary MCLs and MDH Health Risk Limits.

Table 4.1-41 Summary of Maximum Concentrations Predicted Using Deterministic Transient Flow Modeling for Mine Site under the Proposed Action

Parameters	Units	Evaluation Point	Groundwater Evaluation Criteria	Liner Leakage Model(s) with Criteria Exceeded	Predicted Model Maximum Concentration	Period Exceeding Groundwater Criteria (Mine Years)	Predicted Maximum Concentration (no sorption)
Flow Path #1 - Category 1 and 2 Waste Rock & Overburden Stockpile							
Antimony	µg/L	Property Boundary	6	Low	**16**	Unknown	**16**
Arsenic	µg/L	Property Boundary	10	None	2.8	None	**140**
Sulfate	mg/L	Property Boundary	250	Low	**460**	~100 – 2000	**460**
Flow Path #2 - West Pit							
Antimony	µg/L	Property Boundary	6	Low, Average, High	**9.5**	~200 - 2000	**9.5**
Arsenic	µg/L	Property Boundary	10	None	2.8	None	**82**
Sulfate	mg/L	Property Boundary	250	None	110	None	110
Flow Path #3 - Lean Ore Surge Pile							
Iron	µg/L	Partridge River	300	High	**470**[1]	~60 – 125	**470**
Manganese	µg/L	Partridge River	50/300	High	**66**[1]	~60 – 125	**66**
Nickel	µg/L	Partridge River	100	None	1.0	None	**150**
Sulfate	mg/L	Partridge River	250	None	23	None	23
Flow Path #4 – East Pit & Category 4 Waste Rock Stockpile							
Antimony	µg/L	Partridge River	6	Low, Average, High	**15**	Unknown	**15**
Iron	µg/L	Partridge River	300	Low, Average, High	**500**	~75 – 2000	**500**
Manganese	µg/L	Partridge River	50/300	Low, Average, High	**110**	~75 – 2000	**110**
Nickel	µg/L	Partridge River	100	None	3.7	None	**290**
Sulfate	mg/L	Partridge River	250	None	68	None	68
Flow Path #5 - Category 3 Waste Rock Stockpile							
Antimony	µg/L	Partridge River	6	Low, Average, High	**46**	Unknown	**46**
Arsenic	µg/L	Partridge River	10	None	2.3	None	**46**
Copper	µg/L	Partridge River	1,000	None	100	None	**3,200**
Iron	µg/L	Partridge River	300	Low, Average, High	**4,200**	~50 – 2000	**4,200**
Manganese	µg/L	Partridge River	50/300	Low, Average, High	**900**	~50 – 2000	**900**
Nickel	µg/L	Partridge River	100	Low, Average, High	**1,000**	~50 – 2000	**12,000**
Sulfate	mg/L	Partridge River	250	High	**280**[1]	~100 – 200	**280**
Flow Path #6 - Category 3 Lean Ore Stockpile							
Copper	µg/L	Partridge River	1,000	None	43	None	920
Iron	µg/L	Partridge River	300	High	**1,300**[1]	~50 – 2000	**1,300**
Manganese	µg/L	Partridge River	50/300	High	**250**[1]	~50 – 2000	**250**
Nickel	µg/L	Partridge River	100	Average, High	**650**	~50 – 2000	**3,400**
Sulfate	mg/L	Partridge River	250	None	58	None	58

Source: Modified from Table 6-30, 6-31, and 6-32, RS74A, Barr 2008.

NOTES: **Bold** (e.g., **0.014**) indicates predicted concentration exceeds groundwater evaluation criteria.

NA = not applicable or not modeled

[1] Parameters that are predicted to only exceed groundwater evaluation criteria under the high liner leakage model must be carefully evaluated on a case by case basis considering the low probability of the high liner leakage rate occurring.

As Table 4.1-39 indicates, antimony (at four flow paths), manganese (at only one flow path with an exceedance of the MDH Health Risk Limit of 300 µg/L), and nickel (at two flow paths) are predicted to exceed USEPA primary MCLs and/or MDH Health Risk Limits. In terms of antimony, these results do not account for any natural attenuation by sorption, even though the site specific sorption testing did find low levels of sorption occurring. As mentioned previously, the predicted antimony concentrations may be overestimated because the concentration cap from the contaminated humidity cell results was used.

Waste Rock Stockpiles Uncertainty Analysis

The Proposed Action would involve the permanent storage of highly reactive waste rock in surface stockpiles. Agency review of the deterministic modeling revealed a significant degree of uncertainty regarding key model input assumptions (i.e., the parameters assumed to be most important for predicted effluent load rates) such as:

- Rate of production of the various constituents from the stockpile rock;
- Composite scale-up factor between humidity cell results and actual field conditions;
- Maximum concentrations caps allowed for select constituents in rock effluent (i.e., chemical limits to the concentration);
- Water flux into the waste rock (i.e., "liner yield," which is the amount of water percolating through the waste rock surface and reaching the liner at the bottom of the stockpile); and
- Water seepage out the bottom of the waste rock facility (i.e., "liner leakage," which is the volume of liner yield that then seeps out to groundwater through flaws in the liner beneath the waste rock facility).

Therefore, an Uncertainty Analysis using Monte Carlo simulations was conducted to help assess the range of probabilities around the deterministic model results. The Uncertainty Analysis did not evaluate all stockpiles for all mine years, but rather focused on solute loadings from two representative waste rock stockpiles (the Category 1/2 stockpile, which is the largest stockpile with the greatest liner leakage rate; and the Category 3 lean ore stockpile, which is the largest stockpile with a geomembrane liner) and the West Pit lake. Further, the simulations targeted the periods expected to produce the highest effluent concentrations: years 10 and 15 for Category 1/2 waste rock stockpiles, and years 15 and 25 for Category 3 Lean Ore Stockpile.

The deterministic modeling and the Uncertainty Analysis used slightly different input assumptions (Table 4.1-42). The net effect of these differences can be assessed by comparing the final solute loadings for the common parameters used in each model. As Table 4.1-43 illustrates, the deterministic modeling uses higher solute loadings for antimony, copper, cobalt, nickel, and vanadium, while the Uncertainty Analysis uses higher arsenic, fluoride, and sulfate loadings.

Table 4.1-42 Comparison of Deterministic Modeling and Uncertainty Analysis Assumptions for Waste Rock Stockpile modeling

Input Parameters	Deterministic Modeling	Uncertainty Analysis
Constituent	26 parameters, including calcium, chloride, fluoride, hardness, potassium, magnesium, sodium, sulfate, and a full suite of metals.	Limited to 8 parameters, including antimony, arsenic, cobalt, copper, fluoride, nickel, sulfate, and vanadium.
Stockpile dissolution rates (also referred to as rate of production)	Used 95th percentile rates from the 130 weeks humidity cell data.	Used the 95th, 50th, and 5th percentile rates from 60 week humidity cell data to define a probability distribution, and applied an acidification factor of 10.1 to account for anticipated increased acidity.
Composite Scaling factors	0.1	Assumed distribution with median of 0.11 and range of 0.045 to 0.25 (see Figure 3, Hinck and Wong 2008).
Concentration caps	Based on Table 7-2, RS53/42, SRK 2007	Same as deterministic modeling, but different caps used for antimony, arsenic, and cobalt and a concentration cap was applied to vanadium (Hinck and Day 2009). Assumed pH range of 6.6 to 8.0 for Category 1/2 waste rock stockpile and a pH of less than 4 for the Category 3 Lean Ore stockpile. For Category 3 Lean Ore analysis, multiplication factors (i.e., 1x, 2x, and 3x) were used to increase concentration caps to capture uncertainty in concentration caps.
Fluoride	Considered Ca F_2 precipitation	Did not consider Ca F_2 precipitation
Liner Yield	High, average, and low yield	High, average, and low values assumed to define the 97.5th, 50th, and 2.5th percentile probabilities.
Liner Leakage	High, average, and low leakage based on assumed values for liner yield, slope, liner defects, and subgrade permeability.	Assumed liner leakage factor distribution for Category ½ waste rock and Category 3 lean ore (see Figures 6 and 7, Hinck and Wong 2008).
Sorption	Sorption considered	No sorption considered

Source: Hinck and Day 2009; Hinck and Wong 2008.

Table 4.1-43 Comparison of Final Solute Loadings for the Category 3 Lean Ore Stockpile Mine Year 15 in the Deterministic Modeling and Uncertainty Analysis

	Deterministic Model		Uncertainty Analysis	
Solute	**Liner Yield**	**(mg/kg/week)**	**Probability**	**(mg/kg/week)**
Antimony	High	**0.000015**	95th	0.0000011
	Average	**0.000010**	50th	0.0000007
Arsenic	High	0.00013	95th	**0.0003**
	Average	0.00009	50th	**0.0002**
Cobalt	High	**0.0081**	95th	0.0033
	Average	**0.0056**	50th	0.0007
Copper	High	**0.037**	95th	0.0048
	Average	**0.026**	50th	0.0016
Fluoride	High	0.000011	95th	**0.00029**
	Average	0.000008	50th	**0.00019**
Nickel	High	**0.12**	95th	0.0375
	Average	**0.10**	50th	0.0088
Sulfate	High	1.8	95th	**3.3**
	Average	1.2	50th	**2.1**
Vanadium	High	**0.00046**	95th	0.00007
	Average	**0.00046**	50th	0.00005

Source: Tables 1a and 1b, Hinck and Day 2009.
Note: Higher values shown in bold.

The results of the Uncertainty Analysis for the rock stockpiles (i.e., only Category 3 Lean Ore and Category 1/2 waste rock and Overburden stockpiles) indicated mixed results regarding the conservatism of the deterministic model predictions for groundwater quality. For the Category 3

Lean Ore stockpile (i.e., solute source for Flow Path #6), none of the 5,000 model runs yielded values as high as those predicted from the deterministic model (generally the conservative high liner leakage scenario). Since the Category 3 Lean Ore Stockpile would have similar cover and liner system designs as the Category 3 waste rock stockpile and Category 4 waste rock stockpile (i.e., solute sources for Flow Paths #4 and #5), the Uncertainty Analysis would suggest that the deterministic model results for these stockpiles were also conservatively high.

Similarly, the simulations of the Category 1/2 and Overburden stockpile (i.e., solute source for Flow Path #1) indicated that the deterministic transient flow model predictions for arsenic, antimony, nickel, sulfate, and vanadium were conservatively high (i.e., predicted concentrations in the deterministic model were higher than the median value of the Uncertainty Analysis). Conversely, the Uncertainty Analysis revealed that the steady state model may have underestimated the concentrations of fluoride, cobalt, and copper in liner leakage (i.e., predicted concentrations in the deterministic model were lower than the median value of the Uncertainty Analysis). High fluoride concentrations are unusual when calcium is present because fluoride solubility is limited by fluorite (CaF_2) saturation. As indicated in Table 4.1-42, the Uncertainty Analysis did not consider the effects of CaF_2 precipitation, which would result in unrealistically high estimates of fluoride concentrations.

West Pit Lake Uncertainty Analysis

Predicting the water quality of the West Pit is very complicated given the many sources of hydrologic input, including:

- Mine Site WWTF/hydromet flow via East Pit treatment wetlands;
- East Pit subsurface flow;
- Surface runoff to East Pit;
- Surface runoff to West Pit;
- Groundwater inflow to West Pit;
- Category 1/2 waste rock stockpile liner leakage to West Pit;
- Direct net precipitation to East Pit; and
- Direct net precipitation to West Pit.

As a result, an Uncertainty Analysis was conducted to predict West Pit water quality around Post-Closure, focusing on eight parameters – antimony, arsenic, cobalt, copper, fluoride, nickel, sulfate, and vanadium (Hinck and Wong 2008). The results of the Uncertainty Analysis suggest that the actual concentrations of antimony, arsenic, and vanadium would probably be lower than predicted by the deterministic modeling (i.e., predicted concentrations in the deterministic model were several times higher than the median value of the uncertainty range). Conversely, the Uncertainty Analysis suggest that the actual concentrations of cobalt, copper, fluoride, nickel, and sulfate would probably be higher than predicted by the deterministic modeling (i.e., highest predicted concentrations in the deterministic model were lower than the median value of the uncertainty range). PolyMet states that these higher predicted concentrations are the result of ignoring interactions with calcium (applies to fluoride), application of the constant solute production method instead of the exponential decay method for predicting solute loading from the pit wall (applies to cobalt, nickel, and sulfate), and exclusion of the effects of adsorption in the West Pit water (applies to copper). Nevertheless, based on the results of the Uncertainty Analysis, sulfate and nickel may exceed groundwater evaluation criteria, while copper would remain below the criterion. There is no groundwater evaluation criterion for cobalt, but the predicted value is much higher than the surface water standard for cobalt. Groundwater outflow from the West Pit would be approximately 18 gpm.

Conclusions

Within the Category 2, 3, and 4 waste rock stockpiles, oxidation is expected to release solutes to percolating water. The primary concern is where modeling results suggest that solute concentrations could exceed groundwater standards at some potential evaluation points (e.g., property boundary or Partridge River).

In some cases the deterministic modeling and the Uncertainty Analysis conflicted, which makes it difficult to draw firm conclusions. Antimony, for example, is predicted by the deterministic modeling to exceed groundwater evaluation criteria at several flow paths, conservatively, assuming no sorption. The Uncertainty Analysis, on the other hand, suggests that the deterministic modeling predictions for antimony were conservatively high, even without considering sorption. Although the conservatism of some of the assumptions used in the Uncertainty Analysis can be argued, it is clear that the Proposed Action would exceed USEPA primary MCLs or MDH Health Risk Limits in groundwater for at least several solutes (i.e., manganese, nickel, sulfate, and probably antimony at least Flow Path #5) along several flow paths, even when accounting for high liner leakage rates and assuming natural attenuation by sorption (Table 4.1-41). As indicated in Table 4.1-41, some of the waste rock stockpiles have the potential to leach solutes to groundwater for long periods (i.e., at least 2,000 years).

Effects on Groundwater Quality at the Tailings Basin

Seepage from the Tailings Basin would affect downgradient groundwater quality. Several sources contribute solutes to the Tailings Basin, including the tailings themselves (which reflect a combination of ore and reagent solutes), Mine Site process water (principally during Years 1 to 11), Colby Lake make-up water, and watershed runoff. The contribution from the Mine Site is influenced by the predictions of stockpile leachate and mine pit water quality and the ability of the WWTF to achieve design concentrations prior to pumping to the Tailings Basin.

Table 4.1-44 Summary of Deterministic Groundwater Modeling and Uncertainty Analysis at the Mine Site

Flow Path	Source	Evaluation Point	Results of Deterministic and Uncertainty Analysis[1] (assumes natural attenuation by sorption)
1	Cat 1/2 & Overburden	Property Boundary	Antimony (USEPA primary MCL and MDH Health Risk Limit) and sulfate (USEPA secondary MCL) may to exceed groundwater evaluation criteria
2	West Pit	Property Boundary	Antimony (USEPA primary MCL and MDH Health Risk Limit), and possibly nickel (MDH Health Risk Limit) and sulfate (USEPA secondary MCL) are predicted to exceed groundwater evaluation criteria.
3	Lean Ore Surge Pile	Partridge River	All parameters are predicted to be in compliance with groundwater evaluation criteria.
4	East Pit & Cat 4 Waste Rock	Partridge River	Antimony (USEPA primary MCL and MDH Health Risk Limit) may exceed groundwater evaluation criteria.
5	Category 3 Waste Rock Stockpile	Partridge River	Antimony (USEPA primary MCL and MDH Health Risk Limit), manganese and nickel (MDH Health Risk Limits), and possibly sulfate (USEPA secondary MCL) are predicted to exceed groundwater evaluation criteria.
6	Category 3 Lean Ore Stockpile	Partridge River	Nickel (MDH Health Risk Limit) is predicted to exceed groundwater evaluation criteria.

Sources: RS74A, Barr 2008; Hinck and Wong 2008.
[1] Exceedences of USEPA secondary MCL standards are not included except for sulfate.

These solutes can be released from tailings by direct dissolution of minerals, but solutes of concern are released primary by oxidation of sulfide minerals in the tailings. The oxidation rate in tailings, and thus the rate of solute release, is typically limited by the rate that atmospheric oxygen can diffuse into the facility. The diffusion of oxygen is faster in air than water (i.e., ~10,000 times faster in air), therefore, the rate of oxidation and associated solute release would depend strongly on tailings moisture content, with slower oxidation in wetter material. Thus the coarse tailings in the dam and medium-size beach are expected to have the fastest oxidation rate, the fine tailings would have slower oxidation, and the saturated tailings below the pond would be essentially non-reactive.

Solutes released by oxidation (primarily sulfate and regulated metals) would be flushed from the tailings by percolating water. The rate of percolation would depend on the surface type and precipitation. The seepage in the tailings would mix with water that seeps through the bottom of the pond, so the average effluent would depend on the composition of the pond water, the rate of oxidation in the unsaturated tailings, and the rates of water flow through each material.

Based on pilot plant testwork, the processing plant can produce tailings containing much less than 0.2% sulfur if copper sulfate is used to improve the recovery of sulfide minerals during flotation. Testing of tailings containing 0.2% sulfur by MnDNR and from the nearby Babbitt Deposit did not result in acidic leachate because alkalinity produced by weathering of silicates in the rock always exceeded acid produced by oxidation of the sulfides. Assuming that sulfur concentrations in the tailings remain below 0.2%, tailings pH is expected to remain above pH 5.5. Pore water metal concentrations can increase dramatically if pH decreases (RS54/46, SRK 2007). The oxyanions (arsenic, antimony, and selenium), however, tend to have increasing solubility with higher pHs.

Humidity cell test results for NorthMet tailings have tended to support the research by MnDNR and the results from the Babbitt Deposit (Day 2009). Leachate pHs have remained between 6.0

and 7.8 with no trend toward lower pHs. Variation in pH reflects whether copper sulfate was used in the pilot mineral processing, with higher pH leachate results shown by samples produced with the use of copper sulfate.

The seepage from the PolyMet tailings would pass through the underlying LTVSMC tailings (i.e., previous taconite tailings). These underlying tailings may attenuate metals or acidity leached from the PolyMet tailings, and/or may contribute additional solutes to seepage. In order to better understand this dynamic, PolyMet conducted humidity cell testing of the interaction between NorthMet leachate and LTVSMC tailings. The pH of NorthMet leachate is expected to be about the same as the existing pH of the LTVSMC tailings, so no induced leaching is expected due to differences in pH between the NorthMet leachate and the LTVSMC tailings (Day 2008). The test results do suggest, however, that LTVSMC tailings may contribute to the removal of arsenic, manganese, nickel, and vanadium from NorthMet leachate (Day 2009).

PolyMet tailings deposition would begin in Cell 2E until the tailings reach the elevation of the tailings in Cell 1E, which is expected to occur around Year 8. From Year 9 onwards, Cells 2E and 1E would be operated as a single disposal facility. Tailings would be deposited along the outer embankments of both cells to raise the embankments in lifts of about 15 feet simultaneously. Only the exterior embankments along the north edge of Cell 2E and the south edge of Cell 1E would be constructed of coarse tailings.

PolyMet does not propose to line the Tailings Basin, nor is the underlying LTVSMC Tailings Basin lined. PolyMet does propose to construct the tailings embankment out of existing LTVSMC coarse tailings and then place most of the NorthMet tailings in subaqueous zones to prevent oxidation and associated release of solutes (Figure 3.1-38). Nearly all surface seepage would be collected via vertical wells, seepage collection trenches, and sump/pump systems and returned to the Tailings Basin. After operations cease in Year 20, PolyMet proposes to cap the coarse tailings beach adjacent to the exterior embankment with a bentonite amendment to limit water infiltration and reduce oxidation of the coarse tailings. By covering the coarse tailings, seepage from the pond would depend largely on the permeability of the finest tailings under the pond. The surface seepage collection system would continue to operate into Closure until the seeps effectively dry out.

Because of the bedrock topology present at the southeastern portion of the Tailings Basin, nearly all of the groundwater flowing south from the Tailings Basin should be captured by the proposed seepage barrier to be constructed at the headwaters of Second Creek. Therefore, the Tailings Basin would have little effect on water quality in the Partridge River during operations. At Closure, however, PolyMet proposes to remove the seepage barrier at Second Creek and approximately 290 gpm of seepage from the Tailings Basin would be released to the headwaters of Second Creek, as indicated in Table 4.1-33 (Hinck 2009).

Evaluation Methodology

A spreadsheet model was used to predict the concentration of dissolved constituents in the Tailings Basin for seepage that bypasses the collection system and is released to the environment (RS54/46, SRK 2007; RS74B; Barr 2008). Transport and travel times through the basin were computed using MODFLOW-SURFACT (SURFACT), which is a fully integrated flow and transport model. The model includes the ability to simulate unsaturated flow, which is why it was chosen for this application. The SURFACT model simulates deposition of PolyMet tailings as additional layers on top of the existing LTVSMC tailings, which in turn are on top of native material. The spreadsheet model used the SURFACT transport times and assumed plug flow for each source area within the Tailings Basin (i.e., embankment, coarse beach, fine beach, and pond). The contribution from each source area to the concentration of dissolved constituents in groundwater leaving the basin at the toe of the embankment was predicted under steady-state conditions (RS74B, Barr 2008).

For each model run, concentrations were predicted forward in time until equilibrium was achieved or for 1,000 years. The result of this contaminant transport modeling was a series of breakthrough curves for each source area considered for each model year/flow condition simulated (RS74B, Barr 2008). The breakthrough curves were predicted at a hypothetical well location in the center of the toe of the LTVSMC Cell 2E embankment. Table 4.1-45 provides a summary of the assumptions and inputs used in the model.

Table 4.1-45 Tailings Basin Water Quality Model (SURFACT) Assumptions and Inputs

Model Inputs	Source of Input Data	Reference
Model Years	Mine Years 1, 8, 9, 20, and Closure (Closure actually refers to Post-Closure per Mine Site terminology) – same years as used for Tailings Basin water balance	RS13
Source Areas	Embankment (both capped and uncapped), coarse beach areas, fine beach areas, and the pond.	RS74B
Source Term Flows	Infiltration into and flows from Embankment, Coarse Beach, Fine Beach, and Pond Recharge for each year of operation and Closure	RS74B - Table 6-1
Solute mass loadings	Provided for each year of operations and Closure	RS74B – Tables 6-2 thru 6-5
Release ratios	Values for maximum rate of sulfide mineral oxidation and associated metal release in oxygenated tailings were based on humidity cell test results	RS54/46 Table 7-13
Travel Time	Considered only advection and resulted in breakthrough curves	RS74B – Figures 6-5 thru 6-16
Captured Water Flow	Based on results from MODFLOW model and agreed to by agencies	RS13
Tailings Moisture Content	Average moisture content of the coarse and fine tailings was calculated from water infiltration rates obtained using EPA HELP model, moisture flow and content using HYDRUS model, and estimated moisture-retention properties of the various tailings.	RS13
Tailings Oxygen Diffusivity	Oxygen diffusivity in tailings (i.e., the ability of the tailings to transmit oxygen gas, a parameter related to porosity and moisture content	RS54/46
Porewater Concentrations	Concentration of solutes in course and fine tailings porewater was calculated by dividing solute production rate by the volumetric water flow rate.	
Effluent Solute Concentrations	Concentrations of solutes in Tailings Basin effluent was calculated by combining water and solute concentrations from various sources—coarse tailings, fine tailings, pond seepage-- during deposition, as determined from the Tailings Basin construction plan.	
Discharge Apportionment Scaling	Infiltration through the NorthMet tailings would enter the underlying LTVSMC tailings, and hydraulic flow estimates divide the various flow between groundwater recharge and capture by horizontal drains in the LTVSMC tailings.	
Scaling Correction Factors (from laboratory to field conditions)	Temperature – 0.3 to adjust to lower ambient field conditions	
	Frozen Ground – 0.75 assumes that the ground if frozen 25% of the time; however, lower diffusion in frozen ground surface was not supported by MnDNR's literature review.	
Vertical saturated conductivity	1.2×10^{-3} cm/s in course tailings located 0-400 feet from spigot	RS39/40 Appendix H
	2.5×10^{-5} cm/s in fine tailings located 400-700 feet from spigot	RS39/40 Appendix H
Porosity	0.5 in both course and fine tailings	RS 39/40 Appendix H
Infiltration Rate Thru Tailings	25 in/yr during construction (i.e., when spigotting water onto tailings)	HELP model
	7.7 in/yr from meteoric water on unvegetated tailings surface	
	0.23 in/year under synthetic liners placed in the tailings dam	
Water Saturation	38% in coarse and 89% in fine tailings	
	~100% in tailings slime, which reduces oxidation rate to essentially 0	

Table 4.1-46 provides the predicted seepage water quality as it leaves the Tailings Basin, not accounting for any advection, dilution, or sorption as the seepage moves through the aquifer downgradient of the Tailings Basin. The toe of the Tailings Basin is not considered an evaluation point in terms of compliance with groundwater standards.

Table 4.1-46 Water Chemistry of Cells 1E and 2E Seepage to Groundwater

	Unit	Years 1-6[1]	Year 10	Year 15	Year 20	Closure	Max
General Parameters							
Calcium	mg/L	73	104	76	60	63	107
Chloride	mg/L	16.6	3.9	3.9	3.6	3.9	16.6
Fluoride	mg/L	3.3	0.5	0.5	0.5	1.1	3.3
Hardness	mg/L	404	320	255	221	398	404
Magnesium	mg/L	54	15	15	17	55	55
Potassium	mg/L	10.3	8.2	6.8	6.3	21.1	21.1
Sodium	mg/L	64	33	29	25	26	64
Sulfate	mg/L	188	212	171	149	174	241
Metals – Total							
Aluminum	µg/L	157	144	158	176	78	176
Antimony	µg/L	5.4	10.5	7.7	6.9	1.2	11.1
Arsenic	µg/L	6.8	9.2	7.7	7.3	27.8	27.8
Barium	µg/L	19	33	27	23	19	36
Beryllium	µg/L	0.3	0.5	0.4	0.4	1.3	1.3
Boron	µg/L	71	127	105	95	148	148
Cadmium	µg/L	0.3	0.7	0.6	0.5	1.2	1.2
Cobalt	µg/L	1.4	1.5	1.7	2.0	2.7	2.7
Copper	µg/L	5.1	6.2	7.6	10.0	14.0	14.0
Iron	mg/L	227	343	467	569	98	569
Lead	µg/L	0.6	2.6	2.5	2.1	1.0	3.4
Manganese	µg/L	76	74	71	67	140	140
Nickel	µg/L	16	24	21	23	6	25
Selenium	µg/L	0.8	1.4	1.3	1.2	3.3	3.3
Silver	µg/L	0.2	0.5	0.4	0.3	1.2	1.2
Thallium	µg/L	0.4	0.7	0.6	0.5	0.1	0.8
Zinc	µg/L	15	59	63	58	13	79

Source: Modified from Table 4-5, RS74B, Barr 2008.

[1] Water quality predictions for Years 1 through 6 are the same for each year as this reflects residual LTVSMC tailings seepage water quality. It is estimated that it will take over 6 years for NorthMet tailings seepage to reach the toe of the Tailings Basin.

A two-step modeling approach was used for evaluating Project effects on groundwater quality, including both steady state and transient flow modeling (Table 4.1-47), both of which use the predicted seepage water quality at the toe of the Tailings Basin (Table 4.1-46) as the initial water quality condition prior to transport. The initial steady state flow modeling was used as a "screening level model" to determine the dissolved constituents of concern at the Tailings Basin. The steady state model conservatively assumed only advection and dispersion using the maximum predicted Tailings Basin seepage rates and concentrations, and did not assume any sorption. If the dissolved constituents being evaluated were not predicted to exceed groundwater evaluation criteria under these assumptions, those constituents were not carried forward to the next phase of modeling. More detailed transient modeling was conducted for those constituents that showed potential exceedances of groundwater evaluation criteria using the steady state model. Because of the heightened concern regarding sulfate concentration as it relates to mercury and wild rice, sulfate was carried forward to the next phase of modeling regardless of the steady state model results.

Table 4.1-47 Steady State and Transient Flow Model Inputs and Assumptions

Evaluation Points	Property boundary, first residential well, and the Embarrass River (see Figure 3-2, Barr, 2008)			
Evaluation Criteria	Primary and secondary USEPA drinking water standards and Minnesota Health Risk Limits (see Table 4.1-4)			
Sources Evaluated	Seepage from northern edge of the Tailings Basin (Cell 2E only, Cell 2W not included) towards the Embarrass River			
Dispersion Coefficients	Dx(ft)	Dz(ft)	D_x(m)	D_z(m)
	63	3.15	19.2	0.96
Source Flow Inputs	Known elevations of Plant Site and Embarrass River along flowpath.			
	Maximum predicted seepage rates from Cell 2E from Table 8-7 in RS74B (Barr 2008) used for steady-state screening model. Transient flow rates used for 11 stress periods: years 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19-20, 21-2000.			
	Recharge from precipitation was set at 1.5 inches per year as used in the calibrated Mine Site model.			
Source Concentrations	Maximum predicted seepage concentrations from Cell 2E (Table 5-2 in Barr, 2008) used for steady-state screening model. Transient concentrations used for above 11 stress periods given in Table 5-2 in Barr, 2008.			
Background Concentrations	Median groundwater concentrations determined in RS74B (Barr, 2008), from Regional Copper Nickel Study (Siegel and Ericson, 1980 or from groundwater data collected for the Embarrass River watershed (MPCA, 1999), given in Table 4-1 in Barr, 2008.			
Model Cell Dimensions	Δx – 25 meters Δy – 10 meters Δz – surficial deposits – 1 meter The model consists of 5 layers simulating an average thickness of 5 m of surficial deposits.			
Hydraulic Conductivity	Values were based on those used in the Plant Site MODFLOW in RS13 and RS13B(Barr 2008)			
	Highest values were used to evaluate worst-case scenario (highest values cause less mixing resulting in higher predicted solute concentrations, Kx = Kz)			
		Kx	Kx	
	Surficial deposits	65.6 ft/day	20 m/day	
Concentration Caps	Maximum equilibrium concentration of about 400 µg/L dissolved aluminum was used (SRK, June 23, 2009)			
Sorption	Transient cross-sectional models were run both with and without any solute sorption. Linear sorption is modeled with a partition coefficient (K_d) that relates the concentration of a sorbed constituent to the concentration of the constituent in solution. Arsenic K_d =25.			

Source: Modified from Table 6-4 in RS74A, Barr 2008; Barr 2008, Plant Site Groundwater Impacts Predictions

A transient flow model was used to predict groundwater concentrations at three evaluation points along the flow path (Figure 4.1-24):

- The property boundary (approximately 3,770 feet from the toe of the Tailings Basin embankment);
- The closest domestic well downgradient of the Tailings Basin (approximately 8,450 feet from the toe of the Tailings Basin embankment); and
- The Embarrass River (approximately 15,500 feet from the toe of the Tailings Basin embankment).

Steady State Flow Model Results

The steady state flow model predicted the quality of seepage leaving the toe of Cell 2E embankment and flowing north for selected operational years and during Closure. These simulations included only advection and dispersion using the maximum predicted Tailings Basin seepage rate (from Year 20) and the maximum predicted seepage concentrations (typically from Closure). In the steady state flow model, the only mechanism for reduction of solute concentrations prior to reaching the Partridge River would be mixing with recharge from precipitation; sorption was not considered.

The steady state flow model identified aluminum, antimony, arsenic, fluoride, iron, manganese, and sulfate as having the potential to exceed groundwater evaluation criteria. Predicted beryllium and thallium concentrations exceed evaluation criteria in the steady state flow simulations, but these parameters were affected by the use of analytical data with detection limits above the evaluation criteria, which resulted in scale-up issues and unrealistically high predictions. Therefore, these parameters were not included in the transient modeling (Barr 2008, Plant Site Groundwater Impacts Predictions).

Transient Flow Model Predictions for Groundwater Downgradient from the Tailings Basin

As mentioned above, the initial steady state modeling identified seven constituents that potentially could exceed groundwater evaluation criteria, which were then subjected to more detailed analysis using transient flow modeling.

The transient model estimated water quality downgradient from the Tailings Basin both with and without sorption as at the Mine Site. Similar to the Mine Site, PolyMet conducted site specific sorption testing at the Tailings Basin to validate their proposed use of USEPA screening level values. The sorption testing found that the site specific sorption values exceeded the low range of the USEPA screening values for all parameters except antimony (Table 4.1-48). As we discussed in our evaluation of the waste rock stockpile seepage, the site specific sorption results are compelling enough for us to feel comfortable accepting the low end of the USEPA screening level values, except for antimony.

For antimony, the site specific sorption testing resulted in an average K_d value of 10.4. This value is considerably less than the low end of the USEPA screening levels (K_d = 45), and, in addition, the agencies raised some concerns regarding the procedures used for the sorption testing (Blaha 2009). Therefore, we are uncomfortable using either the USEPA screening level value or the average site specific K_d value. The site specific sorption testing, however, did indicate that some sorption is occurring. As a result, a conservatively low K_d value of 2 was found acceptable, which is less than the lowest site specific sorption test result. In fact, the transient flow modeling results found that sorption did not have to be considered in order for antimony to meet groundwater evaluation criteria.

Table 4.1-48 Comparison of Site Specific and Literature Sorption Values at the Tailings Basin

Parameter	Literature Sorption Value USEPA Screening Value	Site Specific Sorption Values Boring RS-22	Boring RS- 24	Average	K_d Values Accepted for Use in Groundwater Modeling
Antimony	45	15.4	5.5	10.4	2
Arsenic	25	>52	590	~320	25
Copper	22	257	344	300	22
Nickel	16	39	16	27	16

Source: Barr 2009, Technical Memorandum: TB-1 Preliminary Results of Site-Specific Soil Sorption Tests: Tailings Basin Area.

Table 4.1-49 provides a summary of the transient flow modeling results, which shows that only aluminum and manganese are predicted to exceed groundwater evaluation criteria. The model predicts aluminum (at two evaluation points) to be above the minimum range of the groundwater evaluation criteria, but below the upper range, and manganese (at all three evaluation points) to exceed groundwater evaluation criteria (USEPA secondary MCL). As discussed in Section 4.1.1.3, USEPA has established secondary MCLs as guidelines to manage aesthetic (e.g., taste, color, and odor) considerations in drinking water, not to protect human health. These predicted levels of aluminum and manganese would be within the range of ambient groundwater concentrations found in nearby wells (Barr 2009, Technical Memorandum: Results of Residential Well Sampling North of LTVSMC Tailings Basin).

Table 4.1-49 Summary of Maximum Concentrations Predicted Using Transient Flow Modeling at the Tailings Basin

Solute	Unit	Groundwater Evaluation Criteria	Predicted Maximum Concentration (with sorption) Property Boundary Location	Residential Well Evaluation Location	Embarrass River Evaluation Location	Period Exceeding Groundwater Criteria (Mine Years)	Predicted Maximum Concentration (no sorption) Prop boundary
Aluminum	µg/L	50 - 200	**77**	**62**	43	~60 - >500	**77**
Antimony	µg/L	6.0	3.4	2.8	1.9	NA	3.4
Arsenic	µg/L	10	3.0	3.0	3.0	NA	**20**
Fluoride	mg/L	2.0	0.9	0.7	0.6	NA	0.9
Iron	µg/L	300	167	127	71	NA	167
Manganese	µg/L	50	**192**	**193**	**193**	~1 - >500	**192**
Sulfate	mg/L	250	122	96	61	NA	122

Source: Table 4-6, Barr 2009, Technical Memorandum: TB-14 Plant Site Groundwater Impacts Predictions.
Notes: **Bold** values exceed groundwater evaluation criteria

Sulfate concentrations are predicted to remain below the groundwater evaluation criterion for sulfate (250 mg/L) at all evaluation locations. The effects of this predicted sulfate loading on surface water quality in the Embarrass River (142 mg/L) are discussed in the following “Surface Water Resources” section, but the predicted sulfate concentrations should not result in any significant adverse effects on groundwater quality.

Conclusions

Based on the results of the deterministic modeling, the Project would have relatively little adverse effect on groundwater quality downgradient of the Tailings Basin. Predicted aluminum and manganese concentrations, although above USEPA secondary MCLs, would be within the range of natural background concentrations for the area, within the range of concentrations found at nearby residential wells, and would not pose a risk to human health.

No Uncertainty Analysis was conducted to evaluate the effects of the Proposed Action on groundwater downgradient of the Tailings Basin. There are, however, several key assumptions in the deterministic model that may warrant further evaluation, possibly using Uncertainty Analysis. These assumptions include:

- Lack of segregation of tailings as they are spigoted into the Tailings Basin;
- Lack of interactions of seepage with the underlying LTVSMC tailings;
- Tailings beach width as it relates to geotechnical stability; and
- Use of an average tailings sulfur content of 0.13%.

Surface Water Resources

This section discusses Project effects on hydrology (i.e., surface water flows and lake levels) and surface water quality in the Project area.

Effects on Surface Water Flows and Lake Levels

Evaluation Methodology

The XP-SWMM model (USEPA 2007) and the MODFLOW model (McDonald and Harbaugh 1988, Harbaugh et al. 2000) were separately used to predict potential impacts on Partridge River flows. The flow results from the modeling with XP-SWMM were corrected to incorporate the separate MODFLOW model predictions of the effects of mine pit dewatering on Partridge River flows (Barr, RS73A and B, 2008). Predictions of Partridge River flow impacts were made at the following seven locations, as displayed in Figure 4.1-7:

- Station SW-001 is located on the North Branch of the Partridge River upstream of all Mine Site facilities, but downstream of the Peter Mitchell Pit discharge with a drainage area of 6.2 mi^2;
- Station SW-002 is located on the North Branch of the Partridge River northeast of the Mine Site with a drainage area of 13.3 mi^2;
- Station SW-003 is located on the North Branch of the Partridge River east of the Mine Site with a drainage area of 15.2 mi^2;

- Station SW-004 is located on the North Branch of the Partridge River immediately upstream of the confluence with the South Branch, but downstream of 64 percent of the proposed Mine Site facilities with a drainage area of 23.0 mi^2;
- Station SW-004a is located on the Partridge River immediately downstream of the confluence of the North and South branches, and downstream of 99 percent of the proposed Mine Site facilities with a drainage area of 54.1 mi^2;
- Station SW-005 is located on the Partridge River at a railway crossing, and downstream of 100 percent of the proposed Mine Site facilities with a drainage area of 98.7 mi^2; and
- USGS Gaging Station #04015475 is located on the Partridge River upstream of Colby Lake with a drainage area of 103.4 mi^2.

Table 4.1-50 summarizes the primary input assumptions for the XP-SWMM model.

Table 4.1-50 XP-SWMM Model Primary Assumptions/Inputs for the Partridge River

	Value and notes	**Source/Description**
Surface water flow data from USGS gages	Daily data sets, average flow computed is 88 cfs at Hoyt Lakes gaging station	USGS 04015475 – Partridge River above Colby Lake at Hoyt Lakes, 9/19/78 – 11/2/88 USGS 04015455 – South Branch Partridge River Near Babbitt 6/1/77 – 11/5/80
Mean annual precipitation	29.2 in	Combined from National Weather Service data
24-hour precipitation events		2 year 2.31 inches 5 year 2.88 inches 10 year 3.36 inches 25 year 4.08 inches 50 year 4.64 inches 100 year 5.20 inches
Evaporation	20.8 in	PolyMet combined estimates from Siegel and Ericson (1980) and Meyer (1942)
Runoff/Precipitation ratio	0.43 (average)	Baker et al (1979)
Computational locations (nodes)	Eight locations: SW-001, SW-002, SW-003, SW-004, SW-004a, SW-005, and USGS 04015475, and Colby Lake	
Digital elevation model	Vertical error = 2 ft	DEM
Hydrological conditions simulated	Snowmelt base temperature=38ºF 5.2 in 6.2 in	Snowmelt (100-yr, 10 day) 100-yr, 24-hr 500-yr, 24-hr
Percent wetland in catchment	43%	1992 GAP Analysis, MnDNR
Development stages simulated		Current conditions, including discharges from Peter Mitchell Pit Years 1, 5, 10, 15, 20, Closure, and Post-Closure year
Flow scenarios	Wet condition Average condition Dry condition	Flow resulting from 10-year 24-hour storm Average annual flow Average 30-day low flow
Modified parameters	ESRI GIS Area weighted from ESRI GIS Digitized average ESRI GIS Area weighted averages From soil types	Catchment areas Subwatershed slopes Subwatershed widths Impervious percentages Infiltration parameters

Source: RS74A, Barr 2008

As discussed in Section 4.1.1.3, there are limited flow data available for the Partridge River and it has been affected by mining operations (e.g., Peter Mitchell Mine pit dewatering) that complicate the interpretation of the flow record and the calibration of the XP-SWMM model.

The model was calibrated using flow data for Water Year (WY) 1984 at the USGS gaging station above Colby Lake and validated using "goodness-of-fit" measurements (i.e., deviation of volume runoff and coefficient of efficiency for the entire period of simulation [1978-1987], which showed a reasonable degree of success). These measurements, however, are not an appropriate measure of model performance during periods of low flow as they tend to be dominated by large flow events. Therefore, another statistical measure (i.e., root mean square error, or RMSE) was used (RS73A, Barr 2008). Although no references on acceptable ranges were found, Barr suggests values that would represent a discrepancy between observed and modeled flows of less than 0.10 inches in runoff over the 30-day period. Using this metric, seven out of the 10 years modeled were found acceptable, with an overall RMSE for the entire period equating to a discrepancy between observed and modeled flows of 0.06 inches in runoff over the 30-day period of low flow.

In order to assess the representativeness of the 1978-1987 period of simulation, we compared precipitation occurring during this period with the 112-year period of record (1896-2008) for Northeast Minnesota available from the National Climatic Data Center (www.ncdc.noaa.gov/oa/climate/climatedata.html) as a surrogate for the relatively short 10-year period of flow records for the Partridge River. The data show that the 1978-1987 period included a few very wet years, several fairly average years, a relatively dry year, but no very dry years. Therefore, there is higher uncertainty regarding the models predictions of dry extremes.

Effects on the Upper Partridge River

The Project would affect the Upper Partridge River by reducing flows, which in turn could affect river morphology, as well as impacting a portion of the Partridge River 100-year floodplain. These potential effects are evaluated below.

Tribal cooperating agencies note that little or no baseline data was collected to develop the modeling described in this document. Therefore, it is the tribal cooperating agencies' position that the model results cannot be used with confidence and do not allow an adequate assessment of environmental impacts.

Effects on Upper Partridge River Flows

The Project could affect flow in the Upper Partridge River in three primary ways:

- Collecting and redirecting surface runoff from the Mine Site – PolyMet proposes to collect the drainage from all mine facilities (e.g., rock stockpiles, access roads, and other areas where drainage may contact reactive rock) and redirect it for reuse as process water at the Plant Site. These mine facilities increase in size during the life of the mine from approximately 1.1 square miles at the end of Year 1 to approximately 2.4 square miles by the end of Year 20 as more area is needed for stockpiles and the mine pits enlarge. The percent of the Partridge River watershed represented by these mine facilities increases from 3.4% at SW-002 to a maximum of 6.5% at SW-004, and then decreases approximately 2.6% at the USGS gage above Colby Lake (Table 4.1-51). This mine facility drainage is effectively removed from the drainage area of the Partridge River and is ultimately lost as seepage to the

Embarrass River from the Tailings Basin or as evaporation for the first 12 years of mine operations. This loss of drainage area represents the greatest Project effect on flow in the Partridge River.

- Reducing the groundwater contribution to river flow by dewatering activities in the mine pits – PolyMet estimates the reduction in average groundwater inflow to the Partridge River as varying over mine years and location, but reaching a maximum of only 0.16 cfs during Year 20 (Table 4.1-52). This estimate uses the 30-day low flow as a proxy for groundwater contribution to the Partridge River during low flow periods. We would expect the reduction in groundwater contributions during average flow conditions to be about 50% higher (or about 0.24 cfs), based on the ratio of average and low flow groundwater contributions at SW-004 (1.43 cfs: 0.99 cfs). In either case, the reduction in the groundwater contribution to river flow would be modest and consistent with our expectation that the reduction would be significantly less than the maximum rate of groundwater inflow to the mine pits (i.e., 1,140 gpm, or 2.54 cfs).

- Altering land cover – would primarily impact drainage and flows in the Partridge River after Closure as forest and wetlands would be replaced with mine pits and vegetated stockpiles. The hydrologic effects of altering land cover during Project operation are captured in the first bullet above.

The XP-SWMM model was used to predict Partridge River flow at the seven evaluation locations at various times during mining (Years 1, 5, 10, 15, 20, as well as the "Mine Facilities Off" scenario, a hypothetical high impact scenario reflecting larger than planned impact areas and referred to herein as the high impact scenario) for a 10-year period (WY 1978-1987). The analysis of Project effects on Partridge River flows in this EIS focuses on the following:

- Location - SW-004 is the location where the maximum impact on flow occurs (Table 4.1-51). The modeling results suggest that the impact of these reduced base flows is reduced downstream (SW-004a, SW-005 and USGS gage) by inflow from the South Branch of the Partridge River. Impacts at Station SW-004a, which includes nearly all of the Mine Site facilities, could be expected to be greater, but it is immediately downstream of the confluence with the unaffected South Branch, which ameliorates the impact.

- Mine Year Scenario – generally the greatest impact on flow would occur during Year 20 when the footprint of the mine facilities would be near its maximum, reclamation of the stockpiles would be still underway, and the West Pit would be reaching its deepest elevation (Table 4.1-51). However, the hypothetical high impact scenario shows the greatest potential impacts and is used for purposes of this analysis.

- Model Year - Since the principal effect of the Project is a reduction in flow, low flow periods would be especially critical. Therefore, the analysis focuses on WY 1979, which generally had the lowest flows of the 10-year period modeled.

Table 4.1-51 Tributary Areas and Percent Reductions (% Red) With Respect to Existing Conditions at Locations in the Partridge River for Different Stages of Mine Site Development

Location	Existing Conditions		Year 1		Year 5		Year 10		Year 15		Year 20		High Impact Scenario	
	Area (mi^2)	% Red.	Area (mi^2)	% Red.	Area (mi^2)	% Red.	Area (mi^2)	% Red.	Area (mi^2)	% Red.	Area (mi^2)	% Red.	Area (mi^2)	% Red.
SW-001	6.22	0.0	6.22	0.0	6.22	0.0	6.22	0.0	6.22	0.0	6.22	0.0	6.22	0.0
SW-002	13.30	0.0	12.93	2.8	12.89	3.1	12.85	3.4	12.85	3.4	12.85	3.4	12.85	3.4
SW-003	15.16	0.0	14.81	2.3	14.74	2.8	14.64	3.4	14.65	3.4	14.65	3.3	14.64	3.4
SW-004	23.01	0.0	21.98	4.5	21.78	5.4	21.61	6.1	21.51	6.5	21.52	6.5	21.50	6.6
SW-004a	54.14	0.0	52.70	2.7	52.08	3.8	51.63	4.6	51.44	5.0	51.40	5.1	51.42	5.0
SW-005	98.72	0.0	97.28	1.5	96.67	2.1	96.20	2.6	96.01	2.7	96.02	2.7	95.99	2.8
USGS Gage	103.10	0.0	101.95	1.4	101.34	2.0	100.87	2.4	100.69	2.6	100.70	2.6	100.67	2.6

Source: Table 1, RS73B, Barr 2008.

Table 4.1-52 Reduction in Baseflow from Existing Conditions in Partridge River

	Baseflow (cfs)							
Mine Year	**SW-001**	**SW-002**	**SW-003**	**SW-004**	**SW-004a**	**SW-005**	**USGS Gage**	**Colby Lake**
Year 1	0.00	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Year 5	0.00	-0.04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Year 10	0.00	-0.07	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09
Year 15	0.00	-0.08	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09
Year 20	0.00	-0.12	-0.13	-0.15	-0.16	-0.16	-0.16	-0.16
Closure	0.00	-0.12	-0.13	-0.15	-0.16	-0.16	-0.16	-0.16
Post-Closure	0.00	-0.11	-0.12	-0.12	-0.13	-0.13	-0.13	-0.13

Source: Appendix A, Table 2-1, RS73B, Barr 2008.

The effects of the Project on flow in the Partridge River were evaluated using the Richter range of variability approach (Table 4.1-53). As indicated above, the largest reduction in flows (in terms of percent) would occur at SW-004, which ranged from 8 to 27% by month during the driest year modeled, but represent only 0.3 to 2.1 cfs in terms of absolute flows. The largest reduction in absolute flows would occur at, and continue downstream of, SW-005 (up to 4.4 cfs), which is downstream of all Project effects, but would only represent 3 to 9% of flow by month during the driest year modeled. Downstream of the confluence with the South Branch of the Partridge River (including locations SW-004A, SW-005, and the USGS gaging station above Colby Lake), Project effects (in terms of percent reduction in flow) would be significantly reduced. In many cases, the large predicted monthly percent reduction in flows involve very small reductions in actual flow (e.g., < 1.0 cfs), which typically occur during the winter (i.e., December through March) when most precipitation is snow and little or no runoff occurs, and during summer droughts. This predicted reduction in flow is often so small that it may not be accurately measurable.

The predicted change in minimum and maximum extreme flows (1-day, 7-day, 30-day, and 90-day) indicate larger percent reductions in minimum flows (over 20% at SW-004) than maximum flows (12% or less at SW-004); but much larger absolute reductions during maximum flow (ranging from 2 to 17 cfs at SW-004) than minimum flows (less than 0.3 cfs at SW-004). The Project would have little effect on the number and duration of high and low pulses.

After Mine Closure, flows would be expected to increase, but would not approach pre-mining levels until the West Pit overflows, which is predicted to occur around Years 65. Even then, the natural hydrology of the Upper Partridge River (upstream of Colby Lake) would still be affected as precipitation, limited surface runoff, and groundwater seepage into the mine pits (collectively averaging about 2.6 cfs per year) would be converted to a surface water discharge several miles downstream (Figure 4.1-20) than where it would occur otherwise. Further, as discussed in Section 4.1.3.1 (Effects on Groundwater Levels), there would be a net lowering of the surficial aquifer of approximately 10 to 20 feet around the East and West pits, respectively, because of the pit outlet control structure elevations. This lowering of the water table would be expected to result in a small reduction in base flows to the Upper Partridge River. Overall these effects are expected to be minor as the base flow in the Partridge River is naturally low (i.e., often less than 2 cfs during the winter and during summer dry periods).

Tribal cooperators strongly disagree with the conclusions in this section. The available data does not support these conclusions.

Effects on Partridge River Morphology

River morphology is primarily influenced by large flows (i.e., 1.5-year recurrence interval or larger flows). In order to assess Project effects on river morphology, we evaluated reductions in the maximum annual one day flows for the 10 years modeled (i.e. 1978 – 1987) at location SW-004 (monitoring station with the largest Project effect on flows), for Year 15 (maximum impact on flows during Project operations) and the high impact scenario (reflecting larger than planned impact areas). At this location for these mine years, the Project is predicted to result in less than a 10% reduction in Partridge River annual maximum one day flows (Table 4.1-54).

Table 4.1-53 Partridge River Flows – Hypothetical High Impact Scenario – 1979 Model Year

		SW-002			SW-003			SW-004			SW-004a			SW-005			USGS		
Statistic	**unit**	**Existing**	**Predict.**	**% change**	**Existing**	**Predict.**	**% change**	**Existing**	**Predict.**	**% change**	**Existing**	**Predict.**	**% change**	**Existing**	**Predict.**	**% change**	**Existing**	**Predict.**	**% change**
Mean Oct flow	cfs	3.4	3.1	-8.8	4.9	4.4	-10.2	6.1	5.0	-18	17.6	15.4	-12.5	19.9	19.0	-4.5	24.0	23.1	-3.8
Mean Nov flow	cfs	13.1	12.3	-6.1	14.6	13.7	-6.2	26.1	24.0	-8.1	60.1	57.1	-5	129.1	124.7	-3.4	132.9	128.6	-3.2
Mean Dec flow	cfs	2.1	1.9	-9.5	2.2	2.0	-9.1	3	2.6	-13.3	5.1	4.6	-9.8	10.4	9.9	-4.8	10.7	10.2	-4.7
Mean Jan flow	cfs	1.2	1.0	-16.7	1.4	1.1	-21.4	1.9	1.5	-21.1	3.7	3.2	-13.5	7.0	6.5	-7.1	7.3	6.8	-6.8
Mean Feb flow	cfs	1.0	0.8	-20	1.1	0.9	-18.1	1.7	1.3	-23.5	3.5	3.0	-14.3	6.5	6.0	-7.7	6.8	6.3	-7.4
Mean March flow	cfs	3.0	2.8	-6.7	3.9	3.6	-7.7	5.3	4.5	-15.1	12.6	11.2	-11.1	16.3	15.5	-4.9	18.3	17.5	-4.4
Mean April flow	cfs	12.9	12.2	-5.4	14.5	13.7	-5.5	23.3	21.5	-7.7	52.3	49.4	-5.5	105.6	102.1	-3.3	109.7	106.2	-3.2
Mean May flow	cfs	0.8	0.6	-25	0.9	0.7	-22.2	1.2	1.0	-16.7	2.5	2.3	-8	4.9	4.7	-4.1	5.3	5.0	-5.7
Mean June flow	cfs	0.9	0.7	-22.2	1.1	0.8	-27.2	1.4	1.1	-21.4	3.7	3.1	-16.2	6.7	6.1	-9	7.5	6.9	-7.6
Mean July flow	cfs	0.6	0.5	-16.7	0.7	0.6	-14.3	1.1	0.8	-27.2	2.7	2.4	-11.1	5.4	5.1	-5.6	6.0	5.7	-5
Mean Aug flow	cfs	1.5	1.3	-13.3	1.7	1.4	-17.6	2.1	1.6	-23.8	5.4	4.7	-12.7	8.5	8.0	-5.9	9.9	9.3	-6.7
Mean Sept flow	cfs	5.9	5.4	-8.5	7.2	6.6	-8.3	12.1	10.7	-11.6	29.1	26.9	-7.6	54.7	52.5	-4	58.0	55.7	-4
Max 1 day flow	cfs	72.8	67.9	-6.7	84.9	79.4	-6.5	140.4	123.2	-12.3	396.5	368.5	-7.1	571.5	536.9	-6.1	587.1	552.4	-5.9
Max 3 day flow	cfs	60.6	56.8	-6.3	75.0	70.6	-5.9	123.2	111.4	-9.7	329.1	304.0	-7.6	526.0	503.5	-4.5	537.3	514.6	-4.2
Max 7 day flow	cfs	40.2	37.7	-6.2	50.0	47.2	-5.6	87.7	79.2	-9.7	222.7	209.0	-6.2	400.8	386.0	-3.7	420.0	405.3	-3.5
Max 30 day flow	cfs	15.2	14.3	-5.9	17.9	16.9	-5.6	29.7	27.1	-8.8	71	66.5	-6.3	135.5	131.0	-3.3	142.5	138.0	-3.2
Max 90 day flow	cfs	6.4	5.9	-7.8	7.4	6.9	-6.8	11.9	10.7	-10.1	27.9	26.0	-6.8	53.5	51.6	-3.6	56.3	54.4	-3.4
Min 1 day flow	cfs	0.22	0.17	-22.7	0.29	0.23	-20.70	0.41	0.32	-22.00	1.01	0.91	-9.90	2.14	2.02	-5.6	2.36	2.24	-5.1
Min 3 day flow	cfs	0.22	0.17	-22.7	0.29	0.23	-20.70	0.41	0.32	-22.00	1.01	0.91	-9.90	2.14	2.02	-5.6	2.36	2.25	-4.7
Min 7 day flow	cfs	0.24	0.19	-20.8	0.31	0.25	-19.30	0.45	0.35	-22.20	1.09	0.98	-10.10	2.45	2.31	-5.7	2.67	2.54	-4.9
Min 30 day flow	cfs	0.52	0.40	-23.1	0.63	0.49	-22.20	0.87	0.68	-21.80	2.24	2.01	-10.30	4.37	4.12	-5.7	4.90	4.66	-4.9
Min 90 day flow	cfs	0.68	0.53	-22.1	0.81	0.64	-21.00	1.12	0.88	-21.40	2.83	2.54	-10.20	5.38	5.08	-5.6	6.00	5.71	-4.8
Min 7-day flow/mean annual flow	cfs	0.063	0.054	-14.3	0.070	0.060	-14.3	0.064	0.056	-12.50	0.066	0.065	-1.50	0.079	0.078	-1.3	0.082	0.081	-1.2
# of high pulses	#/year	6	6	0.00	5	5	0.00	5	5	0.00	7	7	0.00	5	5	0	5	4	-20
# of low pulses	#/year	14	14	0.00	15	15	0.00	8	9	12.50	11	11	0.00	11	11	0	11	12	9
Mean HP duration	days	9	9	0.00	10.6	10.4	-1.90	10.60	10.40	-1.90	7.9	7.7	-2.50	10.4	10.4	0	10.6	12.8	20.8
Mean LP duration	days	6.7	6.7	0.00	6.1	6.2	1.60	14.30	12.60	-11.90	11	11	0.00	11.9	11.9	0	11.6	10.9	-6

Source: RS73A, Barr 2008.

Table 4.1-54 Project-related Reduction in Annual Maximum One Day Flows at SW-004 in the Partridge River

Year	Existing Flows (cfs)	Year 15 Flow (cfs)	Change in Flow (cfs)	Change in Flow (%)	High Impact Scenario (cfs)	Change in Flow (cfs)	Change in Flow (%)
1978	283.4	259.2	24.2	8.5%	258.6	24.8	8.8%
1979	140.4	123.6	16.8	12.0%	123.2	17.2	12.3%
1980	142.4	131.9	10.5	7.4%	131.6	10.8	7.6%
1981	217.9	195.0	22.9	10.5%	194.5	23.4	10.7%
1982	232.5	211.8	20.7	8.9%	211.3	21.2	9.1%
1983	242.7	220.0	22.7	9.4%	219.5	23.2	9.6%
1984	173.8	156.7	17.1	9.8%	156.3	17.5	10.0%
1985	240.9	220.3	20.6	8.6%	219.9	21.0	8.7%
1986	225.0	199.7	25.3	11.2%	199.1	25.9	11.5%
1987	165.4	148.1	17.3	10.5%	147.7	17.7	10.7%
Average			19.8	9.7%		20.3	9.9%

Source: Appendix A - Table 4, RS73B Barr 2008

This reduction in flow and presumably velocity could increase deposition of fine sediments in the stream channel. The data, however, also indicate that the reduction in flow is proportionately less for the larger modeled flows (only 8.8% for the largest flow in 1978) and would presumably be even less for even larger flow events (e.g., 25-year flood). Further, this reduction in flow would be well within the natural range of maximum annual flow variability, which exceeded 100% for just this 10-year modeled period. Therefore, any sediment deposition that may occur would likely only be temporary and would be flushed when larger storms occurred. No other significant effects on river morphology would be expected.

It is the tribal cooperating agencies' position that the available data do not support the conclusions presented in this section. The impacts predicted by technical reports (RS73B) to the Partridge River are primarily reduction in base flow due to mine pit dewatering and those impacts are predicted by the MODFLOW model. MODFLOW modeling in (RS22-Appen.B) forms the foundation for the predicted impacts. The MODFLOW model (RS22 Appen.B) is not calibrated to a data set representative of the area and predicts fluxes to the Partridge River based an a non-unique solution. A differently formulated and calibrated MODFLOW model could predict much higher inflow to the PolyMet pits and therefore, show greater impacts to stream baseflow

The surface water model (SWMM) used for predicting impacts is calibrated to Partridge River flows from 1978 to 1988, seventeen mines downriver of the mine site. During the period of record, the Peter Mitchell pits were dewatered with unknown effects on the river flow data. According to technical documents (RS73A, page 21) the flow record at the Partridge River gage above Colby Lake (USGS #04015475) may have been impacted by mine discharges on the north branch. The monthly average flow recorded at this gaging station during 1978-1988 varied between a minimum of 1.3 cubic feet per second and a maximum of 454 cubic feet per second.

The discharges from the Peter Mitchell Pit could account for up to 34 cubic feet per second. Since the timing, duration and location of mining discharges may be different now than during 1978-1988, the present hydrologic regime of the Partridge River may not be well represented by the period of record at USGS #04015475.

The other potential geomorphic effect of the Project would be at the outfall of the West Pit (Figure 4.1-20). The annual average overflow from the West Pit is estimated at approximately 2.6 cfs, with 10-year and 100-year peak flows of 14 and 33 cfs (Appendix F, RS74A, Barr 2008). PolyMet would form the West Pit outlet channel out of bedrock or cast-in-place a reinforced concrete weir with adequate capacity to pass the 100-year storm flow. The outlet channel would direct overflows into an existing wetland, which ultimately flows through a culvert (OS-5) under Dunka Road and into the Partridge River. It is unclear whether overflow velocities would be sufficient to scour a channel through these wetlands. We recommend that PolyMet either provide engineering calculations showing that this outfall would be stable or provide appropriate energy dissipation or erosion control measures prior to discharge to the wetlands.

Effects on 100-Year Floodplain

The Project would impact a small area of the 100-year floodplain in the headwaters of the Partridge River. These impacts, however, would not increase the 100-year flood elevation and, as a result, would not require any Federal Emergency Management Agency or MnDNR flood insurance program permits.

Effects on Water Levels in Colby Lake and Whitewater Reservoir

Minnesota Power and Cliffs Erie LLC (to be replaced by PolyMet) jointly hold a Water Appropriations Permit that allows for withdrawals of up to 12,000 gpm for any continuous 60-day period and a maximum instantaneous withdrawal rate of 15,000 gpm from Colby Lake, but requires that withdrawals from Colby Lake when it falls below elevation 1,439.0 feet msl be replaced on a gallon for gallon basis with pumping from Whitewater Reservoir.

PolyMet proposes to withdraw water from Colby Lake for make-up water at the Plant Site during Project operations. These withdrawals are expected to have an annual average of 3,500 gpm, but would exceed 5,000 gpm about 10 percent of the time and 8,000 gpm about 1 percent of the time. We evaluate below the effect of these withdrawals on water levels in Colby Lake and Whitewater Reservoir. Colby Lake and Whitewater Reservoir were modeled for a representative period when no LTVSMC water use occurred (October 1, 2001 to September 30, 2005, which includes two relatively dry years – WY 2003 and 2004) and for three withdrawal scenarios (PolyMet withdrawals of 3,500 gpm, 5,000 gpm, and a Combined High Demand consisting of 8,000 gpm for three months per year and 4,400 gpm for other nine months). The model assumed transfer of water from Whitewater Reservoir in order to maintain water levels above the critical outflow elevation of 1,438.5 feet at all times in Colby Lake.

Under average flow conditions (Table 4.1-55), Project withdrawals would result in an average water level drawdown from the base case (0 gpm withdrawal) of between 0.01 feet (5,000 gpm withdrawal) and 0.03 feet (3,500 gpm withdrawal) for Colby Lake. The model indicates that the water levels in Colby Lake would remain above elevation 1,438.5 feet and would actually be below elevation 1,439.0 feet less often than under the base case because of active water level management (i.e., pumping from Whitewater Reservoir). Water level fluctuations would increase in Whitewater Reservoir as a result of this pumping from 2.85 feet (base case) up to 6.84 feet (5,000 gpm pumping scenario).

Table 4.1-55 Project Effects on Water Levels in Colby Lake and Whitewater Reservoir During Average Flow Conditions

	Colby Lake				Whitewater Reservoir			
Water withdrawal (cfs)	0	3,500	5,000	CHD	0	3,500	5,000	CHD
Average Water Level (feet msl)	1,439.45	1,439.42	1,439.44	NA	1,439.33	1,438.94	1,438.33	NA
Average Drawdown (ft)	NA	0.03	0.01	NA	NA	0.39	1.00	NA
Maximum Annual Fluctuations	3.90	3.63	3.61	NA	2.85	4.22	6.84	NA
% days below el. 1,439.0	10.5	9.0	0.5	NA	NA	NA	NA	NA

Source: Table 8, RS73B, Barr 2008.
Notes: CHD = Combined High Demand; NA = Not Applicable.

Even under 50-year low flow conditions (Table 4.1-56), Project withdrawals would not reduce water level fluctuations and the frequency water elevations would be below elevation 1,439.0 feet at Colby Lake in comparison with the base case because of the active water management. Water level fluctuations in Whitewater Reservoir would increase from 2.83 feet (base case) up to 9.87 feet (5,000 gpm withdrawal) as a result of the required increased pumpage to maintain water levels in Colby Lake.

Table 4.1-56 Project Effects on Water Levels in Colby Lake and Whitewater Reservoir During 50-Year Low Flow Conditions

	Colby Lake				Whitewater Reservoir			
Water withdrawal (cfs)	0	3,500	5,000	CHD	0	3,500	5,000	CHD
Average Water Level (feet msl)	1,439.30	1,439.27	1,439.31	1,439.29	1,439.18	1,438.46	1,437.50	1,437.49
Average Drawdown (ft)	0.00	0.03	+0.01	0.01	0.00	0.72	1.68	1.69
Maximum Annual Fluctuations	3.12	2.93	3.00	2.98	2.83	5.86	9.87	9.74
% days below el. 1,439.0	38.5	31.0	3.5	12.5	NA	NA	NA	NA

Source: Table 10, RS73B, Barr 2008.
Notes: CHD = Combined High Demand; NA = Not Applicable.

Under either low or average flow conditions, the analysis indicates that sufficient make-up water would be available from Whitewater Reservoir to meet Project water demands while still complying with the Colby Lake water level requirements as established in the Water Appropriation Permit. PolyMet would be able to maintain water elevations in Colby Lake above the critical 1,438.5 feet and would actually reduce the frequency that Colby Lake would be below elevation 1,439.0 feet because of active water management. Project effects on water levels in Whitewater Reservoir would be more pronounced with maximum drawdowns of 6.84 feet (average flow conditions) to 9.87 feet (low flow conditions). Whitewater Reservoir, however, was originally constructed as a water supply source for mining and power generation and water fluctuations of this magnitude would be expected.

Effects on Flow in the Lower Partridge River Downstream of Colby Lake

The Project would reduce flow in the lower four miles of the Partridge River downstream of Colby Lake as a result of the combined effects of Mine Site activities (i.e., collecting and redirecting surface runoff and reducing groundwater contributions, installation of a seepage barrier at the headwaters of Second Creek and pumping collected seepage back to the Tailings Basin during mine operations, and by water withdrawals from Colby Lake for process water at the Plant Site until Year 20. During an average year, Mine Site activities are predicted to reduce monthly flows by a maximum of about 1.5 cfs at the USGS gage station above Colby Lake, the Second Creek seepage barrier would reduce flow ultimately to the Partridge River by approximately 1.2 cfs (Hinck 2009), and the average water withdrawal from Colby Lake (3,500 gpm) equates to approximately 7.8 cfs, for a total reduction in flow of approximately 10.5 cfs. Mean annual flow downstream of Colby Lake is estimated at 116.6 cfs (Barr 2009, External Memorandum: Additional information in support of NorthMet DEIS Critical Path Requires Actions); therefore the Project would result in an average 9 percent reduction in flow in the Lower Partridge River. As discussed above, during low flow conditions, water would be pumped from Whitewater Reservoir to offset PolyMet water withdrawals when water levels in Colby Lake fall below elevation 1,439.0 feet. The net effect of the Project on flows downstream of Colby Lake would be to reduce average flows and increase the frequency of low flows equating to releases from Colby Lake at elevation 1,439.0 feet. The Project should have minimal effect on the magnitude or frequency of flow releases from Colby Lake below elevation 1,439.0 feet. This overall reduction in flow downstream of Colby Lake could affect other mining projects that propose discharges to the Partridge River (e.g., Mesabi Nugget).

Effects on Flow in the Embarrass River

The Project would have no surface water discharge to and would not change the drainage area to the Embarrass River (i.e., redirect drainage to or from the watershed). As a result, detailed hydrologic modeling (e.g. XP-SWMM) was not conducted for the Embarrass River. Low, average, and high flows were estimated at two locations along the Embarrass River (i.e., PM-12 and PM-13; Figure 4.1-1) based on flow data from USGS gages at Embarrass and near McKinley. There would be alterations to flows in the Embarrass River, however, due to uncontrolled seepage from the Tailings Basin during Project operations, Closure, and Post-Closure. Under existing condition, the uncontrolled seepage from the LTVSMC Tailings Basin (Cells 1E/2E) is estimated at approximately 900 gpm (2.0 cfs) (Hinck 2009).

It is the tribal cooperating agencies' position that there will be surface water discharge to the Embarrass River. Aerial photography and state Public Waters inventory maps indicate that there is currently a direct surface water connection between the northwest corner of cell 2W and the Embarrass River. Aerial photos show that water discharging from the tailings basin follows a natural channel westward, through existing wetlands and intersects a channel that leads directly to the Embarrass River.

During Project operations, unrecoverable PolyMet seepage from the Tailings Basin (Cells 1E/2E) would vary from 1,600 to 2,909 gpm (up to approximately 6.5 cfs) (see Table 4.1-33). This unrecoverable seepage may not be directly seen in the Embarrass River as a sustained flow because of flow attenuation by the intervening wetlands. After Closure, the steady-state PolyMet seepage from the Tailings Basin (Cells 1E/2E) would be approximately 490 gpm (1.1 cfs) (Hinck 2009). This long-term steady state seepage would be approximately 45 percent lower than the current LTVSMC seepage. The predicted net increase in Tailings Basin seepage to the Embarrass River of approximately 4.5 cfs (6.5 cfs – 2.0 cfs) during mine operations is small (about 6 percent) compared to average annual flows in the Embarrass River (approximately 81.5 cfs at nearby PM-13), not accounting for attenuation by the intervening wetlands. Similarly, the net decrease in Tailings Basin seepage to the Embarrass River during Closure of approximately 0.9 cfs (2.0 cfs – 1.1 cfs) is again small (about 1 percent) compared to the average flow in the Embarrass River. Therefore, the Project effects on flow in the Embarrass River are considered negligible.

Effects on Surface Water Quality

The Proposed Action may affect the water quality of the Partridge and Embarrass rivers and their tributaries that drain the Mine Site and Tailings Basin. PolyMet proposes to treat, reuse, and recycle water, resulting in no surface water discharges until when the West Pit overflows in approximately Year 65. Nevertheless, several potential pathways for surface water quality impacts remain, including non-contact stormwater runoff; seepage from rock stockpiles liners, the hydrometallurgical waste storage area; the Tailings Basin; and pit lake overflows. Below, we describe the methodology used in modeling surface water quality and then discuss the predicted effects of the Proposed Action on surface water quality in the Project area.

Evaluation Methodology

Project effects on surface water quality were evaluated using mass balance models linked to the hydrology predictions from the XP-SWMM model. A mass balance water quality model was developed and calibrated for the Partridge River watershed, including Colby Lake (RS74A, Barr 2008) at seven locations (Figure 4.1-11). Similarly, a mass balance water quality model was also developed and calibrated for the Embarrass River (RS74B, Barr 2008) at monitoring stations PM-12 (upstream control site) and PM-13 (downstream site) (Figure 4.1-7). The models predicted water quality for seven time periods (Years 1, 5, 10, 15, 20, Closure, and Post-Closure) during low, average, and high flow conditions. In most cases, low flows are the critical flow condition for assessing impacts, which is defined for purposes of the surface water modeling as the 30-day low flow. This flow condition equates to flows that are lower than the 7-day/10-year low flow, or 7Q10, which is the low flow condition used for calculating total maximum daily loads and waste load allocations in Minnesota (*Minnesota Rules*, part 7052.0200) so this represents a very conservative flow condition.

The models predicted concentrations for 26 parameters (i.e., silver, aluminum, arsenic, boron, barium, beryllium, calcium, cadmium, chloride, cobalt, copper, fluoride, iron, hardness, potassium, magnesium, manganese, sodium, nickel, lead, antimony, selenium, sulfate, thallium, vanadium, and zinc). Mercury was not included in either model because data for mercury were not available for stockpile liner leakage (RS53/42, SRK 2007) or groundwater recharge from the East and West pits (RS31, SRK 2007).

Deterministic water quality predictions were computed using the best available flow and chemistry data. When necessary, conservative assumptions were made (e.g., all the liner leakage/seepage from the Mine Site would reach the Partridge River as groundwater). In addition, the mass-balance model does not account for possible reductions in loadings resulting from the transport of the solutes to and within the Partridge River.

Uncertainty Analyses were not conducted for surface water quality because there were fewer variables and unknowns as compared to the groundwater modeling. However, the results of the waste rock stockpile and pit lake solute loading Uncertainty Analysis was considered in evaluating Project effects on Partridge River water quality.

Wastewater

The Project would generate both domestic wastewater and process wastewater. PolyMet proposes to manage domestic wastewater by providing portable facilities serviced by a supplier at the Mine Site and continuing use of existing septic systems at various buildings at the Plant Site (e.g., Administration Building, Area 1 and 2 shops, Tailings Basin Reporting Building). These portable facilities and septic systems should be adequate to manage the domestic wastewater requirements of the Project.

PolyMet proposes a WWTF at the Mine Site that would treat process water (i.e., pit dewatering, drainage from the waste rock/lean ore stockpiles, and runoff from other site operations) (Figure 3.1-2). The proposed treatment system would include chemical precipitation treatment for the low-volume high-strength flows (e.g., drainage from the waste rock/lean ore stockpiles) and nanofiltration to concentrate the high-volume low-strength flows (e.g., pit dewatering, site operations runoff, Category 1/2 stockpile drainage) (RS29T, Barr 2007).

The Project would generate an annual average maximum of 1,600 gpm (2.3 mgd) of process water during Year 10 (Figure 4.1-15). Within any given year, the process water flow would vary significantly with lower flows during the winter (generally 0.5 to 0.7 times the annual average flow) and higher flows during the spring (generally 2.0 to 2.5 times the annual average flow). The WWTF's maximum design flow would be 3,000 gpm (4.3 mgd) (RS29T, Barr 2007). Because these flows would vary significantly over the Project life and within any given year, the WWTF design includes two equalization ponds that would store excess process water when the WWTF is operating at full capacity.

The WWTF would operate for the life of the Project operations (Years 1-20), but would also continue to operate after Closure because the waste rock stockpile drainage and leachate from the Hydrometallurgical Residue Facility (which at Closure could no longer be routed back into the hydrometallurgical operations) would continue to require treatment. Based on MODFLOW modeling, the hydrometallurgical leachate is expected to decrease from an average initial rate of 215 gpm in Year 21 to 0 gpm by Year 34 (RS74A, Barr 2008). The waste rock stockpile drainage would continue to receive treatment at least until the West Pit fills around Year 65. At that time, water quality monitoring of the West Pit overflow would determine whether continued treatment would be necessary. Tribal cooperating agencies note that the analysis of stockpile leachate collection (Table 4.1-41) indicates that collection would be needed for 2000 years in order to avoid violations of water quality standards. Furthermore, periodic collection of wastewater from the hydrometallurgical tailings facility would have to continue in perpetuity. Therefore, it is the tribal cooperating agencies' position that the WWTF would also have to operate for a minimum of 2000 years. Tribal cooperating agencies suggest that this does not meet the Minnesota goal of maintenance free closure.

The WWTF would not have a discharge to a natural waterbody, but, instead, the treated process water would be pumped via the CPS from Years 1 through 11 to the Tailings Basin for reuse at the Beneficiation Plant. During Years 12 through 20, the treated process water would be primarily used to help fill the East Pit (after mining would be completed in Year 11), but some effluent would still be used for make up water as needed at the Plant Site. After Year 20, when ore processing would be completed, all the treated process water would be pumped to the head of the East Pit, where it would flow through a proposed wetland treatment facility and ultimately drain to the West Pit. It is the tribal cooperating agencies' position that the long-term effectiveness of the wetland treatment system has not been demonstrated by the applicant (See discussion on constructed wetlands below). Without a demonstration of effectiveness, the wetland treatment must be assumed to be ineffective due to short-circuiting. The primary objectives for the WWTF are to ensure that the treated process water is of sufficient quality to allow reuse in the Beneficiation Plant and to help meet groundwater standards for groundwater seepage from the Tailings Basin. The treated process water quality design targets reflect a combination of state surface and groundwater standards, although the most restrictive of the two is not always proposed (RS29T, Barr 2007). The WWTF effluent represents the primary source of antimony, arsenic, and sulfate to the Tailings Basin pond and seepage from Cells 1E/2E during mine operations (Wenigmann, Pint, and Wong 2009). Since the WWTF effectiveness would be an important factor affecting the quality of groundwater seepage from the Tailings Basin, we recommend monitoring of the WWTF effluent as a leading indicator of potential groundwater issues at the Tailings Basin (Section 4.1.3.5).

Upper Partridge River Water Quality

Water-quality in the Partridge River is already affected by discharges from the Peter Mitchell Mine and the City of Hoyt Lakes WWTP. As mentioned above, PolyMet does not propose any surface water discharges until the West Pit overflows around Year 65 (RS21, Barr 2007). However, non-contact stormwater runoff; unrecoverable groundwater seepage from the temporary and permanent waste rock/lean ore stockpiles, mine pits, overburden storage/laydown areas, various sumps, process water ponds, and the WWTF equalization ponds; and the ultimate overflow of the West Pit represent potential pathways for the Project to affect water quality in the Partridge River. Table 4.1-57 presents the estimated volume contributions from each of these sources, which shows that most of the contaminant sources would be very small. The water quality results from both deterministic modeling and the incorporation of results from the Uncertainty Analysis for the Partridge River are discussed below.

Table 4.1-57 Summary of Collected Seepage and Liner Leakage Rates at the Mine Site

Potential Contaminant Sources	Maximum Rate During Mine Operations (gpm)	Maximum Rate During Post-Closure (gpm)
Overburden Storage and Laydown Area[1]	34.29	0
Category 1/2 sumps[2]	0.002083	0.002083
Category 3 Sumps[3]	0.000008	0.000008
Category 3 Lean Ore Sumps	0.000016	0.000016
Category 4 Sumps	0.000007	0.000007
Category 4 Lean Ore Sumps	0.000014	0
PW-1 Overburden Runoff[1]	8.48	0
PW-2 haul Road Runoff	0.006028	0
PW-3 Rail Transfer Hopper	0.000004	0
PW-4 Haul Road Runoff	0.012917	0
PW-7 Overburden Runoff[1, 3]	15.93	0
WWTF Equalization Ponds[4]	0.013200	0

Source: Modified from Table 4-30, RS74A, Barr 2008.
1 No liner present.
2 Only the southern-most sump of the Category 1/2 pile (S-1) drains to Partridge (17% of the total leakage), others drain to pits.
3 PW-7 exists only in Year 1 and 5.
4 Rates are averaged over period during which water is in the pond (typically 8-30 days).

Non-contact Stormwater Runoff

PolyMet proposes to collect non-contact stormwater runoff from undisturbed and reclaimed vegetated areas within the Mine Site and route it to the Partridge River via existing drainage patterns to the extent possible. Stormwater quality is not expected to differ significantly from existing conditions because it would not contact any reactive rock, but there is the potential for increased suspended solids. PolyMet would provide sedimentation ponds at the outlet locations to manage suspended solids prior to discharge to surface waterbodies (Figures 3.1-14, 3.1-15, and 3.1-16). These sedimentation ponds should be adequate to manage suspended solids, but we recommend monitoring of the discharge as part of any NPDES/SDS permit.

Stormwater runoff from the process plant area (excluding the Tailings Basin) would be routed to Second Creek, a tributary of the Partridge River (RS74B, Barr 2008). PolyMet indicates that stormwater management facilities may be needed to manage sediment associated with this flow, but does not propose any at this time. This lack of stormwater management facilities could result in increased pollutant loadings to the Partridge River. This issue is further discussed in Section 4.1.3.5.

Groundwater Seepage and Pit Overflow Effects

The deterministic model results generally indicate that the 30-day low flow condition represents the scenario in which the impact of the Project on the water quality of the Partridge River would be the greatest. This is primarily attributable to the high concentrations that were predicted for most trace metals in the stockpile leachate (RS53/RS42, SRK 2007) and the lack of flow under low flow conditions to provide dilution. The highest predicted concentrations in the Partridge River for all flow conditions for the main water quality variables of interest are provided below in Table 4.1-58. Since most of the stockpile seepage and the West pit overflow would reach the

Partridge River downstream of SW-003, the highest predicted concentrations would all occur at downstream locations.

Table 4.1-58 Predicted Water Quality along the Upper Partridge River for the Proposed Action

Parameter	Units	Water Quality Standard	Existing Modeled Concentration	Predicted Max Concentration	Location	Flow Conditions
General						
Fluoride	mg/L	--	0.2	0.3	SW-004a	Low Flow
Hardness	mg/L	500	108	119	SW-004a	Average Flow
Sulfate	mg/L	--	17.9	31.7	SW-004a	Low Flow
Metals						
Aluminum	µg/L	125	107	115	USGS	Low Flow
Antimony	µg/L	31.0	1.5	6.9	SW-004a	Average Flow
Arsenic	µg/L	53.0	3.4	8.3	SW-004a	Low Flow
Cadmium	µg/L	1.2[1]	0.1	0.1	All stations	All Flows
Cobalt	µg/L	5.0	0.5	2.1	SW-004	Low Flow
Copper	µg/L	8.3[1]	2.1	7.0	SW-004	Low Flow
Lead	µg/L	2.9[1]	0.8	1.1	SW-004a	Low Flow
Nickel	µg/L	46.5[1]	1.9	25.6	SW-004	Low Flow
Zinc	µg/L	85.0[1]	24.2	24.6	USGS	Low Flow

Source: Tables 5-4 to 5-24, RS74A, Barr 2008

[1] Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration at that location.

All modeled constituents meet minimum in-stream Minnesota water quality standards at all locations along the Partridge River during low, average and high flow conditions for all mine years modeled under the Proposed Action. The mass balance model was re-run using the higher 95th percentile solute loading values from the rock stockpile Uncertainty Analysis. Even with these higher loadings and assuming no natural attenuation, the model results indicate that water quality standards for the Partridge River would be maintained for the eight constituents studied (i.e., antimony, arsenic, fluoride, cobalt, copper, nickel, vanadium, and sulfate) under all flow conditions and mine years modeled (Hinck and Wong 2008).

Therefore, even using relatively conservative assumptions, the Project is not predicted to result in any exceedances of surface water quality standards for the Partridge River at the modeled locations.

<u>West Pit Overflow</u>

In Post-Closure (i.e., beginning around Year 65), the West Pit is predicted to overflow at an annual average rate of 2.6 cfs. This overflow would represent the one and only surface discharge from the Project. During Post-Closure, the West Pit would receive inflow from direct surface drainage, groundwater seepage (including liner leakage from the Category 1/2 waste rock stockpile), and precipitation, as well as overflow from the East Pit. From Year 12 at least until the West Pit overflows, the WWTF would continue to treat process water and discharge it to the head of the East Pit. Once the East Pit is filled around Year 20, PolyMet proposes to construct a passive wetland treatment system in the East Pit, which would provide additional treatment ("polishing") of the WWTF effluent. Sometime after the West Pit overflows, the WWTF would be decommissioned and the constructed wetlands would indefinitely provide the primary treatment of waste rock stockpile leachate. We evaluate below the potential effectiveness of the proposed constructed wetland, and then, based on those conclusions, evaluate the likely water quality of the West Pit overflow.

Tribal cooperating agencies believe the characterization in the previous paragraph is misleading. First, as previously indicated, the WWTF would need to operate for a minimum of 2000 years in order to treat leachate from the stockpiles. Second, the effectiveness of the passive wetland treatment system has not been demonstrated and it is likely that the wetland treatment system would not function as the applicant has suggested (see discussion below). Finally, the long term water quality of the pit lake is a concern. It is unlikely that this water would ever meet surface water quality standards. It is the tribal cooperating agencies' position that the DEIS should discuss the implications of leaving a polluted pit lake at this site in perpetuity.

Constructed Wetlands

PolyMet assumed wetland removal efficiencies in the East Pit passive wetland system would range from 50 to 90 percent for six parameters (Table 4.1-59). Constructed wetlands have proven effective in removing various pollutants in several cases. For example, an experimental bioreactor achieved high metal removal efficiencies for both neutral and low pH acid rock drainage in a very controlled laboratory setting (Willow and Cohen 2003). Experience with the effectiveness of field scale constructed wetlands has been much more variable. For example, four constructed wetlands treat several waste rock stockpile seeps at the nearby Dunka Mine north of Babbitt. These constructed wetlands were consistently effective in removing cobalt and copper, but in some cases actually resulted in increases in nickel and zinc concentrations. In some cases, metal removal effectiveness of these wetlands had strong seasonal variability. Sulfate removal was highly variable.

Table 4.1-59 Estimated Wetland Removal Efficiencies

Parameter	PolyMet Estimate[1] Low	Medium	High	Dunka Mine Wetland Performance[2]	Mine Drainage Wetland Performance[3]	Constructed Wetland Performance[3]	Laboratory Performance[4]
Antimony	50%	75%	90%	--	--	50-75%	--
Arsenic	50%	75%	90%	--	--	0%	30-96%
Cobalt	50%	75%	90%	30-100%	--	--	--
Copper	50%	75%	90%	30-100%	80-90+%	25-100%	~100%
Nickel	50%	75%	90%	Highly Variable	--	0-90%	--
Sulfate	50%	75%	90%	Highly Variable	10-30%	--	--

Sources:
1 Hinck and Wong 2008.
2 Appendix D, RS29T, Barr 2007.
3 Halverson 2004; Birch et al 2006; Versar 2000; USEPA 2002; Jin et al 2003; Knox et al 2006; Nelson et al 2005; Nelson et al 2002; and Kropfelova et al 2008.
4 Willow and Cohen 2003; and Rahman et al 2008.

A limited literature review also reveals a wide range of variability in the pollutant removal effectiveness of constructed wetlands managing mine drainage and other pollutant sources (Table 4.1-59). In most cases, these wetlands were used to "polish" treated effluents and the incremental improvement they offer is valuable. We conclude, however, that constructed wetlands performance is not sufficiently reliable to function as the primary treatment measure for assuring consistent year-round compliance with water quality standards. Further, the assimilative capacity of these wetlands is limited and they would presumably require long-term maintenance to ensure its effectiveness.

Based on these uncertainties, it is the tribal cooperating agencies' position that primary water treatment at the WWTF would need to continue for thousands of years. This does not meet the Minnesota goal for maintenance free closure.

West Pit Overflow Water Quality

The deterministic modeling results predict that several parameters (i.e., aluminum, arsenic, cobalt, fluoride, and selenium) would exceed surface water quality standards when the West Pit overflows (Table 4.1-60). An Uncertainty Analysis was conducted for the West Pit water quality, but was limited to eight parameters. The results of the Uncertainty Analysis predicted exceedances for cobalt, copper, fluoride, and nickel (Table 4.1-60).

Table 4.1-60 Summary of West Pit Water Quality Post-Closure under Proposed Action

Constituent	Units	Water Quality Standard	Deterministic Model	Uncertainty Analysis (90% probability)
General Parameters				
Chloride	mg/L	230	21.4	--
Fluoride	mg/L	--	**2.3**	**2.8**
Hardness	mg/L	500	364	--
Sulfate	mg/L	--	247	330
Metals – Total				
Aluminum	ug/L	125	**140**	--
Antimony	ug/L	31	21.3	10.1
Arsenic	ug/L	53	**198**	40
Cadmium	ug/L	6.8[1]	0.15	--
Cobalt	ug/L	5.0	**8.0**	**63.1**
Copper	ug/L	28.1[1]	17	**464**
Iron	ug/L	--	150	--
Lead	ug/L	16.5[1]	6.5	--
Manganese	ug/L	--	116	--
Nickel	ug/L	156[1]	71.5	**592**
Selenium	ug/L	5.0	**7.7**	--
Thallium	ug/L	0.56	0.26	--
Vanadium	ug/L	--	77.8	14.1
Zinc	ug/L	358[1]	48.6	--

Source: Table 4-25, RS74A, Barr 2008; Hinck and Wong, 2008; Wenigmann and Wong 2009; Hinck, July 15, 2009; Hinck, Pint, and Wong 2009.

1 Water Quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 364 mg/L.

The West Pit overflow would discharge to an unnamed "waters of the state" and would have to meet effluent limitations based on meeting surface water quality standards, taking into account the assimilative capacity of the receiving waters under the 7-day/10-year (7Q10) low flow. The modeling results suggest that perhaps as many as seven parameters could exceed water quality standards, in addition to relatively high sulfate concentrations, although there is no applicable surface water standard for sulfate. The unnamed tributary to which the West Pit would discharge would essentially function as a mixing zone and water quality standards may be exceeded. The water quality of the West Pit overflow, however, is not predicted to result in exceedances of surface water standards in the Partridge River at SW-004 (located approximately 1,000 feet downstream from where the West Pit overflow would reach the Partridge River) (Table 4.1-58). Tribal cooperating agencies strongly disagree with this approach. It is the tribal cooperating agencies' position that all waters of the state are protected by Minnesota water quality standards and using this unnamed water as a mechanism to dilute mine related contamination is not appropriate. In addition no flow information for this unnamed water is available.

This impact may also represent the effects of a first flush of solutes and be relatively short term. We would expect water quality in the West Pit to improve as oxidation would be negligible once the pit walls are submerged. In Section 4.1.3.5, potential mitigation and monitoring measures are discussed to address the potential for exceedences of surface standards in the West Pit overflow. Tribal cooperators note that the previous paragraph is speculative. It is the tribal cooperating agencies' position that because of continued inputs from the stockpiles, the tailings basins, and the pit walls, the pit lake could exceed surface water quality standards for thousands of years. Tribal cooperating agencies note that 20 feet of pit wall will never be submerged and as such constitute a perpetual source of mine related contaminants.

Colby Lake and Whitewater Reservoir Water Quality Results

The Project should have negligible effect on water quality in Whitewater Reservoir because only high Partridge River flows would be diverted into Whitewater Reservoir when any potential contaminants from the Project would be diluted and predicted to be well below all surface water evaluation criteria. The Project would also result in increased water level fluctuations in Whitewater Reservoir as water would be pumped from the reservoir to maintain water levels in Colby Lake. These increased water level fluctuations could potentially affect water quality (e.g., DO, eutrophication) in Whitewater Reservoir, but these effects are expected to be negligible as water levels would remain within historic ranges and ambient water quality in the reservoir is generally good.

Colby Lake receives drainage from upstream discharges such as the Peter Mitchell Mine and the City of Hoyt Lakes WWTP. As with the Partridge River, the 30-day low flow condition represents the scenario in which the effect of the Proposed Action on Colby Lake water quality would be the greatest. Under these critical conditions, all of the other parameters meet surface water quality standards in Colby Lake for all modeled time periods except for arsenic, iron, and thallium, as shown in Table 4.1-61 (RS74A, Barr 2008).

Table 4.1-61 Predicted Water Quality at Colby Lake for the Proposed Action

Parameter	Unit	Standard	Existing Modeled Conditions	Predicted Highest Concentration	Mine Year	Flow Conditions
General						
Fluoride	mg/L	2.0	0.1	0.1	Post-Closure	Low flow
Sulfate	mg/L	250	10.1	15.3	Post-Closure	Low flow
Metals						
Aluminum	µg/L	125	76	76	Year 15	Low flow
Antimony	µg/L	5.5	1.5	3.9	Post-Closure	Low flow
Arsenic	µg/L	2.0	**2.1**	**5.1**	Post-Closure	High flow
Cadmium	µg/L	2.5[1]	0.1	0.1	Multiple years	Multiple flows
Cobalt	µg/L	2.8	0.6	0.8	Post-Closure	Low flow
Copper	µg/L	9.3[1]	1.8	2.5	Year 15	High flow
Iron	µg/L	300	**1,717**	**1,713**	Closure	Low flow
Lead	µg/L	3.2[1]	0.6	0.7	Post-Closure	Low flow
Manganese	µg/L	50	149	149	Year 15	High flow
Nickel	µg/L	52.0[1]	3.3	5.1	Post-Closure	Low flow
Thallium	µg/L	0.28	**0.4**	**0.4**	All Years	All flows
Zinc	µg/L	120[1]	18	18	Post-Closure	Low flow

Source: Tables 5-25 to 5-27, RS74A, Barr 2008

[1] Water quality standards for this metal is hardness-dependent. The listed values reflect a predicted hardness concentration of 100 mg/L.

The elevated arsenic concentration appears to be at least partially an artifact of model input assumptions. For example, the deterministic modeling predicts existing arsenic concentrations of 2.1 µg/L in Colby Lake, whereas recent monitoring found arsenic concentrations in Colby Lake are much lower (0.8 µg/L) (Wenigmann and Wong 2009). The highest arsenic concentration was predicted during Post-Closure period, which is primarily attributable to arsenic loadings from the West Pit overflow. The West Pit Uncertainty Analysis concluded that arsenic concentrations in the West Pit were likely to be less than those predicted by the deterministic modeling (even when adjusting to a 0 percent arsenic removal efficiency for the East Pit treatment wetlands). Using the 90 percent cumulative probability as our standard, the predicted arsenic concentration in the West Pit overflow would be 40.0 µg/L rather than 198.5 µg/L as predicted in the deterministic modeling. Substituting the arsenic concentrations from the recent monitoring (0.82 µg/L) for both the Colby Lake and surface runoff existing conditions, and assuming a 40.0 µg/L arsenic concentration for the West Pit overflow, the highest predicted arsenic concentrations in Colby Lake for all of the model years would be 1.9 µg/L, which is less than the 2.0 µg/L standard (Wenigmann and Wong 2009).

The elevated iron concentration is not attributable to the Project, but rather is related to the existing concentrations in the Partridge River. The Class 1B Minnesota water quality standard for iron is 300 µg/L. The average concentration of iron from surface water quality monitoring in 2004, 2006 and 2007 at SW-005 (immediately upstream of Colby Lake) was 1,340 µg/L. Therefore, the Minnesota water quality standard for iron would be exceeded even without the Project. Iron is a secondary MCL standard and is readily removed at publicly-owned treatment works prior to distribution to the community.

The elevated thallium concentration is also not attributable to the Project, but rather is related to its detection limit. The deterministic water quality predictions for thallium in the Upper Partridge River did not exceed Minnesota water quality standards under the Proposed Action. However, thallium standards are stricter for Colby Lake (0.28 µg/L) because it is classified as a Class 2Bd water. Thallium was not detected in any of the recent water quality monitoring, so the background concentration for thallium in the modeling was based on a single value from MPCA monitoring in the early 1990s. Use of this value resulted in an artificially high predicted concentration in Colby Lake. Further testing of thallium using a lower detection limit in the Partridge River would be necessary to determine predicted concentrations with a higher certainty.

Therefore, the Project is not expected to result in the exceedance of any surface water quality standards in Colby Lake.

<u>Water Quality in the Lower Partridge River</u>

The Proposed Action should have no effect on water quality in the Partridge River downstream of Colby Lake. Although not specifically modeled, the predicted water quality of Colby Lake would be a reasonable surrogate of expected water quality in the Lower Partridge River. We would expect all parameters to meet surface water standards under all flow conditions for all mine years as is predicted for the Upper Partridge River and Colby Lake. It is the tribal cooperating agencies' position that contaminants from the project would contribute to exceedances of standards below Colby Lake. Wild rice beds are located on the Partridge River immediately below Colby Lake. Therefore, the State of Minnesota wild rice standard for sulfate of 10 mg/l should apply along all of the Lower Partridge River.

Embarrass River Water Quality Results

Although the Tailings Basin is not designed to be overtopped or to have a discharge, the Project could affect surface water in the Embarrass River watershed by groundwater seepage, which would eventually be expressed as base flow in the Embarrass River, and surface water seepage through the tailings embankment to the wetland complex north of the Tailings Basin. PolyMet proposes a seepage collection system that would intercept and collect virtually all surface seepage from the Tailings Basin (Figure 4.1-21). Groundwater seepage from the Project, however, would not be recovered and is expected to range from 1,600 gpm (Year 1) to over 2,900 gpm (Year 20), which would eventually impact surface water quality in the Embarrass River (Hinck 2009). In addition, liner leakage from the hydrometallurgical cells would seep from Cell 2W. Although only a small volume (maximum of 8.7 gpm), this hydrometallurgical cell liner leakage is predicted to have a very high sulfate concentration (i.e., over 7,300 mg/L). This predicted sulfate concentrations probably overestimates the sulfate load as the solubility cap for sulfate is around 1,600 mg/L, and higher concentrations of sulfate will typically form gypsum.

Water quality in the Embarrass River is already affected by discharges from the City of Babbitt WWTP (average discharge of 0.33 cfs) and the Area 5 NW Pit overflow (average flow of 1.99 cfs with high sulfate concentrations). The existing ambient and predicted maximum water quality concentrations for the Proposed Action are provided in Table 4.1-62 for PM-12 (upstream of Project effects) and PM-13 (downstream of all Project effects).

At PM-12, all modeled parameters meet surface water quality standards during all flow conditions (i.e., low, average and high flows) for all modeled scenarios (i.e., Years 1, 5, 10, 15, 20, Closure, and Post-Closure) under the Proposed Action. At PM-13, downstream of the Tailings Basin, all constituents would meet surface water quality standards during all flow conditions for all modeled scenarios under the Proposed Action with the possible exception of aluminum.

Aluminum is predicted to exceed the surface water standard of 125 µg/L for low and average flow conditions in all mine years (i.e., Year 1 through Post-Closure) with a predicted high concentration of 346 µg/L. The exceedances are in part explained by the fact that average aluminum concentrations in the Embarrass River already exceed surface water standards under existing conditions, with an average concentration of 192 µg/L, and a peak concentration of 356 µg/L based on available monitoring data, and a modeled existing low flow concentration of 671 µg/L. Further, the surface water standard is for dissolved aluminum, whereas the modeled values predict total aluminum. It is unclear what fraction of the predicted total aluminum concentration would be dissolved and whether the predicted concentrations would actually exceed the surface water standard. Aluminum is an USEPA secondary MCL and the predicted maximum concentration (i.e., 346 µg/L at low flow during Mine Closure) would not pose any human health risk.

Table 4.1-62 Predicted Water Quality along the Embarrass River for the Proposed Action

Parameter	Units	PM-12				PM-13			
		Standard	**Modeled Existing Conditions**	**Predicted High Concentration**	**Flow Conditions**	**Standard**	**Modeled Existing Conditions**	**Predicted High Concentration**	**Flow Conditions**
General									
Chloride	mg/L	230	6.5	6.5	High Flow	230	10.2	13.1	Low Flow
Fluoride	mg/L	--	0.3	0.3	Low Flow	2.0	0.8	1.7	Low Flow
Hardness	mg/L	500	82.6	82.6	Low Flow	500	256	295	Low Flow
Sulfate	mg/L	--[1]	7.3	7.3	Low Flow	--	96	146	Low Flow
Metals									
Aluminum	µg/L	125	119	119	High Flow	125	**671**	**346**	Low Flow
Antimony	µg/L	31	1.1	1.1	Low Flow	31	0.9	5.0	Low Flow
Arsenic	µg/L	53	2.2	2.2	Low Flow	53	2.7	7.6	Low Flow
Cadmium	µg/L	1.0[2]	0.2	0.2	Low Flow	2.4[3]	0.2	0.4	Low Flow
Cobalt	µg/L	5.0	1.0	1.0	Low Flow	5.0	1.3	1.6	Low Flow
Copper	µg/L	7.9[2]	3.3	3.3	Low Flow	17.5[3]	4.1	6.7	Low Flow
Iron	µg/L	--	2,883	2,883	High Flow	--	2,884	2,874	High Flow
Lead	µg/L	2.5[2]	0.9	0.9	Low Flow	10.4[3]	1.1	1.7	Low Flow
Manganese	µg/L	--	299	299	High Flow	--	612	375	Low Flow
Nickel	µg/L	44.4[2]	5.4	5.4	Low Flow	115[3]	6.7	14.2	Low Flow
Selenium	µg/L	5.0	2.2	2.2	Low Flow	5.0	2.1	2.6	Low Flow
Thallium	µg/L	0.56	0.2	0.2	Average and High Flow	0.56	0.1	0.4	Low Flow
Zinc	µg/L	78.5[2]	16.0	16.0	High Flow	234[3]	12.6	34.5	Low Flow

Source: Barr 2008, External Memorandum: Changes to the Tailings Basin Flows in the Embarrass River Watershed – PolyMet RS-74; and Barr 2009, External Memorandum: TB-15 – Surface Water Quality Model Assumptions and Results for Tailings Basin – Proposed Action and Tailings Basin – Alternative

1 Sulfate standard of 10 mg/L applies if designated wild rice waters are present. .

2 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 80 mg/L.

3 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 250 mg/L.

Note: Values in bold indicate an exceedance in water quality standards.

It should be noted that a sulfate standard of 10 mg/L applies to designated “wild rice waters”. The only clearly designated “wild rice water” in the Project area is Hay Lake, which is located downstream of the Project on a tributary to the Embarrass River and would be unaffected by the Project. There is another wild rice stand in the Embarrass River watershed that was identified in the Wild Rice Legislative Report (MnDNR 2008), but its exact location and size are unknown and it is not clear whether it would be considered a designated wild rice water. Tribal cooperating agencies have a clear position on this issue. The wild rice standard applies where wild rice is growing. MPCA has requested PolyMet to provide additional information regarding the presence of wild rice along both the Embarrass and Partridge rivers (Clark, May 2009, Personal Communication) so that a site-specific determination can be made as to how the 10 mg/L standard may apply to the Project. Existing ambient sulfate concentrations in the Embarrass River already exceed 10 mg/L (e.g., average existing sulfate concentration at PM-13 is 36.1 mg/L), at least downstream of Spring Mine Creek, where the overflow from Pit 5NW has an average sulfate concentration of 1,046 mg/L. Therefore, if any portion of the Embarrass River is determined to be wild rice waters, water quality would already exceed the sulfate standard.

Field observations and research indicate that wild rice can grow in waters with sulfate concentrations significantly higher than 10 mg/L (MnDNR 2008, Natural Wild Rice). Dore (1969) states that sulfate retards the growth of wild rice at concentrations exceeding 50 mg/L. The Lac du Flambeau Band of Lake Superior Chippewa Indians in Wisconsin is currently proposing a 50 mg/L standard for sulfate to protect wild rice within their reservation pursuant to sections 303 and 518 of the Clean Water Act (Lac du Flambeau Tribe 2009). Other studies, however, have variously reported wild rice growing in water with sulfate concentrations of 118 to 282 mg/L in Minnesota (Baven and Berndt 2008; Moyle 1944); and between 105 and 575 mg/L in northern Saskatchewan (Peden 1982), but no information is provided regarding the health of the stands. It is unclear to tribal cooperating agencies why potential future water quality standards of a tribe located in Wisconsin have any bearing on the existing water quality standards in Minnesota. Extensive research in Minnesota has demonstrated that healthy and viable wild rice beds occur in waters with less than 10 mg/l of sulfate. While it is the prerogative of the PCA to seek a change in water quality standards anytime it chooses, it is the tribal cooperating agencies’ position that the standard, as currently in place, must be enforced.

The deterministic model predicts that the Project would increase sulfate concentrations at PM-13 to as high as 146 mg/L during low flow conditions in Year 10, but would return to approximately ambient concentrations during low flows Post-Closure (i.e., 96 mg/L, Table 4.1-62). A Culpability Analysis was conducted to determine the relative contribution of various contaminant sources on the deterministic water quality predictions. The analysis indicates that seepage from Cells 1E/2E would be the primary input of sulfate to the Embarrass River during low flows in all mine years (i.e., Year 1 through Post-Closure) (Wenigmann, Pint and Wong 2009). During average and high flow conditions, discharge from the LTVSMC Pit 5NW (nearby inactive taconite pit) and natural surface runoff from the watershed represent the primary sources of sulfate, respectively. It is the tribal cooperating agencies’ position that because the Embarrass River already exceeds water quality standards, it would be difficult to permit the addition of additional contamination from new or expanded sources.

In summary, water quality modeling indicates that the Project would likely meet surface water standards in the Embarrass River, but may worsen an existing exceedance of the surface water quality standard for sulfate if portions of the Embarrass River are determined to be wild rice waters.

Mercury in Surface Waters

Project construction and operation have the potential to promote the release of mercury to surface or groundwaters, either through mobilization of mercury stored in rock, soil, peat, and vegetation on site, or through enhanced methylation of mercury. Methylmercury is the biologically active form of mercury that accumulates in fish and is toxic to humans and wildlife. Current scientific understanding of the factors and mechanisms affecting mercury methylation and bioaccumulation is limited. This section discusses mercury from only a water quality perspective; the potential Project effects on the bioaccumulation of methylmercury in fish are discussed in Section 4.5.

Direct Release of Mercury to Waterbodies from the Mine Site

At the Mine Site, mercury could be released to waterbodies by exposing rock that contain mercury and the clearing of vegetation (primarily peat).

The NorthMet waste rock and ore contain trace amounts of mercury. Laboratory analysis of humidity cell leachates from waste rock samples found average total mercury concentrations between 5 and 7 ng/L, with concentrations unrelated to rock type or sulfur content (RS53/42, SRK 2007). Separate 36-day batch tests using local rainfall (12 ng/L total mercury) found that contact with Duluth Complex rock actually decreased total mercury concentrations to between 1.9 and 3.2 ng/L (RS53/42, SRK 2007). Therefore, mercury release from NorthMet waste rock appears to be below background levels and the data suggest that mercury in rainfall may actually be attenuated by contact with mine waste rock. For these reasons, the release of mercury from waste rock and ore at the Mine Site is not expected to be a constituent of concern in groundwater seepage.

Forest foliage is a major sink for airborne mercury. Mercury accumulated in the foliage of vegetation is then added to the surface litter layer and the soil upon litterfall (Ericksen et al. 2003). Porvari et al (2003) reported significant increases in total mercury and methylmercury concentrations and loads in streams following clear-cutting and soil treatment (e.g., harrowing, scarification, and mounding) in a boreal forest catchment. Organic matter contained in peat also constitutes a large reservoir of mercury, but this mercury is strongly bound to the organic material (Drexel et al. 2002). Disruption of peat deposits resulting in oxidation and decomposition of the peat would increase the mobility of the stored mercury.

Mining operations at the Project would result in forest clearing and soil and wetlands disruption over an area of approximately 3,260 acres. Desiccation-induced acidification of the peat can also be expected to mobilize mercury bound to the peat (Tipping et al. 2003). Periodic rewetting of exposed peat by precipitation and water level fluctuations may then promote methylation of mercury by sulfate-reducing bacteria within the oxidizing peat material and thereby mobilize mercury that has accumulated over many years.

PolyMet proposes to place the peat in either the Category 1/2 waste rock stockpile or the Overburden Storage and Laydown Area (Barr 2009, Technical Memorandum: NorthMet Waste Management and Modeling Assumptions for Overburden Material). Drainage from these stockpiles would be considered process water, which would be collected, possibly treated at the

WWTF, and either pumped to the Tailings Basin for reuse/ultimate disposal (Years 1-11) or to help in the filling of the mine pits (Years 12-65). The WWTF is not predicted to be very effective in removing mercury, with an average non-flow adjusted reduction during mine operations of approximately 16 percent (from about 8.5 ng/L to 7.1 ng/L) (RS29T Addendum, Barr 2007). Since the WWTF is not expected to be very effective and effluent concentrations are predicted to remain above the Great Lakes Initiative standard of 1.3 ng/L, mercury removal prior to release (i.e., Tailings Basin seepage and West Pit overflow) would be important.

Data suggesting that the LTVSMC and PolyMet tailings would be effective in removing mercury from WWTF effluent discharged to the Tailings Basin during Years 1-11 are discussed in the following subsection. Once mining of the East Pit is completed in Year 11, most WWTF effluent would no longer be pumped to the Tailings Basin, but instead would be pumped to help fill the East Pit, and would not receive the benefit of mercury removal in the tailings. PolyMet proposes to construct an approximately 160-acre wetland at the East Pit once filling is completed, which would receive and further treat effluent from the WWTF. There is very limited data regarding the effectiveness of constructed wetlands in removing mercury. The available water quality monitoring at the Dunka Mine constructed wetlands, which served as a model for PolyMet's proposal, showed total mercury removal rates varying from 0 to 75% (Appendix D, RS29T, Barr 2007). Based on the scientific literature, we would expect the constructed wetlands to be variably effective in removing total mercury, and could function, if not carefully managed, as a source for methylmercury production (Bavin and Berndt 2008).

PolyMet has not provided an estimate of predicted mercury concentrations in the West Pit overflow, which would be considered a discharge and subject to the Great Lakes Initiative standard for mercury (1.3 ng/L). Since neither the WWTF nor the East Pit constructed wetlands, which are the two primary treatment facilities for inflow to the West Pit, are expected to be consistently effective in mercury removal, we have some concerns regarding the potential mercury concentration in the West Pit. As discussed above, PolyMet did conduct batch tests to simulate the effects of mine area rock on pit water chemistry using local rainfall (12 ng/L total mercury). The test results indicated that contact with Duluth Complex rock actually decreased total mercury concentrations to between 1.9 and 3.2 ng/L (RS53/42, SRK 2007). Water quality sampling indicates that, on average, most area pits (11 out of 14 sampled) meet the 1.3 ng/L standard for mercury (range from 0.55 to 1.87 ng/L) (Borovsky 2009). Nevertheless, there is some uncertainty as to whether the West Pit overflow would meet the Great Lakes Initiative standard for mercury and we recommend additional analysis of this issue.

Tribal cooperating agencies agree that further analysis should be conducted. Tribal cooperating agencies take the position that the analysis should be incorporated in the DEIS so that environmental impacts can be predicted and reviewed by the public.

Direct Release of Mercury to Waterbodies from the Tailings Basin

The Plant Site would receive inputs of mercury from two sources – natural trace concentrations in the ore (average of 4.6 mg/kg or 10.7 lbs/yr) and process consumables (Section 3.1.7) (average of 8.6 mg/kg, or 5.5 lbs/yr), with minor contributions from Colby Lake process water (5.4 ng/L, or 0.027 lbs/yr) and Mine Site process water (3.7 ng/L or about 0.022 lbs/yr) (RS66, Addendum 01, Barr 2007). The Project, however, is not expected to release a significant amount of mercury to ground or surface waters for the reasons described below.

Based on bench studies, about 95 percent of the mercury in the ore entering the Process Plant is predicted to remain within, or be adsorbed to, either the flotation tailings or the hydrometallurgical residue, where it would remain isolated from further transport to the environment (RS29T, Appendix B, Barr 2007). Further, any leakage from the flotation tailings or hydrometallurgical residue in the Tailings Basin would have to pass through the existing LTVSMC taconite tailings. MnDNR (Berndt 2003) found that taconite tailings appear to be a sink for mercury in full-scale actual tailings basins in Northern Minnesota, as evidenced by lower mercury concentrations in waters seeping from tailings basins (specifically at U.S. Steel's Mintac Mine and Northshore Mining's Peter Mitchell Mine) than in either precipitation input or pond water in the tailings basin. This finding is supported by surface and groundwater monitoring around the LTVSMC Tailings Basin, which found mercury concentrations consistent with background levels (Table 4.1-29), generally averaging <2.0 ng/L. All samples were well below average concentrations in precipitation, so most mercury appears to be sequestered in the LTVSMC tailings.

The total mercury concentration in seepage from the NorthMet Tailings Basin is predicted to be approximately 0.9 ng/L, which would be less than the Great Lakes Initiative standard of 1.3 ng/L (RS29T, Appendix B, Barr 2007).

Enhanced Mercury Methylation

Virtually all dispersal of mercury in the environment (especially atmospheric dispersal) occurs in inorganic form (Fitzgerald and Clarkson 1991), but nearly all of the mercury accumulated in fish tissue (>95 percent) is organic methylmercury (Bloom 1992). Thus, methylation is a key step in bioaccumulation of mercury. Methylmercury is a product of inorganic mercury reduction by sulfate-reducing bacteria, a process that can be stimulated by increased sulfate concentrations (Gilmour et al. 1992; Krabbenhoft et al. 1998). Although the Project is expected to result in a negligible release of inorganic mercury to surface or groundwaters, it could promote mercury methylation by increasing sulfate loading and/or creating hydrologic conditions that enhance methylation. Each of these potential effects is discussed below.

Increased Sulfate Loadings

Research indicates that sulfate-reducing bacteria are the primary mercury methylators in aquatic systems, especially wetlands (Compeau and Bartha 1985). Biologically available sulfur is believed to be a limiting factor for the methylating bacteria (Jeremiason et al. 2006; Watras et al. 2006). Adding sulfate to aquatic systems can therefore stimulate sulfate-reducing bacteria activity, leading to increased mercury methylation (Gilmour et al. 1992; Harmon et al. 2004; Branfireun et al. 1999; Branfireun et al. 2001). Recent research in northern Minnesota suggests that increased sulfate loadings to a wetland can result in increased mercury methylation and export (Jeremiason et al. 2006), but other research suggests that this effect is not linear and diminishes at higher loads (Mitchell et al. 2008). While the amount of sulfate at a given location may exceed the reducing capacity of bacteria at that location, flowing water may transport excess sulfate to other locations where sulfate availability limits methylmercury production.

Many studies have shown that wetlands can be sinks for mercury and sources of methylmercury to surrounding watersheds (St. Louis et al. 1996). Heyes et al. (2000) reported a significant positive correlation between methylmercury and sulfate in a poor fen (R^2=0.765, p=0.005) and in a bog (R^2= 0.865, p=0.022). Galloway and Branfireun (2004) found that wetlands were an important site of sulfate reduction and methylmercury production. Balogh et al. (2004) and Balough et al. (2006) concluded that increases in methylmercury in several Minnesota rivers during high flow events was likely the result of methylmercury transport from surrounding wetlands to the main river channel. A recent study by MPCA found little, if any, correlation between total or methylmercury and sulfate concentrations in Northeast Minnesota streams (Bavin and Berndt 2008). Instead, the study found strong correlations between mercury and dissolved organic carbon (DOC) concentrations and total wetland area. Overall, these studies suggest that most mercury methylation, at least in the St. Louis River Basin, primarily occurs within wetlands rather than in stream channels and the methylmercury is flushed to rivers during storm events.

The Project would result in increased sulfate loadings via groundwater to both the Partridge and Embarrass rivers. At the Mine Site, the data suggests that the transport of sulfate from the waste rock/lean ore stockpiles to the Partridge River would involve very little interaction with wetlands, which are primarily perched bogs. As previously indicated, this assumption is based on a single email (Adams 2009). Tribal cooperating agencies have reviewed this email and found that it does not use methods suitable for prediction of impacts. Further detail on the position of the tribal cooperating agencies is available in section 4.2. Further, the predicted maximum sulfate concentration in the Partridge River would remain relatively low (31.7 mg/L during low flows) and there are relatively few riparian wetlands along the Lower Partridge River or downstream St. Louis River. Therefore, under the Proposed Action, the risk of increased sulfate loadings promoting methylation of mercury in wetlands is expected to be low. Tribal cooperating agencies have found extensive rice beds in the Lower Partridge River and take the position that methylation of mercury may be significant in the Partridge River watershed. The groundwater seepage rate from the Tailings Basin would exceed the aquifer flux capacity, so much of the seepage is expected to upwell into the extensive wetland complex north of the Tailings Basin. The sulfate transported by this seepage would have a long contact period with wetlands before actually reaching the Embarrass River. All of these factors may create nearly ideal conditions for mercury methylation. There are four lakes downstream on the Embarrass River that are on the 303(d) list for mercury in fish tissue impairment. These lakes stratify, which can further promote mercury methylation. Therefore, increasing the sulfate load from the Tailings Basin could increase mercury methylation both in the wetlands north of the Tailings Basin and at the downstream lakes.

The MPCA recognizes the important role of sulfate in methylmercury production, as well as the uncertainties regarding site-specific relationships between sulfate discharges and waterbody impairment. The MPCA has set forth a strategy (MPCA 2006, Strategy to Address Indirect Effects of Elevated Sulfate on Methylmercury Production and Phosphorus Availability) for addressing effects of sulfate on methylmercury production that encompasses technical, policy, and permitting issues. The strategy acknowledges that the technical basis does not exist to establish specific sulfate discharge limits. The strategy, however, sets forth steps MPCA can take to improve the technical basis for controlling sulfate discharges and establishes guidance for considering potential sulfate impacts during environmental review and NPDES permitting. The strategy focuses on avoiding "discharges," which could include groundwater seepage, to "high risk" situations. These high risk areas include wetlands, low-sulfate water (<40 mg/L) where sulfate may be a limiting factor in the activity of sulfate-reducing bacteria, and waters that flow to a downstream lake that may stratify, all of which apply to the area downstream of the Tailings Basin. Therefore, seepage from the Tailings Basin would introduce elevated sulfate concentrations to a high risk situation for mercury methylation.

Hydrologic Changes and Water Level Fluctuations

Methylation of environmental mercury by sulfate-reducing bacteria is also stimulated by drying and rewetting associated with hydrologic changes and water level fluctuations (Gilmour et al. 2004, Selch et al. 2007). Drying (and subsequent increase in exposure to oxygen) of substrate containing reduced sulfur species (sulfides and organic sulfur) oxidizes those species into sulfate, which is remobilized and available to sulfate-reducing bacteria upon rewetting of the substrate. This mechanism stimulates production of methylmercury in sediments exposed to wetting and drying cycles (Gilmour et al. 2004) and probably accounts for the elevated methylmercury concentrations observed in discharge from wetlands during high flow events (Balogh et al. 2006). Thus, hydrologic changes and water level fluctuations can stimulate mercury methylation and enhance bioaccumulation.

The Project would generally reduce flows in the Partridge River, but would not be expected to result in increases in flow fluctuations that can promote mercury methylation. It is the tribal cooperating agencies' position that the data used to support this conclusion is inadequate. Similarly, water level fluctuations in Colby Lake are expected to be less with the Project than under natural conditions (Tables 4.1-55 and 4.1-56) and should not promote mercury methylation. Conversely, water level fluctuations would be expected to increase in Whitewater Reservoir as water is pumped to maintain minimum water levels in Colby Lake. Whitewater Reservoir would only receive inflow from the Partridge River under high flow conditions when sulfate levels are expected to be the lowest. Therefore, increased water level fluctuations in Whitewater Reservoir would be expected to result in limited increases in mercury methylation.

Nondegradation Standards

Minnesota Rules, parts 7050.0185 and 7052.0300, establish nondegradation standards and procedures for surface waters statewide and for waters in the Lake Superior Basin, respectively. The statewide nondegradation procedures are in place to protect all waters from significant degradation from point and nonpoint sources. The Lake Superior Basin nondegradation procedures apply to new or expanded point source discharges of bioaccumulative substances of immediate concern (BSIC) (*Minnesota Rules*, part 7052.0350). The only BSIC with applicability to the Project is mercury. The NorthMet Project would be a new facility, but PolyMet has proposed a water balance that avoids the need for any point source discharges during mine operations. During Post-Closure (approximately Year 65), the West Pit would eventually fill and overflow. Therefore, the Project's only point source discharge that would be subject to nondegradation review would be the West Pit overflow.

As discussed previously, since neither the WWTF nor the East Pit constructed wetlands are expected to be consistently effective in mercury removal, there is some uncertainty whether mercury concentrations in the West Pit, or the ultimate discharge to the Partridge River when the West Pit begins to overflow around Year 65, would meet Great Lakes Initiative water quality standards. Mercury monitoring is recommended to determine if elevated mercury concentrations are found in the West Pit and to minimize the release of mercury to the West Pit (Section 4.1.3.5). Tribal cooperating agencies disagree with this approach. It is the tribal cooperating agencies' position that the determination of the final water quality of the west pit should be included in the DEIS so that potential water quality impacts to Lake Superior can be characterized.

Effects on Surface Water Rights and Uses

A Water Appropriate Permit from MnDNR is required for all users withdrawing more than 10,000 gallons of water per day or one million gallons per year. PolyMet has requested, and Minnesota Power has agreed (Minnesota Power 2007), to transfer LTVSMC's share of the Water Appropriation Permit to PolyMet so it can obtain process water from Colby Lake. This Permit has a stipulation that withdrawals from Colby Lake can not occur when water levels are below elevation 1,439.0 feet msl unless an equal amount of water is pumped into Colby Lake from Whitewater Reservoir. As discussed above, the XP-SWMM modeling results indicate that PolyMet (at least up to withdrawals of 8,000 gpm) should be able to satisfy this requirement while meeting its water demands. Satisfying this requirement may result in more frequent and larger water level fluctuations in Whitewater Reservoir than have occurred since LTVSMC stopped their withdrawals in 2001.

In order to safeguard water availability for natural environments and downstream higher priority users, Minnesota law requires the MnDNR to limit consumptive appropriations of surface water under certain low flow conditions. Should conditions warrant, MnDNR Waters may suspend surface water appropriation permits as determined by its Surface Water Appropriation Permit Issuance and Suspension Procedures.

Summary of the Proposed Action

Table 4.1-63 provides a summary of the primary water resource effects of the Proposed Action. At the Mine Site, the permanent surface storage of highly reactive waste rock is predicted to result in long term exceedances of groundwater evaluation criteria for several parameters. The seepage rate from the Tailings Basin during mine operations would greatly exceed the groundwater flux capacity of the aquifer, which would result in significant upwelling of groundwater with high sulfate concentrations. This upwelling would inundate many of the wetlands found north of the Tailings Basin, introduce relatively high sulfate concentrations to the wetlands and downstream lakes on the Embarrass River that represent high risk situations for mercury methylation, and could represent a violation of the sulfate standard for "wild rice waters."

Table 4.1-63 Water Resources Impact Summary of the Proposed Action

Key Potential Issues	Project Effects	Reference Page Number
Groundwater levels at the Mine Site	Drawdown expected during mine operations and filling of West Pit (~65 years), but minimal impact to surrounding wetlands expected. Tribal cooperating agencies disagree with this conclusion. Their position is that the above conclusion is based on faulty assumptions and weak data.	4.1-48
Groundwater quality at the Mine Site	Manganese, nickel, and possibly antimony concentrations would exceed either USEPA primary MCLs or MDH Health Risk Limits in groundwater, potentially for long term. Sulfate concentrations would exceed USEPA secondary MCLs.	4.1-53
Flows in the Upper Partridge River	Minimal reduction in annual 7-day low flow (~0.1 cfs). No significant effect on river morphology or 100-year floodplain. Tribal cooperating agencies disagree with these conclusions because there is insufficient data.	4.1-77
Water quality in the Upper Partridge River	All parameters would meet surface water quality standards under all flow conditions for all mine years. West Pit overflow in Closure is predicted to initially exceed standards, but water quality is expected to improve over time. Tribal cooperating agencies note that the west pit is predicted to violate surface water standards for all years that predictions were made. .	4.1-87
Water levels in Colby Lake	Negligible increase in average water level drawdown and improvement in maximum annual fluctuation and % days below critical lake elevation.	4.1-83
Water quality in Colby Lake	Predicted to meet all water quality standards for all flow conditions for all mine years.	4.1-92
Flows in the Lower Partridge River	Reduce average flows by as much 10.5 cfs (9%) and increase the frequency of low flows. Tribal cooperating agencies disagree. There is not enough data to support this conclusion.	4.1-84
Water Quality in Lower Partridge River	All parameters should meet surface water quality standards under all flow conditions for all mine years. Tribal cooperating agencies disagree. The wild rice standard for sulfate and the Lake Superior standard for mercury would be exceeded.	4.1-93
Groundwater levels downgradient of the Tailings Basin	Groundwater seepage would exceed aquifer flux capacity resulting in significant seepage upwelling and wetland impacts.	4.1-51
Groundwater quality downgradient of the Tailings Basin	Seepage from the Tailings Basin would generally meet groundwater evaluation criteria with the possible exception of aluminum and manganese. These two parameters are USEPA secondary MCL standards for managing aesthetics considerations and not to protect human health, and both of which are naturally found in elevated concentrations in the Project area. Tribal cooperating agencies disagree. Existing contamination has not been considered in the analysis.	4.1-67
Flows in the Embarrass River	Net 6% increase in average flow during operations and net decrease of 1% during Closure would have negligible effect on Embarrass River.	4.1-85
Water quality in the Embarrass River	Generally all parameters would meet surface water quality standards during all flow conditions for all mine years. Elevated sulfate concentrations (146 mg/L at PM-13), however, could exceed “wild rice waters” standard if applicable. Tribal cooperating agencies take the position that the wild rice sulfate standard is applicable and would be exceeded.	4.1-94
Mercury in Water	Relatively high sulfate concentrations in seepage from Tailings Basin would be released to wetlands north of the Tailings Basin and lakes downstream on Embarrass River that represent “high risk situations” for mercury methylation. There is some uncertainty as to whether the West Pit overflow would meet the Lake Superior mercury standard.	4.1-97

4.1.3.2 No Action Alternative

Effects on Groundwater

Under the No Action Alternative at the Mine Site, there would not be any mining, therefore, groundwater levels and quality would remain similar to existing conditions.

Under the No Action Alternative at the Tailings Basin, existing groundwater seepage from the LTVSMC Tailings Basin (approximately 1,795 gpm) would continue to decline as the basin dewaters until it reaches a steady state condition (approximately 1,100 gpm). This groundwater seepage rate would continue to exceed the flux capacity of the aquifer (estimated at 155 gpm near the Tailings Basin) and result in upwelling of groundwater near the toe of the Tailings Basin.

Natural dissolution, mobilization, and transport of solutes from the LTVSMC Tailings Basin would still occur at current rates. Elevated (relative to background) concentrations of several parameters including aluminum, fluoride, iron, manganese, molybdenum, sulfate, and TDS would be expected in groundwater downgradient of the Tailings Basin for a long time (e.g., probably centuries). This seepage does degrade groundwater quality at the toe of the Tailings Basin as documented by several monitoring wells, but it is unclear to what extent these elevated concentrations impact groundwater quality downgradient, as there are limited groundwater quality monitoring data available. The little monitoring data that are available do not suggest regular exceedances of groundwater evaluation criteria at downstream evaluation points (e.g., property boundary). It is the tribal cooperating agencies' position that data collected in 2009 show that private wells north of the basin have been impacted by historic tailings basin effluent. Although two additional groundwater samples north of the basins collected in 2009 indicate that exceedances exist at the property boundary, the full extent of the contaminant plume has not been defined.

The Closure Plan for the LTVSMC Tailings Basin calls for regrading (to avoid ponding of stormwater in low areas), vegetative restoration, and water quality monitoring as required by NPDES/SDS Permit #0054809. The Closure Plan does not propose any remediation of groundwater seepage from the Tailings Basin. Tribal cooperating agencies note that there is no up to date closure plan for the proposed project. It is the tribal cooperating agencies' position that a closure plan is needed to evaluate long term environmental impacts and to inform calculations of financial assurance that would be needed for the project. For more information refer to section 3.1.7.

Over 60 AOCs have been identified at the former LTVSMC property (see Tables 4.1-9 and 10). Several of these have been closed through the VIC program, and many others are at various stages of completion within this program. With few exceptions, the sites that have been investigation have had limited or no contamination. There are a few sites with more significant contamination, including two sites contaminated with petroleum products. The contaminated soils have been landfarmed at a permitted land treatment facility in Cell 2W. We anticipate that the remaining AOCs will be investigated and remediated as required.

It is difficult to estimate what effect any remediation activities may have on groundwater quality at the Tailings Basin. Over time, we would expect groundwater quality to approach background conditions, but the relatively high concentrations of aluminum, iron, and manganese currently found downgradient of the Tailings Basin may reflect natural conditions in this area. It is the tribal cooperating agencies' position that the available data does not support this claim. In addition, a basic assumption (i.e. plug flow [TB-14, July 2, 2009, page 9]) of the contaminant transport modeling at the basin (RS74) assumes that all constituents in the groundwater are the result of past and current seepage from the basins.

Effects on Surface Waters

Under the No-Action Alternative, flows in the Partridge and Embarrass rivers, water levels in Colby Lake and Whitewater Reservoir, and surface water quality in the Partridge River would not be affected and should generally remain similar to existing conditions, within the range of natural variability.

Under the No-Action Alternative, groundwater seepage from the LTVSMC Tailings Basin would continue to affect water quality in the Embarrass River. Elevated concentrations, especially for sulfate, will continue to occur along the Embarrass River. Under existing low flow conditions, approximately 66 percent of the sulfate load in the Embarrass River at location PM-13 is attributable to the LTVSMC Tailings Basin, while the Area 5 N pit accounts for approximately 30 percent. Under average flow conditions, the Area 5 N Pit overflow accounts for about 69 percent of the sulfate load, while under high flows surface runoff is the major contributor of sulfate (46 percent) with the Area 5 N pit accounting for 34 percent.

There is no surface water standard for sulfate in Minnesota unless a waterbody is determined to be a "wild rice waters." MPCA has requested PolyMet to provide additional information regarding wild rice so it can determine how the wild rice standard applies to the Embarrass River. The Area 5 N Pit and the LTVSMC Tailings Basin clearly represent the major anthropogenic sources of sulfate to the Embarrass River. Corrective actions at these sites would reduce sulfate loadings and enable water quality at location PM-13 to approach that found at location PM-12. The tribal cooperating agency position on this issue is clear. The wild rice standard applies to all waterbodies where wild rice is found to be growing. It is the expectation of the tribal cooperating agencies that the PCA will enforce the standard accordingly.

Mercury in Water

The No Action Alternative would have no effect on mercury production at the Mine Site. At the LTVSMC Tailings Basin, the seepage rate would continue to exceed the aquifer flux capacity, resulting in the upwelling of groundwater. This seepage has relatively high sulfate concentrations (152 mg/L) and would continue to discharge into the wetlands north of the Tailings Basin and would eventually reach the chain of lakes downstream on the Embarrass River. Both these wetlands and the downstream lakes are considered high risk situations for mercury methylation. Therefore, we would expect the sulfate in the seepage from the LTVSMC Tailings Basin to continue to promote the methylation of mercury in the Embarrass River watershed for an undetermined duration. There is, however, little mercury monitoring data is available to confirm this assumption. MPCA has approved a proposed mercury monitoring plan submitted by PolyMet that should provide better data to help understand mercury dynamics in the wetlands and lakes downstream from the Tailings Basin.

Summary of the No Action Alternative

Table 4.1-64 provides a summary of the primary water resource effects of the No Action Alternative. Under this alternative, the Project would not occur and no environmental impacts would result. As discussed above, groundwater seepage from the LTVSMC Tailings Basin would still exceed the aquifer flux capacity resulting in the continued upwelling of groundwater to wetlands north of the Tailings Basin (refer to Section 4.2 for discussion of wetland impacts associated with the No Action Alternative). This groundwater has relatively high sulfate concentrations, which would be released to wetlands and eventually flow to downstream lakes, both of which are considered high risk situations for promoting mercury methylation.

Table 4.1-64 Water Resource Impact Summary of the No Action Alternative

Key Potential Issues	Project Effects	Reference Page Number
Groundwater levels at the Mine Site	No effect	
Groundwater quality at the Mine Site	No effect	
Flows in the Upper Partridge River	No effect	
Water quality in the Upper Partridge River	No effect	
Water levels in Colby Lake	No effect	
Water quality in Colby Lake	No effect	
Flows in the Lower Partridge River	No effect	
Water quality in the Lower Partridge River	No effect	
Groundwater levels downgradient of the Tailings Basin	Groundwater seepage would exceed aquifer flux capacity resulting in continued seepage upwelling and wetland impacts. The tribal cooperators take the position that the basins will drain until seepage equals precipitation at which point the hydrology will have returned to approximately pre-basin conditions. As seepage declines, as has been already seen over the past 8 years, surrounding wetlands will begin to recover from the previous hydrologic impacts.	4.1-104
Groundwater quality downgradient of the Tailings Basin	Anticipate slight improvement in groundwater quality as Areas of Concern are investigated and remediated as appropriate. The tribal cooperators take the position that the assumption of plug flow in the contaminant modeling suggests that as precipitation becomes the dominant source of new water to the aquifer, groundwater quality may improve dramatically.	4.1-104
Flows in the Embarrass River	Slight reduction in base flow as a result of gradually reduced seepage rate from Tailings Basin.	4.1-105
Water quality in the Embarrass River	Potential slight improvement in water quality as Areas of Concern are investigated and remediated as appropriate.	4.1-105

Mercury in Water	Relatively high sulfate concentrations in seepage from Tailings Basin would continue to be released to wetlands north of the Tailings Basin and lakes downstream on Embarrass River, both of which represent "high risk situations" for mercury methylation.	4.1-105

4.1.3.3 Mine Site Alternative

Under the Mine Site Alternative, all Category 2, 3, and 4 waste rock would be used to fill the East Pit (rather than Category 1 and 2 waste rock) in order to minimize the duration that the more reactive sulfide-bearing rock would be allowed to oxidize in surface stockpiles and virtually eliminating long-term sulfide oxidation and associated solute release. Limestone would be added to temporary stockpiles (Category 2 and 3 waste rock, Category 3 lean ore, and Category 4 waste rock) to neutralize acid formation until the rock can be backfilled into the East Pit beginning in Year 12. A key assumption is that the addition of limestone would be effective in maintaining a relatively high pH of 8 in order to limit metal solubility. This can be done, but we recommend close monitoring of the pH and water quality of collected leachate from these stockpiles to insure the effectiveness of the lime treatment (Section 4.1.3.5). Tribal cooperating agencies disagree with this approach. The tribal cooperators take the position that the effectiveness of lime treatment is very important in the final water quality of mine effluent. Therefore, this analysis should be conducted prior to the constriction of the facility and the results included in the DEIS.

The only permanent stockpiles would be for Category 1 waste rock and overburden. The temporary higher sulfide waste rock stockpiles would have similar bottom liner systems as those in the Proposed Action to minimize the volume of unrecoverable leakage to groundwater (Table 3.1-1). This higher sulfide waste rock would only be stored in surface stockpiles until the mining of the East Pit is completed, when the waste rock would be used as backfill. Several of these stockpiles would then be converted to store Category 1 waste rock from the West Pit; care would be taken to insure that the composite liner system would not be damaged during the conversion and remain functional, but only evapotranspiration caps would be installed. The tribal cooperators take the position that the effectiveness of the evapotranspiration caps has not been demonstrated. Tribal cooperating agencies have requested that this analysis be done (GLIFWC Comment letter of June 30, 2008 and GLIFWC comment letter of February 6, 2009).

As with the Proposed Action, most of the leachate (i.e., recoverable seepage) would be collected, drained to stockpile sumps, and then pumped to the WWTF. PolyMet proposes to mitigate the increased solute load expected in the East Pit from the disposal of the higher sulfide waste rock by pumping East Pit water through the WWTF from Year 21 to 50. Most of the treated water would be returned to the East Pit, but a portion would be discharged through a wetland treatment system into the West Pit. As previously discussed, the tribal cooperating agencies' position is that the effectiveness of the wetland treatment system is in doubt. The remainder of the Proposed Action would remain unchanged (RS74A, Barr 2008). The overall water balance would remain essentially the same as for the Proposed Action, except for pumping the East Pit water through the WWTF.

The Mine Site Alternative would not affect the size or depth of the mine pits, so its affects on groundwater levels at the Mine Site and in the area surrounding the Mine Site are expected to be the approximately the same as for the Proposed Action. It is the tribal cooperating agencies' position that the effects on groundwater levels at the mine site are unknown for both the proposed project and the mine site alternative because of insufficient analysis. The Mine Site Alternative would not affect the water budget for the Project, so the affects on flow in the Partridge and Embarrass rivers and on water levels at Colby Lake and Whitewater Reservoir are expected to be approximately the same as for the Proposed Action. Under the Mine Site Alternative, there would be no substantive change in the amount of ore processed, the amount of tailings generated, or the quality of the tailings disposed in the Tailings Basin. Therefore, the Mine Site Alternative is expected to have similar effects on groundwater levels and quality at the Tailings Basin as the Proposed Action. This alternative only involves activities within the Partridge River watershed, so it would have no direct or indirect effects on surface water quality in the Embarrass River.

The Mine Site Alternative, however, could potentially affect groundwater quality at the Mine Site and surface water quality within the Partridge River watershed, so these two potential effects are evaluated below.

Effects on Groundwater Quality at the Mine Site

The two principal geochemical issues associated with subaqueous disposal of Category 2, 3, and 4 waste rock would be the dissolution of oxidation products formed prior to inundation with water in the East Pit (i.e., during temporary surface stockpiling) and continued reaction of the rock once submerged.

Evaluation Methodology

Modeling to estimate solute loadings from the source areas (e.g., rock stockpiles and mine pit walls) and solute transport to evaluation points used the same methodology as used for the Proposed Action. Based on the proposed liner and cap systems, three liner leakage scenarios (i.e., low, average, and high) were evaluated as part of the deterministic modeling.

As discussed previously, it is believed that the high liner leakage scenario would result in an unreasonably high leakage rate because it assumes a combined worse case scenario (Section 4.1.3.1). For the Proposed Action, we had reservations about using the average liner leakage rate, as it may not fully account for the essentially permanent use of the liner (e.g., liner degradation over time, differential settlement, accidental tears during waste rock placement). We do not have those same reservations about using the average liner leakage rate for the Mine Site Alternative because the reactive rock would only be temporarily (i.e., on average 10 years) stockpiled on these liners so concerns about liner degradation over time and differential settlement are not really applicable. We do still have concerns regarding the adequacy of the proposed overliner cover thickness to protect the liner from accidental tears or rips during waste rock placement or removal given both the size of the waste rock and the equipment necessary to place it or remove it properly. This issue is further addressed in Section 4.1.3.5. Therefore, we evaluate the modeling results using the average liner leakage rate.

A steady state flow model was first used to assess the transport of all solutes under high, medium, and low leakage rates through waste rock liners. The solute sources and flow paths were modified slightly from the Proposed Action to reflect the changes in the stockpiles. For those parameters that showed the potential to exceed groundwater evaluation criteria, more detailed transient flow modeling was conducted using the same methodology and models used for the Proposed Action. As also discussed previously, based on site-specific sorption testing, we are comfortable with accepting values no higher than the low range of the USEPA Sorption Screening Level Values for arsenic, copper, and nickel, but not for antimony even though the testing did show some sorption occurring (Table 4.1-39).

The modeling conservatively assumed that all oxidized solutes would be leached during flooding of the East Pit. In fact, solubility constraints may limit leaching and some portion of the solute load would not be leached. Conversely, the modeling assumed all backfill rock would not oxidize further once submerged.

Model Results

Using the solute loading estimates from the stockpiles and mine pits, the initial steady state modeling was used to identify solutes that could exceed groundwater evaluation criteria. Table 4.1-65 summarizes the results of this initial modeling. It should be noted that aluminum, beryllium, iron (for Flow Paths #1 and 2), manganese (for Flow Paths #1 and 2), and thallium exceeded the groundwater evaluation criteria in the model; however, this was due to high background concentrations that were not attributable to the Project and these solutes were not carried forward for detailed transient flow modeling.

Table 4.1-65 Summary of Potential Exceedances of Groundwater Evaluation Criteria at the Mine Site Using Steady State Model

Flow Path	Potential Groundwater Evaluation Criteria Exceedances	Additional Constituents for Transient Model
#1 – Category 1 & Overburden Stockpile	**Arsenic, antimony, nickel, sulfate** *aluminum, iron, manganese*	--
#2 - West Pit	**Arsenic, antimony,** *aluminum, iron, manganese, beryllium, thallium*	Sulfate
#3 – Lean Ore Surge Pile	**Iron, manganese,** *aluminium, beryllium, thallium*	Sulfate
#4 – East Pit and Category 4 Waste Rock Stockpile	**Iron,** *aluminum, beryllium, thallium*	Sulfate
#5 - Category 3 Lean Ore Stockpile	*Aluminum, beryllium, thallium,*	--
#6 - Category 2/3 Waste Rock Stockpile	**Antimony, arsenic, iron, manganese** aluminum, beryllium	Sulfate

Source: Modified from Tables 8-2 to 8-20 in RS74A, Barr 2008.
Notes: Constituents in **bold** and *italics* exceeded groundwater evaluation criteria. Constituents in *italics* were not carried forward to transient modeling.

Those solutes that were identified as potentially exceeding groundwater evaluation criteria using the initial steady state modeling, as well as sulfate, were then subjected to more detailed analysis using transient flow modeling. Table 4.1-66 provides a summary of the results showing that only antimony (from the Category 1/Overburden stockpile, West Pit, and Category 2/3 stockpile) would exceed USEPA primary MCLs or MDH Health Risk Limits. Iron and manganese (both only from the Category 2/3 Stockpile) would exceed USEPA secondary MCLs at the evaluation points for varying durations.

The predicted antimony concentrations do not account for any sorption even though the site-specific sorption testing at the Mine Site did find relatively low levels of sorption occurring (K_d values of 1.6 and 22, average of 12). Assuming a relative modest sorption value (e.g., $K_d = 4$, which is less than the average of the site-specific testing), antimony would meet groundwater evaluation criteria at all flow paths. Further, as mentioned previously, the predicted antimony concentrations may be overestimated because the concentration cap from the contaminated humidity cell results was used. Therefore, there is some uncertainty as to whether antimony would actually exceed the groundwater evaluation criteria.

Iron and manganese are both only USEPA secondary MCL standards, which are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health or aquatic life.

Table 4.1-66 Summary of Maximum Concentrations Predicted Using Deterministic Transient Flow Modeling for Mine Site Alternative

Parameters	Unit	Evaluation Point	Groundwater Evaluation Criteria	Liner Leakage Model(s) with Criteria Exceeded	Predicted Model Maximum Concentration	Period Exceeding Groundwater Evaluation Criteria (Mine Years)	Predicted Maximum Concentration (no sorption)
Flow Path #1 - Category 1 & Overburden Stockpile							
Antimony	µg/L	Property Boundary	6	Low, Average	**16**	166-2000	**16**
Arsenic	µg/L	Property Boundary	10	None	2.8	NA	**46**
Nickel	µg/L	Property Boundary	100	None	5.7	NA	55
Sulfate	mg/L	Property Boundary	250	None	211	NA	211
Flow Path #2 - West Pit							
Antimony	µg/L	Property Boundary	6	Low, Average	**7.2**	~300-2000	**7.2**
Arsenic	µg/L	Property Boundary	10	None	2.8	NA	**41**
Sulfate	mg/L	Property Boundary	250	None	120	NA	120
Flow Path #3 - Lean Ore Surge Pile							
Iron	µg/L	Partridge River	300	None	220	NA	220
Manganese	µg/L	Partridge River	50/300	None	40	NA	40
Sulfate	mg/L	Partridge River	250	None	14	NA	14
Flow Path #4 – East Pit & Category 4 Stockpile							
Iron	µg/L	Partridge River	300	None	270	NA	270
Sulfate	mg/L	Partridge River	250	None	46	NA	46
Flow Path #5 - Category 2 and 3 Stockpile							
Antimony	µg/L	Partridge River	6	Low, Average	**8.6**	Unknown	**8.6**
Arsenic	µg/L	Partridge River	10	None	2.1	NA	3.4
Iron	µg/L	Partridge River	300	Low, Average	**490**	Unknown	**490**
Manganese	µg/L	Partridge River	50/300	Low	**57**	Unknown	**57**
Sulfate	mg/L	Partridge River	250	None	213	NA	213
Flow Path #6 - Category 3 Lean Ore Stockpile							
Sulfate	mg/L	Partridge River	250	None	14	NA	14

Source: Tables 8-24, 8-25, and 8-26, RS74A, Barr 2008.
Notes: **Bold** (e.g., **0.014**) indicates exceeds groundwater evaluation criteria.

The deterministic modeling indicates that the Mine Site Alternative has less potential to impact groundwater quality than the Proposed Action in terms of the number of flow paths and parameters that are predicted to exceed groundwater evaluation criteria, as well as the magnitude and duration of those exceedances (Table 4.1-67). Under the Mine Site Alternative, the only exceedances of groundwater evaluation criteria would be for secondary MCL standards (i.e., iron and manganese) that can be readily removed in water treatment, and possibly antimony.

Table 4-1-67 Comparison of Exceedances of Groundwater Evaluation Criteria for the Proposed Action and Mine Site Alternative at the Mine Site

Parameters	Proposed Action	Mine Site Alternative
Antimony	Category 1/2 waste rock/overburden stockpile West Pit East Pit & Category 4 waste rock stockpile Category 3 waste rock stockpile	Category 1/overburden stockpile West Pit Category 2/3 waste rock stockpile
Arsenic	No exceedances	No exceedances
Copper	No exceedances	No exceedances
Iron	Lean Ore surge pile East Pit/Category 4 waste rock stockpile Category 3 waste rock stockpile Category 3 lean ore stockpile	Category 2/3 waste rock stockpile
Manganese	Lean Ore surge pile East Pit/Category 4 waste rock stockpile Category 3 waste rock stockpile Category 3 lean ore stockpile	Category 2/3 waste rock stockpile
Nickel	Category 3 waste rock stockpile West Pit Category 3 lean ore stockpile	No exceedances
Sulfate	Category 1/2 waste rock/overburden stockpile West Pit Category 3 waste rock stockpile	No exceedances

Source: Modified from Tables 6-30, 6-31, 6-32, 8-24, 8-25, and 8-26, RS74A, Barr 2008.

Effects on Surface Water Quality within the Partridge River Watershed

The effects of the Mine Site Alternative on groundwater quality discussed above would ultimately affect surface water quality as groundwater contributes to base flow in the Partridge River, as well as to the eventual overflow of the West Pit around Year 65.

Evaluation Methodology

Effects of the Mine Site Alternative on water quality in the Partridge River were evaluated using mass balance models linked to the hydrology prediction from the XP-SWMM model as was done for the Proposed Action. Deterministic water quality predictions for 26 parameters during Years 1, 5, 10, 12, 15, 20, Closure, and Post-Closure for the Mine Site Alternative were conducted for low, average and high flows at seven locations along the Partridge River (Figure 4.1-11) and at Colby Lake (RS74A, Barr 2008).

Partridge River and Colby Lake Water Quality Predictions

The maximum deterministic water quality prediction for some key water quality parameters are summarized below in Table 4.1-68. All constituents meet minimum in-stream Minnesota water quality standards at all locations in the Partridge River during low, average and high flow conditions for all modeled scenarios under the Mine Site Alternative, except for arsenic, iron, and thallium at Colby Lake (RS74A, Barr 2008).

Table 4.1-68 Predicted Water Quality along the Partridge River for the Mine Site Alternative

General Parameter	Unit	Partridge River			Colby Lake	
		Standard	**Maximum Concentration**	**Location**	**Standard**	**Maximum Concentration**
Fluoride	mg/L	--	0.3	USGS	2.0	0.1
Sulfate	mg/L	NA	33.1	SW-004a	250	15.8
Metals - Total						
Aluminum	µg/L	125	114	USGS	125	76.3
Antimony	µg/L	31.0	6.3	SW-004A	5.5	3.7
Arsenic	µg/L	53.0	7.6	SW-004A	2.0	**4.9**
Cadmium	µg/L	0.9[1]	0.1	Multiple	2.5[2]	0.1
Cobalt	µg/L	5.0	1.6	USGS gage	2.8	0.8
Copper	µg/L	7.6[1]	3.4	SW-004a	9.3[2]	2.1
Iron	µg/L	--	1,604	USGS gage	300	**1,713**
Lead	µg/L	2.3[1]	1.2	Multiple	3.2[2]	0.7
Nickel	µg/L	42.4[1]	15.2	USGS gage	52.0[2]	4.6
Thallium	µg/L	0.56	0.4	Multiple	0.28	**0.4**
Zinc	µg/L	86.2[1]	24.9	USGS	120[2]	18.0

Source: Tables 7-1 to 7-24, RS74A, Barr 2008
Assumed hardness concentration of approximately 80 mg/L for Partridge River and 100 mg/L for Colby Lake.

1 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of 80 mg/L.

2 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 100 mg/L.

As discussed for the Proposed Action, the exceedances for iron and thallium are related to the high ambient concentration of iron found during surface water quality monitoring and the laboratory detection limit for thallium. The exceedance for arsenic appears to be an artifact of model input assumptions as discussed for the Proposed Action. High estimates of arsenic concentrations in existing Colby Lake water quality and in West Pit overflow were used. Adjusting existing Colby Lake arsenic concentrations for the results of the recent sampling and the predicted West Pit overflow water quality from the results of the Uncertainty Analysis (90% cumulative probability concentration) would result in a predicted high concentration less than the 2.0 µg/L arsenic standard. Therefore, the Mine Site Alternative is not expected to result in any exceedances of surface water quality standards in the Upper Partridge River or Colby Lake. The Mine Site Alternative would have no effect on water quality downstream of Colby Lake.

Both the Proposed Action and the Mine Site Alternative would comply with all surface water quality standards along the Partridge River. As Table 4.1-69 indicates, the Mine Site Alternative would result in improved water quality for most parameters, although lead, zinc, and sulfate concentrations are predicted to be marginally lower under the Proposed Action. Tribal cooperating agencies note that wild rice grows on the lower Partridge River. Therefore, it is the tribal cooperating agencies' position that the wild rice sulfate standard applies and the mine site alternative effluent would exceed that standard (Table 4.1-69).

Table 4.1-69 Comparison of Highest Predicted Concentrations for the Partridge River under the Proposed Action and Mine Site Alternative

General Parameter	Unit	Standard	Proposed Action	Mine Site Alternative
Fluoride	mg/L	--	0.3	0.3
Sulfate	mg/L	NA	31.7	33.1
Metals - Total				
Aluminum	µg/L	125	115	114
Antimony	µg/L	31.0	6.9	6.3
Arsenic	µg/L	53.0	8.3	7.6
Cadmium	µg/L	0.9[1]	0.1	0.1
Cobalt	µg/L	5.0	2.1	1.6
Copper	µg/L	7.6[1]	7.0	3.4
Lead	µg/L	2.3[1]	1.1	1.2
Nickel	µg/L	42.4[1]	25.6	15.2
Zinc	µg/L	86.2[1]	24.6	24.9

Source: Tables 5-4 to 5-24 and Tables 7-1 to 7-24, RS74A, Barr 2008

[1] Water Quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 80 mg/L.

West Pit Overflow Water Quality Predictions

Around Year 65, the West Pit is predicted to overflow. This overflow would represent the one and only surface discharge from the Project under the Proposed Action. The deterministic modeling results suggest that perhaps as many as three parameters could exceed water quality standards, in addition to relatively high sulfate concentrations, although there is no applicable surface water sulfate standard (Table 4.1-70). The data in Table 4.1-70 reflects the highest predicted concentrations from all flow conditions.

In comparison with the Proposed Action, the Mine Site Alternative would have fewer parameters predicted to exceed surface water quality standards (three vs five parameters), generally lower concentrations for those parameters that would still exceed standards (with the exception of selenium), and generally lower concentrations for most other parameters that would meet standards. Although no Uncertainty Analysis was conducted for the Mine Site Alternative, the Uncertainty Analysis conducted for the West Pit water quality under the Proposed Action indicated that arsenic concentrations may be lower and copper and nickel concentrations may be higher than predicted by the deterministic model.

Table 4.1-70 Comparison of West Pit Post-Closure Deterministic Water Quality Predictions for the Proposed Action and Mine Site Alternative

Constituent	Units	Water Quality Standard	Mine Site Alternative Maximum Concentration	Proposed Action Maximum Concentration
General Parameters				
Chloride	mg/L	230	48	21
Fluoride	mg/L	--	0.5	**2.3**
Hardness	mg/L	500	408	364
Sulfate	mg/L	--	271	247
Metals – Total				
Aluminum	ug/L	125	19	**140**
Antimony	ug/L	31	15.4	21.3
Arsenic	ug/L	53	**188**	**198**
Cadmium	ug/L	7.4[1]	0.23	0.15
Cobalt	ug/L	5.0	**6.9**	**8.0**
Copper	ug/L	31[1]	6.0	17
Iron	ug/L	--	100	150
Lead	ug/L	19.1[1]	7.8	6.5
Manganese	ug/L	--	10	116
Nickel	ug/L	171[1]	61	72
Selenium	ug/L	5.0	**14.8**	**7.7**
Thallium	ug/L	0.56	0.19	0.26
Zinc	ug/L	394[1]	52	78

Source: Table 4-59, RS74A, Barr 2008.

[1] Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 400 mg/L.

The West Pit overflow would discharge to an unnamed "waters of the state" and would have to meet effluent limitations based on meeting surface water quality standards, taking into account the assimilative capacity of the receiving waters under the 7-day, 10-year (7Q10) low flow. The unnamed tributary to which the West Pit would discharge would essentially function as a mixing zone and water quality standards may be exceeded. The water quality of the West Pit overflow, however, is not predicted to result in exceedances of surface water standards in the Partridge River at SW-004 (located approximately 1,000 feet downstream from where the West Pit overflow would reach the Partridge River) or Colby Lake. This impact may also represent the effects of a first flush of solutes and be relatively short term. We would expect water quality in the West Pit to improve as oxidation would be negligible once the pit walls are submerged. Section 4.1.3.5 discusses potential mitigation measures to address the potential for exceedances of surface water standards. As discussed for the proposed action, tribal cooperators disagree with this approach. It is the tribal cooperating agencies' position that all waters of the state are protected by surface water quality standards and using the unnamed water to dilute the contaminants of the West pit is not appropriate. Furthermore, tribal cooperators note that the pit lake is predicted to not meet surface water quality standards for hundreds or thousands of years.

Mercury in Water

The Mine Site Alternative would be expected to result in similar mercury concentrations in the West Pit overflow as the Proposed Action. Since neither the WWTF nor the East Pit constructed wetlands, which are the two primary treatment facilities for inflow to the West Pit, are expected to be consistently effective in mercury removal, we have some concerns regarding the potential mercury concentration in the West Pit. As discussed above, PolyMet did conduct batch tests to simulate the effects of mine area rock on pit water chemistry using local rainfall (12 ng/L total mercury). The test results indicated that contact with Duluth Complex rock actually decreased total mercury concentrations to between 1.9 and 3.2 ng/L (RS53/42, SRK 2007). Water quality sampling indicates that, on average, most area pits (11 out of 14 sampled) meet the 1.3 ng/L standard for mercury (range from 0.55 to 1.87 ng/L) (Borovsky 2009). In summary, there remains some uncertainty as to whether the West Pit overflow would meet the Great Lakes Initiative standard for mercury and we recommend additional analysis of this issue. As previously discussed, it is the tribal cooperating agencies' position that this analysis must be included in the DEIS.

Summary of the Mine Site Alternative

Table 4.1-71 provides a summary of the primary water resource effects of the Mine Site Alternative. Under this alternative, the permanent subaqueous disposal of the most reactive waste rock (all Category 2, 3, and 4, waste rock) in the East Pit, rather than in permanent surface stockpiles, would virtually eliminate long-term sulfide oxidation and associated solute release and would significantly improve groundwater quality at the Mine Site relative to the Proposed Action. This predicted enhancement in groundwater quality would ultimately result in improved water quality in the Partridge River for most parameters.

Table 4.1-71 Water Resource Impact Summary of the Mine Site Alternative

Key Potential Issues	**Project Effects**	**Reference Page Number**
Groundwater levels at the Mine Site	Drawdown expected during mine operations and filling of West Pit (~65 years), but minimal impact to surrounding wetlands expected. Tribal cooperating agencies disagree with this conclusion because it is based on unsupported assumptions and inadequate data.	Same as Proposed Action
Groundwater quality at the Mine Site	Antimony concentrations may exceed USEPA primary MCL and MDH Health Risk Limits.	4.1-107
Flows in the Upper Partridge River	Minimal reduction in annual 7-day low (~0.1 cfs). No significant effect on river morphology or 100-year floodplain. Tribal cooperating agencies take the position that there is insufficient data to support this claim.	Same as Proposed Action
Water quality in the Upper Partridge River	All parameters would meet surface water quality standards under all flow conditions for all mine years. West Pit overflow in Closure predicted to initially exceed standards, but water quality is expected to improve over time. Tribal cooperating agencies take the position that the west pit is predicted to exceed standards for all years for which predictions were made.	4.1-112
Water levels in Colby Lake	Negligible increase in average water level drawdown and improvement in maximum annual fluctuation and % days below critical lake elevation.	Same as Proposed Action
Water quality in Colby Lake	Predicted to meet all water quality standards under all flow conditions for all mine years.	4.1-112
Flows in the Lower Partridge River	Reduce flows by as much 13 cfs (12%) relative to a mean annual flow of approximately 111 cfs at the Aurora gaging station on the Partridge River.	Same as Proposed Action
Water Quality in the Lower Partridge River	All parameters should meet surface water quality standards under all flow conditions for all mine years. Tribal cooperating agencies take the position that the wild rice standard for sulfate would be exceeded.	4.1-112
Groundwater levels downgradient of the Tailings Basin	Not applicable	Not applicable
Groundwater quality downgradient of the Tailings Basin	Not applicable	Not applicable
Flows in the Embarrass River	Not applicable	Not applicable
Water quality in the Embarrass River	Not applicable	Not applicable
Mercury in Water	There is some uncertainty as to whether the West Pit overflow would meet the Lake Superior mercury standard.	4.1-115

4.1.3.4 Tailings Basin Alternative

The intent of the Tailings Basin Alternative is to reduce groundwater contamination by metals from the tailings; avoid the release of seepage with relatively high sulfate concentration to the wetlands north of the Tailings Basin and lakes downstream that represent "high risk situations" for mercury methylation; and minimize conflicts with potential "wild rice waters." These objectives would be achieved by installing vertical wells that would capture approximately 95 percent of the seepage from the Tailings Basin and discharge it either back into the Tailings

Basin for reuse at the processing plant or to the Partridge River downstream of Colby Lake. The Tailings Basin Alternative differs from the Proposed Action in two significant ways that affect water resources:

- Install groundwater extraction wells along the northern embankment of Cells 2E and 2W (and around the west side of Cell 2W if necessary); and

- Extend bentonite amended tailings cover over the top of the entire uppermost lift of the embankment.

Two different options are considered under this alternative, which relate to the extent of recycling seepage back into the Tailings Basin during mine operations (Years 1 – 20). The "Maximum Recycle Option" would return nearly the maximum amount of seepage that could be reused as make up water at the Plant Site in lieu of withdrawals from Colby Lake, and pump the remaining seepage to the Partridge River. The "No Recycle Option" would not return any seepage to the Tailings Basin and would pump all seepage to the Partridge River (although surface seepage would still be captured and returned to the Tailings Basin as with the Proposed Action). These two options essentially provide "bookends" to a range of seepage management options (i.e., the allocation of pumped seepage to the Tailings Basin or the Partridge River). This alternative would provide flexibility during mine operations on where to discharge pumped seepage based on actual water quality. In general, the preference would be to maximize the amount of water recycled to the Tailings Basin (in order to minimize hydrologic impacts to the Partridge River from water withdrawals from Colby Lake), as long as it would not result in exceedances of groundwater or surface water quality standards or become unsuitable for use as make up water at the processing plant. It is the tribal cooperating agencies' position that an untreated discharge of tailings basin water to the Partridge River will exceed water quality standards. In particular the wild rice standard will be exceeded.

It is assumed under the Tailings Basin Alternative that the vertical wells would continue to operate at least through Year 50, which is the same year that operation of the WWTF would cease under the Mine Site Alternative. Actual monitoring of seepage rates and water quality would determine when pumping could be terminated and the seepage allowed to flow naturally toward the Embarrass River. A permeable reactive barrier (PRB) would be installed to provide final treatment of the seepage, if needed, to meet groundwater evaluation criteria, assuming testing during operations demonstrates it to be effective. Tribal cooperating agencies note that pumping could be needed for hundreds or thousands of years if the PRB is not effective. The PRB is untested and has not been demonstrated to work in any similar situations. In addition, the PRB would need periodic recharging/replacement which would need to occur at regular intervals for as long as water treatment is needed (hundreds or thousands of years). It is the tribal cooperating agencies' position that this long term maintenance is at odds with Minnesota's goal of maintenance free closure.

The Tailings Basin Alternative would not modify the size or depth of the proposed mine pits, so its effects on groundwater levels or quality at the Mine Site are expected to be approximately the same as for the Proposed Action. The Tailings Basin Alternative would not modify the drainage volumes or water quality from the Mine Site and, therefore, its effects on flows and water quality in the Partridge River (upstream of Colby Lake) are expected to be approximately the same as for the Proposed Action.

The Tailings Basin Alternative, however, would affect the water budget for the Project by possibly recycling some of the pumped water from the vertical wells for reuse at the Plant Site and discharging the remaining pumped water to the Partridge River. These changes would be expected to affect groundwater levels and quality at the Tailings Basin, surface water flows and quality in both the Embarrass and Partridge rivers and water levels at Colby Lake relative to the Proposed Action. Each of these potential effects is described below.

Effects on Groundwater Levels at the Tailings Basin

Tailings disposal by LTVSMC raised groundwater levels within the Tailings Basin (i.e., mounding) and increased seepage volumes above the flux capacity of the aquifer, resulting in upwelling of seepage to the surface and inundation of wetlands immediately north of the Tailings Basin. Under the Tailings Basin Alternative, vertical wells located along the benches of the northern embankment of Cells 2E and 2W and possibly extended along the eastern side of 2E and the western side of 2W (Figure 3.2-2) would collect most of the PolyMet seepage volume via pumping, with discharge either back into the Tailings Basin for reuse at the Plant Site and/or discharge to the Partridge River. Table 4.1-72 summarizes seepage generation and the amount of seepage that would be recovered and not recovered for existing conditions, various years during mine operations, and Closure. The data indicate that pumping by the vertical wells would reduce the amount of unrecovered NorthMet seepage being released to the aquifer downgradient of the Tailings Basin by approximately 95 percent during operations and 150 percent during Closure (until pumping ceases). There would be no recovery of Tailings Basin seepage under either existing conditions or the Proposed Action. The rate of unrecovered PolyMet seepage would be less than the aquifer flux capacity (i.e., 155 gpm), but the total seepage rate (PolyMet seepage plus residual LTVSMC seepage from Cell 2W) would still significantly exceed aquifer flux capacity during operations and would about double aquifer capacity during Closure.

Effects on Groundwater Quality Downgradient of the Tailings Basin

Seepage from the Tailings Basin would affect downgradient groundwater quality. Under the Tailings Basin Alternative, most of this seepage would be collected via pumping from the vertical wells, which would be discharged either back into the Tailings Basin for reuse at the Plant Site and/or discharged to the Partridge River. In either case, most of the solutes transported by this seepage would not be released to the aquifer downgradient of the Tailings Basin.

Table 4.1-73 provides the predicted seepage water quality as it leaves the Tailings Basin, not accounting for any advection, dilution, or sorption. The toe of the Tailings Basin is not considered an evaluation point in terms of compliance with groundwater evaluation criteria. The predicted solute concentrations for the Maximum Recycle Option are, with few exceptions, higher than for the No Recycle Option. Both options generally would have higher solute concentrations than the Proposed Action. This would be expected as the concentrations in the seepage are generally higher than the Colby Lake water it would be replacing as make up water.

It should be noted, however, that the predicted seepage concentrations in Table 4.1-73 would represent the expected water quality of the water pumped by the vertical wells and discharged to the Partridge River; these effects are discussed below (Effects on Water Quality in the Partridge River).

Table 4.1-72 Tailings Basin Groundwater Seepage Toward the Embarrass River for the Tailings Basin Alternative (in gpm)

	PolyMet Seepage						Total Seepage					
Mine Year	**Cell 1E/2E Seepage**	**Hydromet Seepage**	**Total Seepage**	**Total Unrecovered Seepage**	**Total Recovered Seepage[2]**	**% Recovered Seepage**	**Total PolyMet Seepage**	**Cell 2W Seepage**	**Total Seepage**	**Total Unrecovered Seepage[2]**	**Total Recovered Seepage[2]**	**% Recovered Seepage[2]**
Existing	900[1]	NA	900[1]	900	0	0%	900	895	1,795	1,795	0	0%
Year 1	1,600	0.5	1,600	80	1,520	95%	1,600	895	2,496	9,75	1,520	61%
Year 5	2,260	6.7	2,267	120	2,147	95%	2,267	895	3,162	1,015	2,147	68%
Year 10	2,490	7.7	2,498	132	2,366	95%	2,498	895	3,393	1,027	2,366	70%
Year 15	2,700	7.8	2,708	143	2,565	95%	2,708	895	3,603	1,038	2,565	71%
Year 20	2,900	8.7	2,909	154	2,755	95%	2,909	895	3,804	1,049	2,755	72%
Closure	490[3]	0.7	491	40	741	151%	491	610	1,101	360	741	67%

Source: Hinck 2009.

1 Existing Cell 1E/2E seepage is a legacy from LTVSMC operations and not attributable to PolyMet.

2 The seepage collection system would collect an additional average of approximately 100 gpm of surface seepage during mine operations.

3 Hinck conservatively assumed 780 gpm of Cell 1E/2E seepage flowed toward the Embarrass River at Closure, when in fact it is predicted that only 490 gpm of seepage would move in that direction, with the remaining 290 gpm flowing toward Second Creek.

Table 4.1-73 Predicted Seepage Water Quality for the Tailings Basin Alternative

Parameters	Unit	Proposed Action		Tailings Basin Alternative No Recycle Option		Tailings Basin Alternative Maximum Recycle Option	
		Operational Maximum	Closure Maximum	Operational Maximum	Closure Maximum	Operational Maximum	Closure Maximum
General Parameters							
Calcium	mg/L	104	63	108	54	112	54
Chloride	mg/L	16.6	3.9	16.6	3.2	19.5	3.2
Fluoride	mg/L	3.3	1.1	3.3	0.9	3.9	0.9
Hardness	mg/L	404	398	404	308	426	308
Magnesium	mg/L	54	55	54	42	58	42
Potassium	mg/L	10	21	11	19	12	19
Sodium	mg/L	64	26	64	20	70	20
Sulfate	mg/L	212	174	241	145	262	145
Metals – Total							
Aluminum	ug/L	176	78	176	77	180	77
Antimony	ug/L	10.5	1.2	11.1	1.1	12.3	1.1
Arsenic	ug/L	9.2	28	12	24	13	24
Barium	ug/L	33	19	36	16	43	16
Beryllium	ug/L	0.5	1.3	0.7	1.2	0.8	1.2
Boron	ug/L	127	148	127	113	147	113
Cadmium	ug/L	0.7	1.2	0.7	0.9	0.9	0.9
Cobalt	ug/L	2.0	2.7	2.3	2.1	2.8	2.1
Copper	ug/L	10	14	10.2	12.1	12.4	12.1
Iron	ug/L	569	98	569	87	325	87
Lead	ug/L	2.6	1.0	3.4	0.8	3.4	0.8
Manganese	ug/L	76	140	96	109	173	109
Nickel	ug/L	24	6	25.4	4.6	34.4	4.6
Selenium	ug/L	1.4	3.3	1.7	2.7	1.8	2.7
Silver	ug/L	0.5	1.2	0.6	1.0	0.7	1.0
Thallium	ug/L	0.7	0.1	0.8	0.1	0.7	0.1
Zinc	ug/L	63	13	79	12	90	12

Source: Tables 2 and 4, Barr 2009, Technical Memorandum: Tailings Basin Seepage Groundwater Quality Impacts Modeling

The same two-step modeling approach was used to evaluate effects of the Tailings Basin Alternative on groundwater as was used for the Proposed Action. The initial steady state flow modeling was used as a "screening level model" to determine the constituents of potential concern, with the only mechanism for reduction in constituent concentrations prior to reaching the evaluation points being mixing with aquifer recharge. The results of the steady state modeling identified nine parameters as having the potential to exceed groundwater evaluation criteria: aluminum, antimony, arsenic, beryllium, fluoride, iron, manganese, sulfate and thallium. As with the Proposed Action, the predicted beryllium and thallium concentrations are affected by the use of analytical data with detection limits above the evaluation criteria, which resulted in scale-up issues and unrealistically high predictions. Therefore, these two parameters were not included in the more detailed transient modeling (Barr 2009, Technical Memorandum: TB-14 Plant Site Groundwater Impacts).

The seven parameters identified in the steady state flow modeling were subjected to more detailed analysis using transient flow modeling. The transient flow model estimated groundwater quality downgradient from the Tailings Basin both with and without sorption. As discussed under the Proposed Action, based on the site-specific sorption testing, we feel comfortable accepting the low end of the USEPA screening level values, except for antimony, where a K_d value of 2 was determined to be conservatively low (see discussion under Proposed Action). Under the Tailings Basin Alternative, antimony (Maximum Recycle Option only) and arsenic were the only parameters for which sorption was included in the transient flow modeling.

Table 4.1-74 and 4.1-75 provide a summary of the transient flow modeling results, which indicate that the predicted concentrations for most parameters would be slightly higher for the Maximum Recycle Option. Both options, however, would meet groundwater evaluation criteria, except for aluminum and manganese, both of which would only exceed the USEPA secondary MCLs, which were established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health.

Table 4.1-74 Summary of Maximum Concentrations Predicted Using Transient Flow Modeling for the Tailings Basin Alternative – No Recycle Option

Solute	Unit	Groundwater Evaluation Criteria	Predicted Maximum Concentration (with sorption)			Period Exceeding Groundwater Criteria (Mine Years)	Predicted Maximum Concentration (no sorption) Prop boundary
			Property Boundary Location	Residential Well Evaluation Location	Embarrass River Evaluation Location		
Aluminum	µg/L	50 - 200	**100**	**80**	49	~60 - >500	**100**
Antimony	µg/L	6.0	4.8	3.8	2.3	NA	4.8
Arsenic	µg/L	10	3.0[1]	3.0[1]	3.0[1]	NA	3.0
Fluoride	mg/L	2.0	0.7	0.6	0.5	NA	0.7
Iron	µg/L	300	256	193	98	NA	256
Manganese	µg/L	50/300	**192**	**193**	**193**	~1 - >500	**193**
Sulfate	mg/L	250	113	87	52	NA	113

Source: Table 4-7, Barr 2009, Technical Memorandum: TB-14 Plant Site Groundwater Impacts
Predictions Notes: **Bold** values exceed groundwater evaluation criteria
1 Assumes a sorption K_d of 25 for arsenic.

Table 4.1-75 Summary of Maximum Concentrations Predicted Using Transient Flow Modeling for the Tailings Basin Alternative – Maximum Recycle Option

Solute	Unit	Groundwater Evaluation Criteria	Predicted Maximum Concentration (with sorption) Property Boundary Location	Residential Well Evaluation Location	Embarrass River Evaluation Location	Period Exceeding Groundwater Criteria (Mine Years)	Predicted Maximum Concentration (no sorption) Prop boundary
Aluminum	µg/L	50 - 200	**103**	**82**	50	~60 - >500	**103**
Antimony	µg/L	6.0	1.9[1]	1.8[1]	1.5[1]	NA	1.9
Arsenic	µg/L	10	3.0[2]	3.0[2]	3.0[2]	NA	3.0
Fluoride	mg/L	2.0	1.0	0.8	0.6	NA	1.0
Iron	µg/L	300	149	117	69	NA	149
Manganese	µg/L	50/300	**192**	**193**	**193**	~1 - >500	**192**
Sulfate	mg/L	250	142	108	58	NA	142

Source: Table 4-8, Barr 2009, Technical Memorandum: TB-14 Plant Site Groundwater Impacts.
Notes: **Bold** values exceed groundwater evaluation criteria
1 Assumes a sorption K_d of 2 for antimony.
2 Assumes a sorption K_d of 25 for arsenic.

Effects on the Partridge River

The Tailings Basin Alternative would discharge tailings basin seepage captured by the vertical wells to the Partridge River, downstream of Colby Lake. This discharge, which varies in volume and slightly in quality between the No Recycle and Maximum Recycle options, would have some affect on flows and water quality in the Lower Partridge River, but would have no effect on flows or water quality in the Upper Partridge River and negligible effect on water quality in Colby Lake. Tribal cooperating agencies take the position that discharging untreated tailings basin water to the Partridge River will have significant adverse impacts.

Water Levels in Colby Lake and Whitewater Reservoir

Under the Proposed Action, it was determined that average Project make up water withdrawals of 3,500 gpm would not have an adverse effect on water levels in Colby Lake because water could be pumped from Whitewater Reservoir to offset these withdrawals. The Tailings Basin Alternative – Maximum Recycle Option would significantly reduce the need for water withdrawals from Colby Lake to an average of approximately 800 gpm (Barr 2009, Technical Memorandum: TB-14 Plant Site Groundwater Impacts). To the extent that PolyMet would still be actively managing water levels within Colby Lake, the Maximum Recycle Option may reduce water level fluctuations in Colby Lake, but would certainly reduce the need to pump water from Whitewater Reservoir to maintain water levels in Colby Lake, thereby reducing water level fluctuations in Whitewater Reservoir.

Flows in the Lower Partridge River

The Proposed Action would reduce flows in the Partridge River during mine operations in three ways:

- Reduction in flow from Mine Site activities, including diversion of surface runoff (contact stormwater) to the WWTF and ultimately to either the Tailings Basin or the East Pit, and a reduction in groundwater baseflow, which total an average of approximately 1.5 cfs;
- Collection of Tailings Basin seepage to Second Creek by the seepage barrier, which pumps approximately 1.2 cfs of seepage otherwise bound to the Partridge River back into the Tailings Basin; and
- Withdrawal of approximately 7.8 cfs (3,500 gpm) of water from Colby Lake for plant make up water.

The Tailings Basin Alternative would still reduce flow in the Partridge River because of Mine Site activities and Second Creek seepage collection, but would withdraw less water from Colby Lake (Maximum Recycle Option only) and would discharge seepage captured by the vertical wells to the Partridge River (both options). As Table 4.1-76 shows, both of the Tailings Basin Alternative options would have less effect than the Proposed Action on flows in the Lower Partridge River. To the extent that much of the Tailings Basin seepage is really "Partridge River water" (i.e., contact stormwater from Mine Site that would be pumped to the Tailings Basin and Colby Lake make up water that would be discharged along with the tailings to the Tailings Basin), the Tailings Basin Alternative would be returning a portion of this flow to the Partridge River.

Table 4.1-76 Comparison of Average Effects on Lower Partridge River Flows during Mine Operations

Alternative	Mine Site Activities[1]	Second Creek Seepage Collection	Colby Lake Withdrawals	Vertical Well Discharge	Net Effect on Partridge River Flow
Proposed Action	-1.5 cfs	-1.3 cfs	-7.8 cfs	0 cfs	-10.6 cfs
Tailings Basin Alternative No Recycle Option	-1.5 cfs	-1.3 cfs	-7.8 cfs	+5.2 cfs	-5.4 cfs
Tailings Basin Alternative Maximum Recycle Option	-1.5 cfs	-1.3 cfs	-1.8 cfs	+1.1 cfs	-3.5 cfs

Source: Barr 2009, Technical Memorandum: TB-2 and TB-14: Tailings Basin Seepage Groundwater Quality Impacts Modeling Methodology; RS73B, Barr 2008.

[1] Average reduction in flow at USGS gage over 10 water years modeled - see Tables 7a-7f, RS73B, Barr 2008

Mean annual flow downstream of Colby Lake is estimated at 116.6 cfs (Barr 2009, External Memorandum: Additional information in support of NorthMet DEIS Critical Path Requires Actions); therefore, the net reduction in Partridge River flow from the two Tailings Basin Alternative options would represent a small percentage of average flow (two to four percent). Under low flow conditions, the MnDNR Water Appropriate Permit would still require maintenance of critical water levels in Colby Lake and minimum flows downstream. Under the

Tailings Basin Alternative, these minimum flows should occur less often, and the slight reduction in flow should not have any measureable effect on Partridge River morphology.

Water Quality in the Lower Partridge River

The two Tailings Basin Alternative options would discharge an average of between 1.1 to 5.2 cfs to the Partridge River over the approximately 20-year life of the mine. Table 4.1-73 provides the estimated seepage water quality at the toe of the Tailings Basin, which represents the likely water quality of any seepage discharged to the Partridge River. These data indicate that the only parameters predicted to exceed surface water standards would be aluminum and thallium. Tribal cooperating agencies note that wild rice grows on the lower Partridge River. Therefore, it is the tribal cooperating agencies' position that the 10 mg/l standard for sulfate applies. This standard would be exceeded by the PolyMet discharge. Furthermore, there are other projects (Mesabi Nugget Phase II and Laskin Energy) that are discharging water with elevated constituents. Given these existing sources, it is unlikely that PolyMet discharge would be able to discharge their untreated tailings basin effluent without violating the clean water act.

In the case of aluminum, the surface water standard of 125 µg/L represents dissolved aluminum, while the predicted concentration represents total aluminum. It is the tribal cooperating agencies' position that the predicted concentrations in TB-15 represent dissolved aluminum (see TB-15, page 1). TB-15 presents the most recent water quality predictions for the Tailings Basin Proposes Action and Alternatives. TB-15 predicts exceedance of standards by dissolved aluminum under the Proposed Action and the Alternatives. The available water quality monitoring data for the toe of the Tailings Basin (Table 4.1-7) indicates that the dissolved aluminum concentrations in at least the LTVSMC seepage is quite low (<25 µg/L) and well below the surface water standard. Therefore, we expect that the discharge of seepage from the vertical wells to the Partridge River would likely meet the surface water standard for dissolved aluminum. As discussed above, the predicted thallium concentrations are affected by the use of analytical data with detection limits above the evaluation criteria, which resulted in scale-up issues and unrealistically high predictions.

Therefore, the Tailings Basin Alternative is not predicted to result in the exceedance of any surface water quality standards. As previously discussed, tribal cooperating agencies disagree. It is the tribal cooperating agencies' position that aluminum exceeds standards under the Proposed Action and the Alternative. The Tailings Basin Alternative, however, would increase contaminant loadings to the Lower Partridge River. Sulfate is a key parameter of interest and would have one of the highest loading in the discharge to the Partridge River. As Table 4.1-77 shows, sulfate concentration would increase in the Partridge River as a result of the discharge of Tailings Basin seepage from the vertical wells. The impact is predicted to be greater from the No Recycle Option as all the pumped seepage would be discharged to the river as opposed to the Maximum Recycle Option where most of the seepage (during operations) would be recycled to the Tailings Basin for reuse at the Plant Site. In general, we would expect to see a similar pattern for other parameters.

Table 4.1-77 Comparison of Predicted Sulfate Concentrations in the Lower Partridge River

Alternative	Sulfate Concentrations during Low Flows (mg/L)	Sulfate Concentrations during Average Flows (mg/L)	Sulfate Concentrations during High Flows (mg/L)
Existing Conditions at Colby Lake	Not available	17.1	Not available
Tailings Basin Alternative No Recycle Option	70.7	26.9	Not available
Tailings Basin Alternative Maximum Recycle Option	47.2	22.2	Not available
Existing Condition at confluence with First/Second creeks	Not available	149	Not available

Effects on the Embarrass River

The Tailings Basin Alternative would capture most of the Tailings Basin seepage and discharge it to the Partridge River downstream of Colby Lake. This discharge would reduce groundwater contribution to flow and affect water quality in the Embarrass River.

Flow in the Embarrass Rivers

The two Tailings Basin Alternative options (No Recycle and Maximum Recycle) would have identical effects on flow in the Embarrass River as the amount of seepage recovered by the vertical wells would be the same under each option. Table 4.1-72 quantifies the reduction in groundwater seepage to the Embarrass River, which would ultimately translate to reductions in flow.

Currently the seepage from Cells 1E/2E to the Embarrass River from the LTVSMC Tailings Basin is approximately 2.0 cfs (900 gpm). As a result of the pumping by the vertical wells, unrecovered seepage to the Embarrass River is predicted to decrease to an average of 0.3 cfs (average of 125 gpm) during Project operations, or a net reduction in flow of approximately 1.7 cfs (775 gpm). During Closure (at least until seepage water quality would be good enough to allow pumping by the vertical wells to cease), PolyMet seepage to the Embarrass River is predicted to decrease to an average of 0.1 cfs (40 gpm), or a net reduction in flow of approximately 1.9 cfs (860 gpm) relative to existing conditions.

These reductions in flow of 1.7 cfs (during operations) to 1.9 cfs (during Closure) are small relative to average flow in the Embarrass River of 81.53 cfs (as estimated at location PM-13), but could be more significant during low flows (30-day low flow at location PM-13 is estimated as 5.66 cfs). To the extent that much of this seepage is expected to upwell to the surface because it would exceed the groundwater flux capacity of the aquifer, these reductions in seepage would not directly translate to reductions in the base flow (groundwater) contribution to the Embarrass River. This effect has already been observed under existing conditions when observed low flows in the Embarrass River are less than the predicted seepage from the LTVSMC Tailings Basin. The effective seepage rate during these low flow periods has been estimated at approximately 1.2 cfs (540 gpm) (RS74B, Barr 2008). Since the predicted total seepage rate (including residual

LTVSMC Cell 2W seepage) for the Tailings Basin Alternative would be 2.3 cfs during operations (0.1 cfs from Cells 1E/2E and 2.2 cfs from Cell 2W) and 0.8 cfs during Closure (0.1 cfs from Cell 1E/2E and 0.7 cfs from Cell 2W), which approximate the estimated effective seepage rate of 1.2 cfs, we do not expect any significant change in low flows in the Embarrass River under this alternative.

Water Quality in the Embarrass River

One of the major objectives of the Tailings Basin Alternative is to improve the predicted water quality in the Embarrass River, especially for sulfate because of potential affects on wild rice and mercury methylation. Under both Tailings Basin Alternative options, most of the Tailings Basin seepage would be collected and discharged to the Partridge River. The same methodology was used to predict water quality in the Embarrass River for the Tailings Basin Alternative as was used for the Proposed Action. Deterministic water quality predictions was conducted for each parameter for seven periods (Years 1, 5, 10, 15, 20, Closure, and Post-Closure), for three flow conditions (low, average, and high) at location PM-13, which is located downstream of all expected Project effects on the Embarrass River. Water quality at PM-12, which is an upstream control location, should not be affected by this alternative and was not remodeled.

Table 4.1-78 provides the maximum predicted concentrations for the parameters evaluated under both the No Recycle and Maximum Recycle options. The data indicates that low flows would be the critical flow condition for most parameters. In general, the predicted water quality is similar between the two Tailings Basin Mitigation options, with concentrations for several parameters slightly higher under the Maximum Recycle Option. For both options, the only parameter that is predicted to exceed surface water standards would be aluminum. Tribal cooperating agencies note that this is not correct. It is the tribal cooperating agencies' position that the wild rice sulfate standard applies (10 mg/l) and would be exceeded.

Table 4.1-78 Predicted Water Quality along the Embarrass River (PM-13) for the Tailings Basin Alternative

Parameter	Units	Standard	Modeled Existing Conditions	No Recycle Option		Maximum Recycle Option	
				Predicted High Concentration	Flow Conditions	Predicted High Concentration	Flow Conditions
General							
Chloride	mg/L	230	10.2	11.4	Low Flow	11.4	Low Flow
Fluoride	mg/L	2.0	0.9	0.8	Low Flow	0.8	Low Flow
Hardness	mg/L	500	255	229	Low Flow	232	Low Flow
Sulfate	mg/L	--[1]	96	101	Low Flow	105	Low Flow
Metals							
Aluminum	µg/L	125	**671**	**427**	Low Flow	**427**	Low Flow
Antimony	µg/L	31	0.9	1.4	Low Flow	1.5	Low Flow
Arsenic	µg/L	53	2.7	2.9	Low Flow	3.1	Low Flow
Cadmium	µg/L	2.4[2]	0.2	0.3	Low Flow	0.3	Low Flow
Cobalt	µg/L	5.0	1.3	1.2	Low Flow	1.2	Low Flow
Copper	µg/L	17.5[2]	4.1	4.3	Low Flow	4.3	Low Flow
Iron	µg/L	--	2,884	2,880	High Flow	2,880	High Flow
Lead	µg/L	10.4[2]	1.1	1.2	Low Flow	1.2	Low Flow
Manganese	µg/L	--	612	453	Low Flow	455	Low Flow
Nickel	µg/L	115[2]	6.7	7.5	Low Flow	7.9	Low Flow
Selenium	µg/L	5.0	2.1	2.4	Low Flow	2.4	Low Flow

Thallium	µg/L	0.56	0.1	0.2	Multiple Flows	0.2	Multiple Flows
Zinc	µg/L	234[2]	12.6	16	High Flow	16	High Flow

Source: Barr 2009, External Memorandum: TB-15 – Surface Water Quality Model Assumptions and Results for Tailings Basin – Proposed Action and Tailings Basin – Alternative

1 Sulfate standard of 10 mg/L applies if designated wild rice waters are present.

2 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 255 mg/L.

Note: Values in bold indicate an exceedance in water quality standards.

As discussed above, the surface water standard of 125 µg/L represents dissolved aluminum, while the predicted concentration represents total aluminum. It is the tribal cooperating agencies' position that the results in TB-15 (see page 1) represent dissolved aluminum. TB-15 predicts exceedance of the aluminum standard. The available water quality monitoring data (Table 4.1-7) indicates that the dissolved aluminum concentrations in at least the LTVSMC seepage is quite low (<25 µg/L) and well below the surface water standard. Therefore, we expect that the aluminum concentration in the Embarrass River would likely meet the surface water standard for dissolved aluminum.

In terms of sulfate, estimated existing sulfate concentrations in the Embarrass River (96 mg/L during low flows at location PM-13) already exceed the 10 mg/L wild rice standard, if it is determined to apply (Table 4.1-79). The tribal cooperating agency position is clear. The wild rice standard applies and must be enforced. Under the Tailings Basin Alternative, the capture of Tailings Basin seepage by the vertical wells would reduce the sulfate loading in the Embarrass River under all flow conditions, which would result in slightly lower sulfate concentrations under average and high flow conditions. Under low flow conditions, the sulfate loading would still be reduced, but this effect would be offset by reduced flows from the seepage capture resulting in slightly higher sulfate concentrations (Barr 2009, External Memorandum: Additional information in support of NorthMet DEIS Critical Path Requires Actions).

Table 4.1-79 Comparison of Predicted Sulfate Concentrations for the Embarrass River

Flow Condition	Modeled Existing Condition	Proposed Action	Tailings Basin Alternative No Recycle Option Max Concentration	Tailings Basin Alternative Maximum Recycle Option Max Concentration
Low	95.9	145.6	101.3	104.7
Average	35.5	45.3	34.8	35.1
High	7.1	8.3	7.0	7.0

Table 4.1-79 also allows for a comparison between the Tailings Basin Alternative and the Proposed Action. The data indicates that the Tailings Basin Alternative would result in significantly reduced sulfate concentrations in the Embarrass River relative to the Proposed Action.

Mercury in Water

The primary way the Tailings Basin Alternative differs from the Proposed Action in terms of mercury in water is related to the potential for sulfate to promote mercury methylation. As discussed previously, sulfate can promote mercury methylation in certain high risk situations, such as wetlands and lakes that stratify.

Under the Tailings Basin Alternative, the peak annual sulfate loading (Year 10) attributable to PolyMet (i.e., excludes legacy LTVSMC seepage from Cell 2W) from the Tailings Basin to the aquifer and wetlands to the north would decrease by over 90 percent from the Proposed Action (Table 4.1-80) and would actually be over 70 percent less than existing conditions. Therefore, the Mine Site Alternative would significantly reduce the potential for mercury methylation in the wetlands north of the Tailings Basin and in the downstream chain of lakes along the Embarrass River that are considered high risk situations by MPCA.

Table 4.1-80 Maximum Annual PolyMet Sulfate Loading from Cells 1E/2E

Alternative	Unrecovered Seepage Rate (gpm)	Concentration (mg/L)	Annual Sulfate Loading (kg/year)
Existing Conditions	900	152	273,000
Proposed Action	2,498	212	1,052,000
MSA – No Recycle Option (Year 15)	132	212	53,000
MSA – Max Recycle Option (Year 20)	132	233	67,000

Source: Barr, 2009, Tailings Basin Culpability Analysis.

Summary of the Tailings Basin Alternative

Table 4.1-81 provides a summary of the primary water resource effects of the Tailings Basin Alternative. Under this alternative, the capture of Tailings Basin seepage, which would be recycled to the Tailings Basin for reuse as make up water at the Plant Site and/or discharged to the Partridge River, would significantly reduce the seepage rate to the aquifer downgradient of the Tailings Basin and associated pollutant loadings. As a result, groundwater downgradient of the Tailings Basin is expected to meet groundwater quality standards. In addition, the seepage, with relatively high sulfate concentrations, would be directed away from the wetlands and downstream lakes on the Embarrass River, resulting in a significant reduction in the risk of mercury methylation and minimization of impacts to any wild rice waters. The discharge of captured seepage to the Partridge River is predicted to meet surface water standards. Tribal cooperating agencies note that wild rice grows on the lower Partridge River. Therefore, it is the tribal cooperating agencies' position that the wild rice sulfate standard applies and would be exceeded by the proposed PolyMet discharge.

Table 4.1-81 Water Resource Impact Summary of the Tailings Basin Alternative

Key Potential Issues	Project Effects	Reference Page Number
Groundwater levels at the Mine Site	Not applicable	Not applicable
Groundwater quality at the Mine Site	Not applicable	Not applicable
Flows in the Upper Partridge River	Not applicable	Not applicable
Water quality in the Upper Partridge River	Not applicable	Not applicable
Water levels in Colby Lake	Reduced water withdrawals (Maximum Recycle Option only) should maintain higher water levels in Colby Lake and reduce water level fluctuations in Whitewater Reservoir, while the No Recycle Option would have negligible effect on average water level drawdown in either reservoir.	4.1-122
Water quality in Colby Lake	Not applicable	Not applicable
Flows in the Lower Partridge River	Average flow reduced by between 3.5 cfs (Max Recycle Option) and 5.4 cfs (No Recycle Option), but should have negligible effect on river morphology.	4.1-123
Water quality in the Lower Partridge River	Discharge of between 1.1 cfs (Maximum Recycle Option) and 5.2 cfs (No Recycle Option) of seepage pumped from vertical wells to the Partridge River would meet all surface water quality standards under all flow conditions for all mine years, although it would significantly increase sulfate loadings. Tribal cooperating agencies note that wild rice occurs on the lower Partridge River. Therefore, Tribal cooperating agencies take the position that the wild rice sulfate standard applies and would be exceeded.	4.1-124
Groundwater levels downgradient of the Tailings Basin	Pumping by vertical wells would reduce the amount of unrecovered PolyMet seepage by approximately 95% during operations and 150% during closure (until pumping is allowed to cease) relative to existing conditions.	4.1-117
Groundwater quality downgradient of the Tailings Basin	Seepage from the Tailings Basin would meet USEPA primary MCLs and MDH Health Risk Limits. As stated in TB-14 "**Manganese:** The concentration of manganese in groundwater is predicted to be above the groundwater standard and the MCL at all four of the evaluation locations."	4.1-118
Flows in the Embarrass River	Average flow reduced by 1.7 cfs (during operations) and 2.1 cfs (during Closure), but should have negligible effect on river morphology.	4.1-125
Water quality in the Embarrass River	All parameters would meet all surface water quality standards in the Embarrass River under all flow conditions for all mine years. Tribal cooperating agencies disagree. The wild rice sulfate standard applies and will be exceeded. TB-15 predicts that dissolved aluminum would exceed surface water standards.	4.1-125
Mercury in Water	Significant reduction in mercury methylation risk by reducing PolyMet sulfate loadings from Cells 1E/2E by over 70% relative to existing conditions.	4.1-127

4.1.3.5 Mitigation Measures

Section 3.2.2 describes potential mitigation measures for impacts from the Project. Some of these measures have the potential to affect water resources. These measures are evaluated below as well as recommended water quality monitoring.

Potential Mitigation Measures

Potential mitigation measures at the Mine Site, Plant Site, and Tailings Basin are discussed below.

It is the tribal cooperating agencies' position that treatment of the tailings basin effluent that is captured by the vertical wells must be an integral part of the tailings basin alternative. This treatment could occur in the WWTF already proposed for this project or in a second facility closer to the discharge point. However, treatment of the tailings basin effluent prior to discharge to the Partridge River is not included in the potential mitigation measures listed below. Tribal cooperating agencies strongly oppose an untreated discharge of tailings basin water to the Partridge River. In addition, there are other existing facilities and mine proposals (Laskin Energy, Mesabi Nugget Phase II) that discharge, or are proposing to discharge water at this same location. Finally, water quality of the discharge would exceed the wild rice sulfate standard that applies to the lower Partridge River.

Mine Site

- Overliner Cover Thickness – PolyMet proposes an overliner cover thickness of 12 to 18 inches to protect the geomembrane at the waste rock stockpiles. We have concerns regarding the adequacy of this thickness to protect the geomembrane from accidental tears and rips during waste rock placement given both the size of the waste rock and the equipment necessary to place it properly. We would recommend a nominal overliner thickness of 24 to 36 inches.

- Chemical Modification of the Reactive Waste Rock Stockpiles - PolyMet currently proposes to construct permanent waste rock stockpiles, which would be revegetated as part of the mine closure. Although revegetation of the surface stockpiles would reduce exposure of the reactive waste rock, there may be opportunities to decrease the likelihood of ARD from the stockpiles through additional treatment prior to revegetation. Treating the stockpiles with limestone (in either lump or ground form) would help neutralize the potential for ARD from the stockpiles, and reduce the potential for acidification of groundwater and surface water at the Mine Site.

- Maximize the Elevation of the Category 1/2 Stockpile – maximizing the height of the Category 1/2 stockpile would reduce the aggregate surface area of the waste rock stockpile and thereby minimize the area exposed to ARD from the stockpile surface. It is expected that the reduction in area would be small because the stockpile height is already at or close to its maximum height from a geotechnical engineering perspective.

- Overburden management - Preliminary sample analysis of overburden materials suggests a potential that sulfate, mercury, and other heavy metals may be leached upon excavation and interactions with air and meteoric waters that may cause impacts to surface and ground water resources. If additional sampling and analysis during permitting confirms this potential impact would be significant, mitigation measures could include developing a field characterization method (possibly including visual identification of peat and saturated mineral soils for segregation), and a revised overburden management plan that minimized its use or placement outside of appropriate temporary and permanent storage facilities.

- Overburden Storage and Laydown Area – PolyMet proposes to store peat and unsaturated overburden in the unlined Overburden Storage and Laydown Area. Peat, in particular, is a sink for mercury. The wetting and drying of the peat that would likely occur in this storage area would promote the methylation of mercury. Drainage from this area should be treated as process water and collected and treated at the WWTF.

- West Pit Overflow – The West Pit, which is predicted to overflow about 45 years after dewatering ceases, would discharge to "waters of the state" and would have to meet effluent limitations based on meeting surface water quality standards, taking into account a mixing zone and the assimilative capacity of the receiving waters under the 7-day, 10-year (7Q10) low flow. Water quality modeling predicts that this overflow would exceed several surface water standards. During the 45 years it would take to fill the West Pit, water quality could be monitored. If water quality is not meeting surface water standards, several corrective actions could be taken depending on the parameters exceeding standards, including:

    - Additional wastewater treatment - during the approximately 45-year closure period, the WWTF would be operating at reduced capacity and this excess capacity could be used to provide additional treatment of process water, East Pit overflow water, or even West Pit lake water.

    - Enhanced wastewater treatment – the WWTF could be enhanced with nanofiltration units in series to improve the removal of sulfate and other solutes.

    - Addition of limestone – targeted addition of limestone could be used to control the pH of seepage water and reduce the dissolution of metals.

    - Addition of iron salts – iron salts could be added directly to the West Pit to improve the co-precipitation and removal of cobalt.

    - Biogeochemical treatment – research at a sulfide mine in Canada found that the application of liquid fertilizer to the pit lake proved effective in removing dissolved cadmium, copper, and zinc mainly by absorption onto and some incorporation into organic matter produced through enhanced primary productivity (Poling et al. 2003).

PolyMet has also proposed an additional passive wetland system between the West Pit outlet and Dunka Road if further treatment is required at the time of overflow (RS 52, Barr 2007). We have concerns regarding reliance on constructed wetlands to remove metals to consistently meet surface water standards. A passive wetland treatment system in this area could be beneficial in "polishing" the outflow to minimize the number of occasional exceedances that may occur. On the other hand, a wetland treatment system in this location could promote mercury methylation, depending on the mercury concentration in the overflow.

If these mitigation measures were not successful at improving West Pit water quality to surface water standards at the time of overflow, the West Pit overflow structure could be altered to route flows to the WWTF for treatment before discharge until the overflow would meet surface water standards. We recommend that the water quality of the West Pit be monitored regularly after Closure so corrective action could be taken such that water quality at the time of overflow would meet surface water standards and diversion to the WWTF would not be required (see Recommended Monitoring Measures below).

Plant Site

- Plant Site Stormwater Management – PolyMet indicates the potential need for, but does not actually propose, stormwater management facilities to control runoff from the processing plant area. The provision of stormwater management facilities at the processing plant area would not only help control erosion and sedimentation both upstream and downstream from the facilities, but would also provide a collection point in the event of an accidental spill. We recommend such storm water management controls be designed and installed.

Tailings Basin

- Use of Alternative Embankment Material – As part of the Proposed Action, PolyMet proposes to use approximately 18 – 24 million cubic yards of LTVSMC coarse tailings as embankment fill material. A culpability analysis (Wenigman, Pint, and Wong 2009) indicates that these LTVSMC tailings represent a significant source of solute loading to the PolyMet Tailings Basin seepage during Closure (65 percent of the sulfate and 51 percent of the arsenic loadings).

  We recommend that that PolyMet investigate alternative sources of relatively inert embankment material to use in lieu of the LTVSMC coarse tailings. Potential sources include controlled material stockpiles in Area 1, 2, 2W, 3, and 5, although those areas may not have sufficient quantities of suitable material to meet all of the fill requirements for the Tailings Basin embankment. MnDNR staff also conducted a preliminary evaluation using remote sensing techniques to delineate potential sources of significant amounts (>100,000 cubic yards) of inert well-graded granular construction material available within a 10-mile radius of the Tailing Basin (Arends 2009). The evaluation resulted to the identification of three sources of potentially inert construction material: 1) landforms with a potential for containing sand and gravel; 2) in-place sources of glacial overburden; and 3) glacial overburden stockpiles from iron ore and taconite mining. It is anticipated that the amount of overburden from these three sources would meet most of the construction needs at the Tailings Basin; however, geochemical testing would be necessary to confirm if this material is inert.

  The substitution of inert fill material in place of the LTVSMC coarse tailings could significantly reduce sulfate and arsenic concentrations in Tailings Basin seepage during closure and help avoid the need for long-term vertical well pumping under the Tailings Basin Alternative.

- Enhanced Tailings Basin Cap – PolyMet proposes to install a bentonite amended cap to the Tailings Basin as a partial dry cover system at Closure. It has been suggested that use of a geomembrane system may function as a drier cap, which would allow clean surface water runoff from the partial dry cap area to flow into the central area of the basin to maintain a pond and to dilute the remaining pond water. The pond area would still receive the bentonite augmentation to reduce infiltration and maintain the pond. Therefore, the only difference between a partial dry geomembrane cap versus a partial dry bentonite amended cap would be the reduction in infiltration through the perimeter embankment and beach area. The estimated infiltration rate for a geomembrane liner is 2.89 inches/year versus 3.58 inches/year for the bentonite amendment, or approximately 0.69 inches/year (Radue 2009). Since most water is predicted to reach the Tailings Basin by infiltrating through the central pond area (>75 percent of total infiltration), which would remain the same under these two capping options, the net effect of the geomembrane cover would be an approximate 5 percent reduction in Tailings Basin infiltration, which would probably result in a roughly proportional (~1 to 5 percent) reduction in seepage contaminant loadings. This modest improvement in seepage water quality comes at a high cost (estimated at $87 million in comparison with $13 million for the bentonite amendment option). A geomembrane cover provides only moderate reduction in infiltration through the beach areas over the bentonite amended tailings layer currently proposed as part of the Proposed Action design. Other mitigation options discussed in this section appear to offer more significant water quality benefits at lower costs. We do not recommend a partial geomembrane cap at this time.

- Seepage to Second Creek – Although most of the seepage from the Tailings Basin flows north and west toward the Embarrass River, some groundwater currently seeps from the Tailings Basin to the south forming the headwaters of Second Creek. During mine operations, PolyMet proposes to install a seepage barrier on Second Creek to capture this seepage and pump it back to the Tailings Basin for reuse. At Closure, however, PolyMet proposes to remove the seepage barrier and allow the seepage (long term steady state rate of 290 gpm) to flow to Second Creek. This seepage is predicted to meet surface water standards, but have a relatively high sulfate concentration (145 mg/L). MnDNR has documented significant rates of mercury methylation occurring in Second Creek, which may be at least partially attributable to high sulfate loading. We have concerns that the long term release of relatively high sulfate seepage from the Tailings Basin to Second Creek would further contribute to methylmercury formation. Therefore, we recommend that PolyMet maintain the seepage barrier during Closure and pump the captured seepage into the proposed surface water discharge pipeline that would transport the seepage collected in the vertical wells around the Tailings Basin to the Partridge River under the Tailings Basin Alternative. This would allow the seepage from the Tailings Basin to bypass Second Creek and eliminate the potential for this seepage to promote mercury methylation. We recommend that this Second Creek seepage collection and pumping continue until the vertical well pumping terminates.

- Permeable Reactive Barrier – the predicted seepage rates for both the Proposed Action and the Tailings Basin Alternative would exceed the estimated aquifer flux capacity resulting in upwelling of groundwater into the wetlands north of the Tailings Basin. The predicted sulfate concentration of this groundwater ranges from 145 to 262 mg/L (Table 4.1-73), which would increase the risk of mercury methylation in the wetlands and downstream lakes and could impact potential wild rice stands. A permeable reactive barrier (PRB) could potentially reduce the concentrations of key parameters in groundwater as it seeps from the toe of the Tailings Basin and prior to it reaching the downgradient aquifer or wetlands.

A PRB is an *in situ* method for remediating contaminated groundwater that combines passive chemical or biological treatment with subsurface flow management. The PRBs are typically constructed as a below ground trench located to intercept groundwater flows. The trench is permeable to provide a preferential flow path for seepage to flow through it, but contains reactive materials (e.g., iron, limestone, carbon materials) or microbes to trap or modify contaminants. According to the USEPA, there are currently about 100 PRBs operating in the United States.

At the NorthMet Project, a PRB could be installed north of and perpendicular to the seepage flow from the Tailings Basin and incorporate both a vertical trench extending from bedrock to the surface and a horizontal unit laying at or just below the ground surface that would capture the upwelling groundwater to reduce concentrations of key parameters (e.g., sulfate, arsenic, antimony) from reaching the wetlands and Embarrass River. To remove sulfate, an organic substrate and sulfate reducing bacteria would likely need to be present within the PRB. While other alternatives may exist for the removal of arsenic and antimony (e.g., zero valent iron), biological reduction is generally considered the only viable alternative for sulfate removal.

Based on some preliminary research on existing operating PRBs, it is estimated that this facility could potentially reduce the concentrations of key parameters (e.g., sulfate) by up to 50 percent. During mine operations, however, the seepage rate and residual sulfate concentrations after passage through the PRB (assuming 50 percent removal efficiency) would still be sufficiently high to pose methylmercury and wild rice concerns. Therefore, use of a PRB may be most appropriate during Closure when seepage rates and sulfate concentrations are lower. Assuming a 50 percent removal efficiency, a PRB could reduce sulfate concentrations in seepage from 145 to about 73 mg/L for the Tailings Basin Alternative at Closure and potentially shorten the duration that the vertical wells would need to continue pumping.

Experience with other PRBs shows that testing may be necessary to find the most effective “mix” of reactive material. Therefore, we recommend that PolyMet establish a PRB test cell during mine operations to facilitate the evaluation of alternative construction materials and a range of mass and flow loading scenarios to help define the effectiveness of a PRB for a full-scale treatment of seepage from the Tailings Basin during closure. The results of the studies would be used to properly design a long-term PRB treatment system.

The primary benefit of installing a PRB would be a reduction in the concentration of sulfate, arsenic, and antimony to wetlands and Embarrass River. The disadvantages of a PRB include the reactive media having a finite operating life and possible need for replacement, difficulty in estimating long term effectiveness since none of the existing PRB systems cited in literatures have been in place for more than 30 years, the potential for producing methylmercury by the sulfate reducing bacteria, and the fact that most analogs in literature are derived from sites with significantly higher mass loadings (sulfate concentrations generally greater than 1,000 mg/L), which may reduce the actual contaminant removal efficiency.

Recommended Monitoring Measures

PolyMet developed a proposed water quality monitoring program for both Project operations and closure (RS52, Barr 2007). This program addresses monitoring of surface waters, stormwater, pit water, stockpile drainage, groundwater, WWTF, pumping station and pipeline flows, wetlands, hydrometallurgical residue drainage, and Tailings Basin pond and seepage. The details of this monitoring program would be finalized during permitting. We briefly discuss below several key monitoring activities identified elsewhere within this EIS.

- Waste Rock Stockpiles - We recommend close monitoring of the pH and water quality of collected leachate from the waste rock stockpiles to insure the effectiveness of the lime treatment in maintaining a relatively high pH of approximately 8 in order to limit metal solubility.

- West Pit - We recommend that the water quality of the West Pit be monitored regularly after Closure so corrective action could be taken such that water quality at the time of overflow would meet surface water standards and diversion to the WWTF would not be required.

- Sedimentation Ponds – We recommend that the sedimentation ponds, which manage non-contact stormwater runoff from the site, be monitored regularly to ensure effective removal of suspended solids prior to discharge to surface waterbodies and to insure that this water does not become contaminated with process water.

- WWTF effluent – We recommend that the effluent from the WWTF be monitored regularly to insure the proper level of treatment is being attained as this effluent is an important factor affecting the quality of groundwater seepage from the Tailings Basin (i.e., it represents the primary source of antimony, arsenic, and sulfate to the Tailings Basin during mine operations) (Wenigmann, Pint, and Wong 2009). The quality of the WWTF effluent would be a good leading indicator of potential seepage water quality issues at the Tailings Basin.

- Tailings – We recommend that the sulfur concentration and pH of the tailings be monitored regularly to ensure they remains below 0.14 percent sulfur and above 5.5 pH to prevent the development of acidic conditions and increased solubility of metals within the Tailings Basin. If elevated sulfur concentrations are found, additional copper sulfate could be used during flotation. If elevated pH concentrations are found, limestone could be mixed in with the tailings prior to disposal in the Tailings Basin.

- Mercury monitoring – The MPCA Mercury Strategy (MPCA 2006) recommends receiving water monitoring for sulfate releases to high risk situations. In response to a request by MPCA and MnDNR, PolyMet submitted a monitoring plan to further characterize background conditions with regard to sulfate loading from the existing LTVSMC Tailings Basin and its effect on methylmercury production within the large wetland complex north of the Tailings Basin and the chain of lakes located downstream in the Embarrass River (Twaroski 2009). The plan calls for the establishment of five monitoring sites on streams draining wetlands receiving seepage from the Tailings Basin and five additional sites at the downstream Sabin and Wynne lakes.

The predicted sulfate concentrations at the toe of the Tailings Basin during Closure (174 mg/L – see Table 4.1-46) would be similar to the sulfate concentrations currently found in LTVSMC seepage (average of 155 mg/L – see Table 4.1-8). Therefore, to the extent the Project could promote mercury methylation in the wetlands north of the Tailings Basin because of elevated sulfate concentrations, we would expect to find methylmercury in water currently draining from the LTVSMC Tailings Basin. The proposed monitoring program should aid in our understanding of the sulfate-mercury interactions north of the Tailings Basin.

PolyMet should develop a similar mercury monitoring plan for the Mine Site, in particular, to ensure that mercury concentrations within the West Pit would meet Great Lake Initiative standards at the time of overflow (~Year 65). This should include monitoring of mercury from peat in the Overburden Storage and Laydown Area as well as mercury concentrations in WWTF effluent.

4.1.4 Cumulative Effects on Water Resources

The Final Scoping Decision Document identified several resources with the potential to be cumulatively affected, including water resources, which would be subjected to a cumulative effects analysis using guidance from the Council on Environmental Quality (CEQ 1997). The Final Scoping Decision Document identified hydrology and water quality as water resource elements with the potential for cumulative effects. Our analysis within this EIS also identified the potential for cumulative effects to surface water hydrology and water quality. Neither the Final Scoping Decision Document nor this EIS identified potential cumulative effects to groundwater. Although the Project would add to the existing seepage from the LTVSMC Tailings Basin, these impacts are localized and already incorporated in the groundwater quality models. Although the Project would affect groundwater levels, this effect would be geographically limited and not subject to cumulative effects. Therefore, the scope of this cumulative impact assessment focuses on the effects of past, present, and reasonably foreseeable future activities on surface water hydrology and quality.

In accordance with the CEQ guidance, a cumulative impact assessment should define the geographic and temporal scope of its analysis. The Final Scoping Decision Document identified the Partridge and Embarrass rivers as the geographic scope for the hydrology and water quality analyses. The analysis in this EIS supports this study area, although we do identify and evaluate the potential for the Project to have effects on hydrology and water quality further downstream in the St. Louis River.

In terms of temporal scope, this assessment considers past and present effects on flow and water quality in the Partridge and Embarrass rivers as reflected in existing baseline hydrologic and water quality conditions. In addition to the NorthMet Project, this assessment considers reasonably foreseeable future activities. In order to be reasonably foreseeable, an activity can not be simply speculative, but should be included in government plans and budgets or, for private projects, have filed for required permits. For this assessment, we considered the activities listed in Table 4.1-82.

Table 4.1-82 Summary of Activities included in the Water Resource Cumulative Impact Assessment

Project	Watershed	Existing or Proposed	Type of Project and Surface Water Discharges
City of Babbitt POTW	Embarrass River	Existing	Wastewater treatment facility, 0.3 mgd surface water discharge
Cliffs Erie Tailings Basin	Embarrass River	Existing	Tailings basin seepage
LTVSMC	Embarrass River	Existing	Waste rock piles
Land use modifications	Embarrass River Partridge River	Existing and future	Wetland loss, wetland bank, mining operations, residential and rural development
Northshore Mining Company	Partridge River	Existing	Pit dewatering discharges
City of Hoyt Lakes POTW	Partridge River	Existing	Wastewater treatment facility, 0.5 mgd surface water discharge
Mesaba Energy Project – East Range Site	Partridge River	Proposed	Integrated Gasification Combined Cycle (IGCC) electric power generating station
Babbitt Connection Highway	Partridge River	Proposed	Highway project, construction and stormwater discharges along the route
Cliffs Erie RR Pellet Transfer Facility	Partridge River	Proposed	Railroad to haul EVTAC pellets to Taconite Harbor, stormwater runoff along the route
Mesabi Nugget Phase II	Partridge River	Existing	Mine, tailings basin and stockpile discharges
Cliffs Erie Pits	Partridge River	Existing	Mine, tailings basin and stockpile discharges
Colby Lake and Whitewater Reservoir	Partridge River	Existing	Water storage facility used in operations for mining, coal-fired system electric power generation
Minnesota Power Syl Laskin Energy Center	Partridge River	Existing	Coal-fired power station, stormwater runoff.
Minntac	St Louis River	Existing	Mine, tailings basin and stockpile discharges
Laurentian Biomass Burner	St Louis River	Existing	Waste (wood) to energy plant, stormwater runoff from waste piles.
ArcelorMittal USA-Minorca Mine Laurentian and East Reserve	St. Louis River	Existing	Mine, tailings basin and stockpile discharges

4.1.4.1 Cumulative Effects on Hydrology

Cumulative effects on hydrology are discussed below for the Partridge River and the Embarrass River.

Partridge River

As discussed in Section 4.1.1.3, The Partridge River forms just south of the Peter Mitchell Mine and flows approximately 32 miles to its confluence with the St. Louis River, draining a total of approximately 161 square miles as measured at Aurora, MN, approximately 3 miles from the St. Louis River confluence. There are limited flow data available for the Partridge River. Data from four USGS gaging stations within the Partridge River watershed are available, but the period of record for each is relatively short and the three that reflect flow from the Project area have all been impacted by mining operations (Table 4.1-12 and Figure 4.1-1). The Partridge River above

Colby Lake (USGS Station #04015475) is the gaging station that best represents flows from the Project area, but only has 10 years of flow records available (1978-1988). Little flow data exists for the Partridge River prior to mining. At the USGS gaging station above Colby Lake, the low (i.e., average annual 30-day minimum flow), average (i.e., mean annual flow), and high (i.e., annual 1-day maximum flow) flows are estimated as 1.2, 88, and 1,960 cfs, respectively.

There are several mines, the City of Hoyt Lakes wastewater treatment plant (WWTP), and Minnesota Power's Laskin Energy Center (power plant) that have discharged in the past, and/or are currently discharging water that affect flows in the Partridge River (Figure 4.1-12). Table 4.1-14 summarizes the NPDES/SDS discharges to the Partridge River and its tributaries. Most of these outfalls do not discharge continuously, and many, although still "active" in terms of permit status, have not discharged for many years (e.g., various mine pit dewatering discharges). Although mine discharges have occurred at least periodically in the Project area since 1956 when the Peter Mitchell Mine began operations, there are few readily available mine pumping records available prior to 1988 when the state began requiring NPDES/SDS permit holders to report this information. Pumping records for the Peter Mitchell Mine from 1976 to approximately 1986 are available and have an annual average of between 6.8 and 15.1 cfs. Since 1988, the highest reported average monthly discharge from the Peter Mitchell Mine to the Partridge River was 34 cfs (RS 74A, Barr 2008). The number and volume of these discharges compared to average and especially low flow in the Partridge River indicate that these discharges have the potential to significantly affect flows and the lack of historical information regarding actual dates of discharge complicate interpreting the flow record.

In general, mining probably has at times both increased and decreased flows in the Partridge River depending on the stage of mine development. Currently, the Peter Mitchell Mine is periodically discharging pit water, LTVSMC Pits 3 and 5S are overflowing, and Mesabi Nugget is dewatering Pit 1 and Pit 6 is overflowing. The net effect of these activities is probably an increase in average flows in the Partridge River, although the uncertain timing of these flows makes quantifying the increase difficult.

The NorthMet Project would reduce average flows in the Partridge River, at least during operations, between 3.5 cfs (Tailings Basin Alternative – Maximum Recycle Option) and 10.6 cfs (Proposed Action).

In terms of river geomorphology, the 10.6 cfs reduction in flow is small relative to high flows (<1%) and should have little effect on sediment deposition or transport. To the extent that current and projected future flows may increase flow, this reduction could offset morphologic impacts from these other projects. The effect of this reduction in flow on downstream flow becomes even less significant as the drainage area and resulting flow increases. The impact of the 3.5 cfs reduction in flow would be even less on river geomorphology.

In terms of low flows, the 10.6 cfs reduction in flow from the Proposed Action could be significant, although it would have less effect downstream of Colby Lake. The 10.6 cfs reduction in flow is more than the annual low flow at the USGS gaging station (1.2 cfs). Under these conditions, the Project's Water Appropriation Permit would require maintenance of critical water levels in Colby Lake and minimum flows downstream via pumping from Whitewater Reservoir. The Project would likely result in more frequent and longer duration low flow releases from Colby Lake, which could impact downstream aquatic resources, although it is difficult to quantify to what extent other mine dewatering activities may offset this effect. The 3.5 cfs reduction in flow from the Tailings Basin Alternative – Maximum Recycle Option would probably have little effect on low flows, especially downstream of Colby Lake and in the St. Louis River as a result of increasing drainage area and flows.

In summary, the cumulative effects of past, present, and reasonably foreseeable future actions on the hydrology of the Partridge River would not be expected to impact river geomorphology under high flows. Depending on the timing of the various activities, the reduction in flow under the Proposed Action could contribute to adverse cumulative effects on the downstream aquatic community under low flows.

Embarrass River

As discussed in Section 4.1.1.3, the Embarrass River originates just south of the City of Babbitt and flows southwest approximately 23.2 miles to its confluence with the St. Louis River, draining 171 square miles as measured at McKinley, near the confluence with the St. Louis River. Relatively little flow data are available for the Embarrass River. There are two USGS gaging stations located within the watershed (#04017000 located about three miles northwest of the Tailings Basin and #04018000 located about 7 miles southwest of the Tailings Basin), but they only provide flow records for 22 and 9 years respectively. Table 4.1-16 provides flow data for the nearest gaging station at Embarrass (Figure 4.1-1). PolyMet estimates low (i.e., average annual 30-day minimum flow), average (i.e., mean annual flow), and high (i.e., annual 1-day maximum flow) at monitoring station PM-13 as 5.7, 81.5, and 853.1 cfs, respectively.

The hydrology of the Upper Embarrass River remains relatively natural, with only a small wastewater discharge from the City of Babbitt WWTP (0.33 cfs). Pit 5NW overflow (1.99 cfs to Spring Mine Creek) and seepage from the LTVSMC Tailings Basin (4.0 cfs) affect the hydrology of the Embarrass River, but more in terms of timing than actual flow volumes. Downstream of the NorthMet Project, dewatering flows from Mesabi Mining's Pit 9 average 7.7 cfs and Mesabi Nugget's Pit 1 average 8.4 cfs, both of which discharge to Wynne Lake, but both of these discharges are intermittent.

The Project would increase seepage toward the Embarrass River by approximately 4.5 cfs (Proposed Action), or decrease seepage by approximately 1.7 cfs (Tailings Basin Alternative), relative to existing conditions.

In terms of river geomorphology, high flows tend to most affect the geomorphology and stability of river channels. The net modification in flow resulting from the above referenced projects (approximately 20 cfs including the maximum from the Proposed Action and assuming both Pit 1 and 9 are discharging at the same time) is small (about 2 percent) relatively to the annual 1-day maximum flow. Further, the chain of lakes on the Embarrass River would tend to attenuate the effects of any increase in flows downstream. Any increases in minimum flows would generally be considered beneficial to the aquatic community.

The potential decrease in seepage (1.7 cfs) under the Tailings Basin Alternative would not be expected to directly translate to reductions in the base flow (groundwater) contribution to the

Embarrass River. This effect has already been observed under existing conditions when observed low flows in the Embarrass River are less than the predicted seepage from the LTVSMC Tailings Basin. The effective seepage rate during these low flow periods has been estimated at approximately 1.2 cfs (540 gpm) (RS74B, Barr 2008).

In summary, the cumulative effects of past, present, and reasonably foreseeable future actions on the hydrology of the Embarrass River would not be expected to impact river geomorphology under high flows or the aquatic community under low flows.

4.1.4.2 Water Quality

Cumulative effects on water quality are discussed below for the Partridge River and the Embarrass River.

Partridge River

Recent (collected by PolyMet in 2004 and 2006) and historic (back to 1956) water quality data are available for various constituents in various locations along the Partridge River, (Table 4.1-20). Most of these water quality data represent occasional grab samples and do not allow a detailed assessment of water quality trends, seasonal effects, or relationship to flow. Nevertheless, collectively, the data can be used to generally characterize water quality in the watershed and draw some comparisons with surface water quality standards. There are no water quality data available, however, that predate the operation of the Peter Mitchell Mine in 1956 and can be used to characterize relatively “undisturbed” conditions in the Partridge River.

Section 303(d) of the Clean Water Act requires states to publish a list of waters that are not meeting one or more water quality standards. The list, known as the 303(d) Total Maximum Daily Load (TMDL) list, is updated every two years. The State of Minnesota 303(d) list, which was updated in 2008, contains 1,475 waterbodies requiring TMDLs. The Partridge River is not listed as an impaired waterbody on the 303(d) list. Analysis of the available water quality data supports this determination as overall water quality meets state standards.

Water quality in Colby Lake is affected by inflow from the upper Partridge River watershed, but also anthropomorphic effects from mine pit dewatering and overflows (e.g., Peter Mitchell Mine in the headwaters; Pits 2/2E/2W/3/5S via Wyman Creek), and two permitted discharges from Minnesota Power’s Laskin Energy Center (e.g., cooling water discharge and a clarified ash pond discharge), as well as pumping from Whitewater Reservoir during low flows. Colby Lake is on the Minnesota 303(d) TMDL list because of mercury concentrations in fish tissue. A TMDL pollution reduction study has not yet been performed for Colby Lake to address this impairment.

Although not on the 303(d) list, downstream of Colby Lake, the Partridge River is impacted by periodic dewatering discharges from Pits 6/9/9S with high sulfate concentrations (>1,000 mg/L), which raise the sulfate concentration in the Partridge River from about 17 mg/L as it flows from Colby Lake to approximately 149 mg/L downstream of the confluence of the First and Second Creek.

The NorthMet Project is predicted to meet all surface water quality standards under all flow conditions for all mine years in the Partridge River. Tribal cooperating agencies disagree. Wild rice grows on the lower Partridge River and it is the tribal cooperating agencies' position that the wild rice sulfate standard applies. The PolyMet discharge under the tailings basin alternative would not meet this standard. The Project would degrade surface water quality by raising ambient concentrations for several parameters, primarily metals (e.g., antimony, arsenic, copper, nickel, zinc), but these concentrations would remain well below surface water standards (Table 4.1-83). Therefore, this cumulative effects analysis will focus on mercury (only parameter on 303(d) list) and sulfate (because of relationship with mercury and wild rice).

Table 4.1-83 Predicted Partridge River Concentrations as a % of Standard

Parameter	Standard	Existing Conditions	% of Standard	Predicted Max Concentration	% of Standard
Antimony	31	1.5	4.8	6.9	22.3
Arsenic	53	3.4	6.4	8.3	15.7
Copper	8.3	2.1	25.3	7.0	84.3
Nickel	46.5	1.9	40.9	25.6	55.1
Zinc	85.0	24.2	28.4	24.6	28.9

Sulfate

Ambient sulfate concentrations in the Upper Partridge River (<18 mg/L) and Colby Lake (10.1 mg/L) are low. The NorthMet Project is predicted to increase sulfate concentrations to a maximum of 31.7 mg/L in the Upper Partridge River and 15.3 mg/L in Colby Lake, under 30-day low flow conditions. There is no surface water standard for sulfate other than in Class IB waters designated for drinking water where the USEPA secondary MCL standard is 250 mg/L. It is the tribal cooperating agencies' position that the wild rice standard for sulfate applies on the Lower Partridge River. The predicted sulfate concentrations in the Upper Partridge River and Colby Lake would meet even the Class 1B standard and would be generally considered to be low concentrations. Downstream of Colby Lake, however, First and Second Creek contribute significant sulfate loadings from various mine pit overflows and dewatering, raising the sulfate concentration in the Partridge River under average flow conditions to approximately 149 mg/L.

Sulfate has been retained for cumulative analysis for its role in mercury methylation. The MPCA Mercury Strategy (MPCA 2006) recommends avoiding discharges of sulfate to high risk situations, which include wetlands, low-sulfate water (<40 mg/L) where sulfate may be a limiting factor in the activity of sulfate-reducing bacteria, and waters that flow to downstream lakes that may stratify.

The Upper Partridge River would be considered a low sulfate water, but this is only true to the confluence with First/Second Creek. There are few riparian wetlands and no lakes downstream of Colby Lake. The St. Louis River is similar with few riparian wetlands and only one lake far downstream. Therefore, the Project would contribute little to the cumulative effect on sulfate and would pose relatively low risk of mercury methylation.

In terms of wild rice, there are no designated wild rice waters along the Partridge River pursuant to *Minnesota Rules*, part 7050.0470 or the Wild Rice Legislative Report (MnDNR 2008). MPCA has requested PolyMet to provide additional information regarding the presence of wild rice along both the Partridge River (Clark, May 2009, Personal Communication) so that a site-specific determination can be made as to how the 10 mg/L standard may apply to the Project. Based on available information, it does not appear that sulfate would have any cumulative effect on wild rice along the Partridge River. As previously stated, the tribal cooperating agencies' position is that this conclusion is unsupported.

Mercury

There is relatively little monitoring data for mercury in the Partridge River. PolyMet estimates that current mercury concentrations average about 3 ng/L in the Upper Partridge River (RS74A, Barr 2008) and between 4.8 and 6.0 ng/L in Colby Lake based on limited sampling. Colby Lake is on the Minnesota 303(d) TMDL list because of mercury concentrations in fish tissue, but a TMDL pollution reduction study has not yet been performed to address this impairment.

The TMDL concluded that 99.5 percent of all mercury in fish tissue, which is the criteria driving the 303(d) listing, is from atmosphere deposition. The mercury load allocation established for surface water discharges is 1.3 ng/L (MPCA 2007). The existence of a TMDL constitutes an existing and comprehensive cumulative analysis of mercury for the entire state, although no mercury load allocation has been determined. In the absence of a load allocation for mercury, we evaluated the cause and effect mechanisms related to mercury and the fish tissue concentrations that drive the impairment. Mercury must become methylated to be absorbed by fish. This process requires specific conditions to occur. As discussed above, the Partridge River is not considered a high risk situation for mercury methylation

The Project would result in increased sulfate loadings via groundwater to the Partridge River. The data suggests that the transport of sulfate from the waste rock/lean ore stockpiles to the Partridge River would involve very little interaction with wetlands, which are primarily perched bogs. Further, the predicted maximum sulfate concentration in the Partridge River would remain relatively low (31.7 mg/L during low flows) and there are relatively few riparian wetlands along the Lower Partridge River or downstream St. Louis River. Therefore, under the Proposed Action, the risk of increased sulfate loadings promoting methylation of mercury in wetlands is expected to be low.

As we discuss in Section 4.1.3.1, there is some uncertainty as to whether the West Pit overflow, which would flow downstream to Colby Lake, would meet the Great Lakes Initiative standard for mercury (1.3 ng/L) and we recommend further study of this issue prior to the issuance of the Final EIS. Therefore, there is the potential for the NorthMet Project to contribute to cumulative effect for mercury concentration in fish tissue in Colby Lake under both the Proposed Action and the Mine Site Alternative.

Embarrass River

The Embarrass River is not on the 303(d) list of impaired waters, however, several lakes downstream of the Project through which the Embarrass River flows are listed for "mercury in fish tissue" impairment, including Sabin, Wynne, Embarrass, and Esquagama lakes (Figure 4.1-1). Further downstream, segments of the St. Louis River are also listed for "mercury in fish tissue" impairment. These lakes and the St. Louis River are not covered by the Statewide Mercury TMDL, but are impaired waters and are still in need of a TMDL pollution reduction study.

Water quality data (ranging from 1955 to 2006) are available for various parameters at three locations along the Embarrass River (Table 4.1-25). As was the case along the Partridge River, these data do not allow a detailed assessment of water quality trends, seasonal effects, or relationship to flow, but collectively can be used to generally characterize water quality in the watershed and draw some comparisons with surface water standards.

Overall, water quality in the Embarrass River meets all surface water standards with the exception of mercury. Although there is no sulfate surface water standard (other than for wild rice waters if applicable), the Embarrass River has elevated sulfate concentrations, which are primarily attributable to the Pit 5NW overflow (average of 1,046 mg/L) and seepage from the LTVSMC Tailings Basin. The position of tribal cooperating agencies is that the wild rice standard for sulfate applies.

The NorthMet Project is predicted to meet all surface water quality standards under all flow conditions for all mine years in the Embarrass River. The Project would degrade surface water quality by raising ambient concentrations for several parameters, primarily metals (e.g., antimony, arsenic, copper, nickel, and zinc), but these concentrations would remain well below surface water standards (Table 4.1-84). Therefore, this cumulative effects analysis will focus on mercury (only parameter on 303(d) list) and sulfate (because of relationship with mercury and wild rice).

Table 4.1-84 Predicted Embarrass River Concentrations as a % of Standard

Parameter	Standard	Existing Conditions	% of Standard	Predicted Max Concentration	% of Standard
Antimony	31	0.9	2.9	5.0	16.1
Arsenic	53	2.7	5.1	7.6	14.3
Copper	17.5	4.1	23.4	6.7	38.2
Nickel	115	6.7	5.8	14.2	12.3
Zinc	234	12.6	5.3	34.5	14.7

Sulfate

Ambient sulfate concentrations in the Embarrass River are moderate during average flow conditions (36.1 mg/L), but can be significantly elevated (96 mg/L) under existing low flow conditions downstream of the Project as a result of the combined effect of the Pit 5NW overflow and LTVSMC Tailings Basin seepage. The NorthMet Project is predicted to increase sulfate concentrations to a maximum of 146 mg/L at Location PM-13 under 30-day low flow conditions during mine operations. There is no surface water standard for sulfate other than in Class IB waters designated for drinking water where the USEPA secondary MCL standard is 250 mg/L. The predicted sulfate concentrations in the Embarrass River would meet the Class 1B standard. As previously indicated, tribal cooperating agencies disagree. It is the position of the tribal cooperating agencies that the sulfate standard for wild rice waters applies.

Sulfate has been retained for cumulative analysis for its role in mercury methylation and potential effects on wild rice. The MPCA Mercury Strategy (MPCA 2006) recommends avoiding discharges of sulfate to high risk situations, which include wetlands, low-sulfate water (<40 mg/L) where sulfate may be a limiting factor in the activity of sulfate-reducing bacteria, and waters that flow to downstream lakes that may stratify. All of these high risk factors apply to the Embarrass River.

In terms of wild rice, the only clearly designated "wild rice water" in the Project area is Hay Lake, which is located downstream of the Project on a tributary to the Embarrass River and would be unaffected by the Project. There is another wild rice stand in the Embarrass River watershed that was identified in the Wild Rice Legislative Report (MnDNR 2008), but its exact location and size are unknown and it is not clear whether it would be considered a designated wild rice water. MPCA has requested PolyMet to provide additional information regarding the presence of wild rice along the Embarrass River (email from Richard Clark, MPCA, to Jim Scott, PolyMet, 28 May 2009) so that a site-specific determination can be made as to how the 10 mg/L standard may apply to the Project. Therefore, we can not at this time evaluate to what extent the Project may cumulatively affect wild rice. Tribal cooperating agencies note that the Army Corps has not completed its consultation with the potentially affected tribes. In addition, a survey for wild rice presence in the waters potentially affected by the proposed mine has only recently begun. Tribal staff have already found extensive stands in the Lower Partridge River. Tribal cooperating agencies believe that the consultation process and wild rice surveys should be completed and the results included in the DEIS. This data can then be used to evaluate the cumulative impact analysis to this important tribal resource.

Mercury

Monitoring over the past two years in the Embarrass River found average total mercury concentrations of 5.1 ng/L at monitoring station PM-12 and 4.5 ng/L at monitoring station PM-13. Average methylmercury concentrations over the same period followed a similar pattern with slightly higher concentrations found at PM-12 (0.6 ng/L) than at PM-13 (0.4 ng/L).

The NorthMet Project would not have any surface water discharges to the Partridge River, so the primary route for the Project to affect mercury loadings is through sulfate enhanced mercury methylation. The groundwater seepage rate from the Tailings Basin would exceed the aquifer flux capacity, so much of the seepage is expected to upwell into the extensive wetland complex north of the Tailings Basin. The sulfate transported by this seepage would have a long contact period with wetlands before actually reaching the Embarrass River. All of these factors may create nearly ideal conditions for mercury methylation. There are four lakes downstream on the Embarrass River that are on the 303(d) list for mercury in fish tissue impairment. These lakes stratify, which can further promote mercury methylation. Therefore, increasing the sulfate load from the Tailings Basin could increase mercury methylation both in the wetlands north of the Tailings Basin and at the downstream lakes.

The MPCA mercury strategy focuses on avoiding "discharges," which could include groundwater seepage, to "high risk" situations. These high risk areas include wetlands, low-sulfate water (<40 mg/L) where sulfate may be a limiting factor in the activity of sulfate-reducing bacteria, and waters that flow to a downstream lake that may stratify, all of which apply to the area downstream of the Tailings Basin. Under the Proposed Action, seepage from the Tailings Basin would introduce elevated sulfate concentrations to several high risk situations for mercury methylation. Therefore, the Project would contribute to cumulative impacts on downstream lakes that are already on the 303(d) list.

The Tailings Basin Alternative would redirect most Tailings Basin seepage away from the high risk areas and discharge it to the Partridge River downstream of Colby Lake, which, as indicated above, is not considered a high risk area. As Table 4.1-80 indicates, both Tailings Basin Alternative options would reduce sulfate loading below existing conditions and, therefore, would not contribute to cumulative effects on mercury concentrations in water or fish tissue.

4.2 WETLANDS

4.2.1 Existing Conditions

4.2.1.1 Introduction

Wetlands in Minnesota are protected under federal and state laws, including the Federal Clean Water Act (CWA), the Wetland Conservation Act (WCA), the Public Waters Work Permit Program, and MPCA's Wetland Standards and Mitigation Rules (*Minnesota Rules*, part 7050.0186).

Although permits are required by both the state and federal agencies, the permitting processes differ in the definition of wetlands/waters that are regulated in each process. Under the WCA regulations, 'isolated' wetlands are regulated, but not 'incidental' wetlands (i.e., a wetland created solely by actions not meant to create the wetland). Conversely, under the federal Section 404 regulations, 'isolated' wetlands are not regulated, but 'incidental' wetlands are. All of the wetlands on the Project site would be regulated through either the CWA or the WCA.

The required public notice for the Section 404 permit was issued by the USACE in May of 2005. The CWA requires any state to act on requests for Section 401 Certificates within one year of the request; otherwise, the applicable CWA Section 401 requirements are waived. The MPCA did not act on the Section 401 request during the one year timeline, subsequently the 401 certification was waived, by default, in May of 2006. Waiver of the certification by MPCA does not affect the applicability of Minnesota Water Quality Standards to the Project.

It is the tribal cooperating agencies' position that the public notice for the Section 404 permit should be re-issued and that the Minnesota Pollution Control Agency should be afforded the opportunity to analyze and make a determination under Section 401 of the Clean Water Act. Significant changes in the design of the Proposed Action have occurred, and other important information needed to determine the nature and magnitude of the Project's impacts has been developed since the public notice was provided by the USACE in May of 2005. Adverse water quality impacts and exceedances of groundwater quality standards are predicted as a result of the proposed Project. Additionally, the Project would lead to significant degradation of aquatic resources, including water quality standard violations in both the Partridge and Embarrass Rivers (see Table 4.1-63 for a summary of water quality impacts). MPCA should be afforded the opportunity to certify or deny certification to the Proposed Action.

4.2.1.2 Wetland Delineation

Existing wetland resources were evaluated within the approximately 3,016-acre Mine Site as well as an additional 1,000 acres at the Plant Site and along the railroad and treated water pipeline corridors. Potential wetland locations were determined through non-field analyses that included review of historic aerial photographs; USGS quadrangle maps; two-foot contoured topographical data; National Wetlands Inventory (NWI) maps; MnDNR color aerial infrared photography; and, where available, soils and hydrology information. It is the position of the tribal cooperating agencies that it is not possible to differentiate between rich forested peatlands, poor fens, and bogs using canopy cover alone. Identification of the low shrub, forb and graminoid layers are required. Final wetland locations were field delineated and characterized from 2004 to 2007 (Figures 4.2-1 through Figure 4.2-4). It is the position of the tribal cooperating agencies that the current wetland delineation does not encompass all wetlands that may be affected by the Project. Because no initial determination of the Project's area of influence (AOI) on wetlands was made, the site field surveys of wetland and other vegetation were limited to little more than the area within the Project fence. The existing characterization of wetland and other vegetation does not cover even one-half the area that might reasonably be expected to be impacted by disruption of the existing hydrology. Around the tailings basin virtually no wetland delineation has taken place although wetland impacts from inundation are likely to occur. The Army Corps is developing a workplan to assess impacts to these additional wetlands but this workplan has not been finalized or implemented. Given the importance of this work in assessing potentially significant impacts to wetlands, it is the position of the tribal cooperating agencies that this work should be included in the DEIS to allow for a full public review.

Soils

The soils at the Mine Site have been mapped by the USFS using the Superior National Forest Ecological Classification System. This system utilizes Ecological Land Types (ELTs). ELTs present at the Mine area include Lowland Loamy Moist (ELT 1), Lowland Loamy Wet (ELT 2), Lowland Organic Acid to Neutral (ELT 6), Upland Deep Loamy Dry Coarse (ELT 13), and Upland Shallow Loamy Dry (ELT 16). With the exception of the Wahlsten-Eaglenest-Rock outcrop complex (ELT 16), all the soils associated with these ELTs are listed as hydric soils (USDA 2009). These ELTs have been cross-correlated by the University of Minnesota with the NRCS classification as follows:

- ELT 1 – Babbitt-Bugcreek complex 0-2% slope;
- ELT 2 – Bugcreek stony loam;
- ELT 6 – Rifle-Greenwood;
- ELT 13 – Babbitt-Eaglenest complex 0-8% slopes; and
- ELT 16–Wahlsten-Eaglesnest-Rock outcrop complex, 2-8% slopes and Eveleth-Conic Rock complex.

Hydrology and Wetland Vegetation

The hydrology of the wetlands at the Mine Site has been stable over time. Factors contributing to this stability include: 1) the lack of continuity between the bedrock and surficial aquifers within the perched wetlands; 2) slow water movement through soils causing the perched wetland water tables; 3) a slow lateral flow component that helps sustain down gradient wetlands with a continual supply of groundwater over time; 4) recharge from surrounding uplands; 5) relatively flat topography across most of the site; and 6) the high water-holding capacity of the soils (Barr 2008, Memorandum: Indirect Wetland Impacts at the Mine Site). This is supported by a review of historical aerial photographs of wetland areas in the vicinity of the nearby Peter Mitchell Mine, where mine pit dewatering has occurred. These surface water bodies and wetlands have not shown that a significant loss of surface water has occurred due to increased seepage loss by dewatering the Peter Mitchell Mine (Adams 2009). Wetland hydrology at the Plant Site has been affected by the operation of the LTVSMC Tailings Basin. Evidence suggests that hydrologic changes from Tailings Basin seepage have resulted in inundation of wetland areas immediately north of the Tailings Basin (Barr 2008; Lined Tailings Basin Alternative – EIS Data Request).

Tribal cooperating agencies strongly object to the characterization of the hydrology at the mine site presented in the previous paragraph. It is the Tribal cooperating agencies' position that the methodology used in the Adams 2009 email is not adequate for characterization of pit dewatering impacts to wetlands (GLIFWC 2009, Memorandum to Jon Ahlness and Stuart Arkley: Photographic evidence for pit impacts to wetland hydrology. April 24, 2009). Problems with the methodology used in the email include:

1. Lack of recognition that aerial photos are a very imprecise measure of surface water level.
2. Photographs presented in the paper show that the Peter Mitchell pits are mostly flooded. Therefore there is little or no stress on surrounding wetlands at the time.
3. Lack of consideration of the topographic relationship of the landscape features including the depth of the Peter Mitchell Pits (P-M Pits approximately 80 feet deep, PolyMet pits approximately 800 feet deep).
4. Lack of recognition that some changes in groundwater hydrology would not be evidenced by the large changes in surface water level that could be detected by aerial photography.
5. Dependence on wetland soil conductivity values that are extremely low and for which supporting source citation in the professional literature cannot be found.

The PDEIS appears to rely on "best professional judgment" for estimating impacts due to hydrologic disruption without incorporating specific knowledge of the ecological requirements of culturally significant wetland vegetation such as cedar, and without requiring sufficient background data regarding groundwater. A "best professional judgment" approach is being used as a replacement for data-based scientific analysis of potential impacts. Quantitative methods for estimating the impacts of drawdown and inundation on wetland hydrology exist, have been used at other mine sites, and can be used in addition to professional judgment.

The soils, hydrology and overall high quality water (low in nutrients) have generally resulted in stable wetland systems comprised in large part by bog communities represented by open and coniferous bogs, shrub carr/alder thicket dominated by alder and willows, and forested swamp communities comprised of hardwood and coniferous trees.

Tribal cooperating agencies take the position that subsurface flow through upland soils likely provides the micro nutrients necessary for rich forested peatlands, cedar swamps and poor fens found in the mine site area. Many of the wetlands that have been identified during delineation as "perched bogs" are actually cedar swamps, northern wet ash swamps, forested rich peatlands, northern alder swamps, and poor fens, all of which require groundwater inputs. Indirect impacts to communities that require groundwater inflow have not been determined, but would likely be significantly different than expected impacts from the Project to perched bogs.

Wildlife habitat type mapping within the Mine Site occurred in 2004. Habitats were characterized based on whether the area was upland or wetland using the USFWS Cowardin Classification System as a guide (Cowardin et al. 1979). The general wetland habitat areas were mapped based primarily on the presence of aerial photographic signatures represented by observed wetland vegetation communities. During this initial field habitat survey sampling effort, portions of approximately one-half of the wetland habitats within the study area were observed.

Based on the habitat mapping, wetland field delineation/mapping was performed in 2004, and supplemented in 2005, 2006, and 2007 (RS14, Barr 2006; RS14 Addendum 01, Barr 2007). These investigations delineated and mapped the portion of each wetland located within the Mine and Plant Sites, rather than the entire wetland. In total, PolyMet delineated 76 wetland areas covering 1,302 acres within an overall area of approximately 3,016 acres within the Mine Site, and an additional 57 acres in eight wetlands along the rail line. In addition, portions of 52 wetlands were delineated within the Tailings Basin drain system, Tailings Basin mitigation, treated water pipeline, and Dunka Road areas (Table 4.2-3, Figures 4.2-1 through 4.2-4). The wetland delineations were based on the 1987 USACE Wetland Delineation Manual. A description of these wetlands is provided below.

Mine Site

The wetland delineation identified 1,302 acres of wetlands within the Mine Site (Figure 4.2-1). The majority of the wetlands are in complexes that either lie in the floodplain of the Partridge River or are tributary to the Partridge River, including:

- Coniferous bog and open bog communities – 938 acres;
- Shrub carr/alder thicket wetland communities – 155 acres ;
- Forested swamp (hardwood and coniferous) communities – 120 acres;
- Wet/sedge meadow communities – 49 acres; and
- Shallow marshes – 39 acres.

A bog is a peatland that is nutrient poor because it lacks access to substantial quantities of mineral-rich ground waters (Brinson 1993). Shrub carr and alder thickets are wetlands in which the upper most stratum of vegetation is comprised primarily of shrubs. Tribal cooperating agencies take the position that northern alder swamps (FPn73) "occur in settings that receive mineral rich surface or subsurface flow, which is maintains surface water with nearly neutral pH." (MN DNR Field Guide to the Native Plant Communities of Minnesota, the Laurentian Mixed Forest Province, pg 205.) Swamps are emergent wetlands in which the upper most stratum of vegetation is comprised primarily of trees. Sedge meadows are wetlands dominated by plants in the Cyperaceae family. Tribal cooperating agencies take the position that "Surface water in Northern Wet Meadow/Carrs is derived from runoff, stream flow, and groundwater sources, it has a circumneutral pH (6.0 - 8.0) and high mineral and nutrient content. " (MN DNR Field Guide to the Native Plant Communities of Minnesota, the Laurentian Mixed Forest Province, pg 292.) Marshes are wetlands with emergent, herbaceous vegetation. Tribal cooperating agencies take the position that Northern mixed cattail marshes "develop in areas occupied by fens or wet meadows following fires-usually during severe droughts-that remove accumulated peat from the fen or meadow". (MN DNR Field Guide to the Native Plant Communities of Minnesota, the Laurentian Mixed Forest Province, pg 298.)

The coniferous bog and open bog communities make up the majority of the wetlands at the Mine Site. Black spruce, tamarack, and balsam fir are the dominant canopy tree conifers. White cedar and deciduous swamp birch are also occasionally found in this community. Tribal cooperating agencies take the position that this canopy cover depicts a northern rich spruce swamp (FPn62) which requires groundwater. Balsam fir and white cedar are both rich forest indicator species. Shrubs are usually ericaceous (belonging to the heath family) and/or speckled alder and raspberry. Sphagnum moss comprises an almost continuous mat with interspersed, nondominant forbs such as bunchberry and blue bead lily along with sedges and grasses. Tribal cooperating agencies take the position that bunchberry and blue bead lily are both indicator species in the forb layer of mineral rich peatlands (MN DNR Field Guide to the Native Plant Communities of Minnesota, the Laurentian Mixed Forest Province, pg 317). Hydrologically, this complex is characterized by a stable water table (RS44, Barr 2006). Tribal cooperating agencies take the position that a stable water table in NE MN is typically the result of groundwater inputs in periods of low precipitation. All but one (wetland ID 27, Table 4.2-3) of the coniferous bog community wetlands identified at the Mine Site are rated as high quality in accordance with the Minnesota Routine Assessment Method for Evaluating Wetland Functions (MnRAM 3.0). Wetland 27 has some fill and therefore was rated as moderate quality. Tribal cooperating agencies take the position that the canopy cover and herbaceous layer noted above indicate significant groundwater inputs to the wetland communities.

The shrub communities are mostly alder thickets, with some willow and raspberry, and generally have a sparse tree canopy. Occasionally, balsam fir and paper birch were observed along the perimeter of the wetlands. Grasses, sedges, rushes, and some ferns comprise most of the ground story vegetation with some areas of sphagnum moss. Hydrologically, this community appears to be characterized by prolonged periods of shallow inundation with the water table dropping 6-12 inches below the ground during dry periods (RS44, Barr 2006). Soils are typically fibric (i.e., the least decomposed of the peats and containing un-decomposed fibers) and hemic peat (i.e., peat that is somewhat decomposed) at the surface underlain by bedrock or mineral soils. All of these wetlands are rated as high quality.

The forested swamp communities are comprised of a mix of coniferous (conifers) and deciduous (hardwood) dominated communities. Common trees include black spruce, tamarack, and balsam fir, with some white cedar, black ash, paper birch, and aspen present. The shrub canopy is comprised of speckled alder, willows, and raspberry. Grasses and sedges comprise a majority of the ground story with occasional sphagnum moss. Soils include organic and mineral soils. Some hydrologic observations indicate a greater level of hydrologic fluctuation in the forested swamp community than in the larger bog wetlands, with saturation near the surface early in the growing season and a lower water table in late summer (RS44, Barr 2006). All of these wetlands are rated as high quality.

Sedges, grasses, and bulrushes dominate wet meadow and sedge meadow communities. Soils are organic at the surface and underlain with mineral soils. These plant communities typically have saturated or inundated water levels for prolonged periods during the growing season (RS44, Barr 2006). Two of these communities, situated between Dunka Road and the railroad, are rated moderate quality, while the others are rated as high quality.

Approximately one-half of the shallow marsh communities at the Mine Site have resulted from artificial impoundments by roads, railroads, and beaver. These wetlands are dominated by cattails, bulrushes, sedges, and grasses. Soils are usually organic at the surface underlain by mineral soils. Inundation with one to four inches of water is common throughout most of the growing season except during dry periods. Six of these shallow marshes are rated as high quality and four as moderate quality. Hydrologic disturbance in these four wetlands is primarily responsible for the moderate quality rating.

Plant Site

The existing Tailings Basin is an actively permitted waste storage facility and is therefore not subject to state and federal wetland regulations. No expansion of the Tailings Basin beyond the existing permitted facility is proposed under the Proposed Action. A Tailings Basin drainage system, however, would need to be constructed to collect seepage and return the seepage water to the basin. Existing wetland resources mapped around the Tailings Basin are shown in Figure 4.2-2 and consist largely of deep marsh with dead black spruce trees scattered throughout resulting from seepage from the basin (Barr 2008, Memorandum: Wetland Impacts – Tailings Basin Mitigation Alternative). Other smaller wetland areas are comprised of shallow marsh, wet meadow, shrub carr, coniferous swamp, and open water. The existing wetlands differ from the wetlands that occupied the area prior to the construction of the Tailings Basin. Historical aerial photographs (1940 and 1948) indicate the presence of large wetland complexes that were a mixture of forested and shrub/scrub wetlands, which were primarily saturated to the surface with minimal open water areas (Barr 2008, Memorandum: Final Tailings Basin Alternative). Past disturbances that have affected the hydrology and vegetative characteristics of the wetlands in the vicinity of the Tailings Basin include seepage from the Tailings Basin along with beaver dams, culverts, road construction, parking areas, railroad embankments, and diversion of flowages (Barr 2008, Memorandum: Wetland Impacts – Tailings Basin Mitigation Alternative, revised). Tribal cooperating agencies take the position that the approximately 5,700 (RS13B) gallons per minute of tailings water released by past mine waste disposal activity has likely had a far greater influence on the hydrology of the area than beaver dams or transportation features.

Rail Line

The proposed rail connection includes approximately one mile of rail line that would connect the existing Cliffs Erie railway to the Processing Plant. There are eight wetlands located in the vicinity of the proposed rail connection totaling 57 acres (Figure 4.2-3). Shallow marsh comprises 36 acres (64%), and shrub carr 19 acres (33%) of the existing wetlands adjacent to the rail line. The wetlands are rated as high quality.

Treated Water Pipeline and Dunka Road Improvements

A treated water pipeline from the Mine Site to the Plant Site would be constructed to facilitate utilization of the mine pit dewatering and stockpile drainage water. In addition, the existing Dunka Road would be upgraded to handle the necessary mine traffic. The wetlands in the vicinity of the treated water pipeline and Dunka Road improvements consist of coniferous swamp, shrub carr, shallow marsh and deep marsh, and open water (Table 4.2-3 and Figure 4.2-4).

4.2.1.3 Wetland Classification System

Wetlands at the Project were classified using the Circular 39 system (Shaw and Fredine 1971); the Cowardin Classification System (Cowardin et al. 1979); and the Eggers and Reed (1997) wetland classification systems (Table 4.2-1). The Eggers and Reed Classification system (1997), used under the WCA (Table 4.2-1), was selected for consistent use in this DEIS.

Table 4.2-1 Wetland Classification System Descriptors

Wetland Plant Community Types[1]	**Classification of Wetlands and Deep Water Habitat of the U. S.**[2]	**Fish and Wildlife Service Circular 39**[3]
Shallow, Open Water	Palustrine or lacustrine, littoral; aquatic bed; submergent, floating and floating-leaved	Type 5: Inland open fresh water
Deep Marsh	Palustrine or lacustrine, littoral; aquatic bed; submergent, floating-leaved; and emergent; persistent and non-persistent	Type 4: Inland deep fresh marsh
Shallow Marsh	Palustrine; emergent; persistent and non-persistent	Type 3: Inland shallow fresh marsh
Sedge Meadow	Palustrine; emergent; and narrow-leaved persistent	Type 2: Inland fresh meadow
Fresh (Wet) Meadow	Palustrine; emergent; broad- and narrow-leaved persistent	Type 1: Seasonally flooded basin or flat Type 2: Inland fresh meadow
Wet to Wet-Mesic Prairie	Palustrine; emergent; broad- and narrow-leaved persistent	Type 1: Seasonally flooded basin or flat Type 2: Inland fresh meadow
Calcareous Fen	Palustrine; emergent; narrow-leaved persistent; and scrub	Type 2: Inland fresh meadow
Open Bog	Palustrine; moss/lichen; and scrub/shrub; broad-leaved evergreen	Type 8: Bog
Coniferous Bog	Palustrine; forested; needle-leaved evergreen and deciduous	Type 8: Bog
Shrub-Carr	Palustrine; scrub/shrub; broad-leaved deciduous	Type 6: Shrub swamp
Alder Thicket	Palustrine; scrub/shrub; broad-leaved deciduous	Type 6: Shrub swamp
Hardwood Swamp	Palustrine; forested; broad-leaved deciduous	Type 7: Wooded swamp
Coniferous Swamp	Palustrine; forested; needle-leaved deciduous and evergreen	Type 7: Wooded swamp
Floodplain Forest	Palustrine; forested; broad-leaved deciduous	Type 1: Seasonally flooded basin or flat
Seasonally Flooded Basin	Palustrine; flat; emergent; persistent and non-persistent	Type 1: Seasonally flooded basin or flat

Source: [1] Eggers and Reed 1997; [2] Cowardin et al. 1979; [3] Shaw and Fredine 1971.

4.2.1.4 Wetland Functional Assessment

Wetlands can serve many functions, including ground water recharge/discharge, flood storage and alteration/attenuation, nutrient and sediment removal/transformation, toxicant retention, fish and wildlife habitat, wildlife diversity/abundance for breeding migration and wintering, shoreline stabilization, production export, aquatic diversity/abundance and support of recreational activities. Both the USACE and WCA use MnRAM 3.0 for quantifying wetland functions and values in Minnesota.

The wetland functions that were typically most applicable to the Mine Site include:

- maintenance of characteristic hydrologic regime;
- maintenance of wetland water quality;
- wildlife habitat; and
- downstream water quality.

Landscape characteristics are also important for evaluating wetland functions within the Project area. Key landscape wetland characteristics considered in rating functional quality in the MnRAM 3.0 assessment are provided in Table 4.2-2.

Table 4.2-2 Key Landscape Factors Influencing Wetland Functional Scores in MnRAM 3.0

MnRAM 3.0 Factor	Role in Wetland Function and Quality
Wetland or Lake Outlet Characteristics	Outlets influence flood attenuation, downstream water quality, and other hydrologic processes
Watershed and Adjacent Land Uses and Condition	Adjacent land uses influence wetland hydrology, sediment and nutrient loading to wetlands, connectivity for wildlife habitat, and other factors
Soil Condition	Soil condition influences plant community type, vegetative diversity, overall wetland quality and productivity (trophic state)
Erosion and Sedimentation	Influences downstream water quality, trophic state of wetlands, vegetative diversity, and overall wetland quality
Wetland Vegetative Cover and Vegetation Types	Influences vegetative diversity and wildlife habitat as well as hydrologic characteristics (e.g., evapotranspiration or resistance to flow in floodplain wetlands)
Wetland Community Diversity and Interspersion	Influences the vegetative diversity and overall wetland quality as well as value for wildlife habitat
Human Disturbance (both past and present)	Mining, logging, road-building, stream channelization, and other alterations to the landscape

Source: MnRAM 3.0

These broader landscape factors were applied and evaluated on a larger scale than a single wetland because there are soil and vegetation similarities within the sub-watersheds that are characteristic of large groups of similar wetland types. Human disturbance factors were also similar across broad areas, notably that the majority of the Mine Site is relatively undisturbed by humans and the limited disturbance that does exist is due to logging. Other local factors were considered for each wetland or small groups of wetlands. Summaries of the vegetative diversity/integrity and overall functional quality rating (low, medium, or high) for each delineated wetland within the Project are tabulated in Table 4.2-3. The plant community diversity/integrity ratings incorporate two principal components: integrity and diversity (MnRAM 3.0). Diversity refers to species richness (i.e. number of plant species). The more floristically diverse a community is, the higher the rating. Integrity refers to the condition of the plant community in comparison to the reference standard for that community. The degree and type of disturbance typically play an important role in the diversity/integrity rating.

4.2.2 Impact Criteria

Determination of the potential impacts on wetland communities is based on the functions and values of the particular wetland. A wetland analysis evaluates the functions (i.e., physical, biological, and chemical processes) and values (i.e., processes or attributes valuable to society) of a wetland. Potential physical impacts affecting a wetland's ability to perform its functions and values are then evaluated to determine the level of potential impact**.**

Wetland impacts may be direct or indirect. The portions of wetlands directly affected by excavation or filling for mining activities would no longer have any wetland functions or values or would not be considered wetland after the mining activity has occurred. Wetlands that are not filled or excavated, but have a reduced function or value, would be considered indirectly affected. The most likely types of indirect impact on the functions and values of remaining wetlands at the Mine Site include fragmentation from haul road construction and indirect hydrological impacts that may result in a conversion of one wetland type to another or the conversion of a wetland to an upland. Other likely impacts include dust accumulation and vehicle emissions and noise.

4.2.3 Environmental Consequences

4.2.3.1 Proposed Action

The Proposed Action includes direct and indirect impacts at the Mine Site, along the transportation corridor (i.e., rail line, water pipeline, and Dunka Road), and at the Plant Site (i.e. specifically the Tailings Basin drainage system). This section describes both direct and indirect impacts within each of these areas and a summary of wetland impacts by project period or time frame.[1]

Potential Direct Wetland Impacts

The direct wetland impacts estimated within the designated proposed Project impact areas would be the result of excavation, filling, or other activities that would result in wetland loss and loss of wetland functions and values. Direct wetland impacts are estimated at 850 acres. Direct impacts to specific Project areas are described in Table 4.2-3.

Mine Site Direct Wetland Impacts

A total of 76 wetlands are located within the Mine Site comprising 1,302 total acres. Of these, 59 wetlands, totaling 804 acres, would be directly impacted. The locations of the wetlands impacted at the Mine Site are shown in Figure 4.2-5. Table 4.2-3 lists the impacted Mine Site wetlands and their community types.

The impacted wetlands would include a number of different types. The most common wetland types are coniferous bog (509 acres) and open bog communities (76 acres). These two communities comprise 73% of the wetland area impacted at the Mine Site (Table 4.2-4). Tribal cooperating agencies disagree. The wetland delineation study (RS14, Appendix A) identified over 390 acres of wetland community with a significant white cedar component. For example, wetland ID-48 (Table 4.2-3) was identified in delineation reports as dominated by white cedar. White cedar is an indicator of mineral rich waters. Renaming wetland ID-48 as a coniferous bog, as was done in Table 4.2-3, does not make that community a bog. Cedar dominated wetlands are cedar swamps, not bogs. The significance of this is that, bogs tend to be precipitation fed while swamps tend to be groundwater fed. Data from the wetland delineations (RS14) suggest that bogs are *not* the most prevalent wetland type. In fact, it appears that wetlands that require groundwater inputs: forested rich peatlands and poor fens are the most prevalent.

[1] Both direct and indirect wetland impact acreages have been modified and changed through the EIS process as the result of refined analysis, and thus impacts enumerated in this DEIS differ to some degree from those in original impact assessment documents and the original PD. The wetland direct and indirect impacts acreages in the following sections and tables depict the proposed wetland impacts based on current information

Table 4.2-3 Total Projected Direct and Indirect Wetland Impact Detail

Project Area	Wetland ID	Dominant Circular 39 Type	Total Wetland Area (acres)	Projected Direct Wetland Impacts (acres)	Projected Indirect Wetland Impacts (acres)	Dominant Community Type	Vegetative Diversity/ Integrity	Overall Wetland Quality	Existing Disturbance Level	Existing Disturbance Type	Wetland Origin	Field Delineated	Impact Type (Direct/Indirect)
Mine Site													
Mine Site	1	3	0.4	0.4	0.0	shallow marsh	Moderate	Moderate	High	Impounded	Natural	Y	Direct
Mine Site	3	3	0.4	0.4	0.0	shallow marsh	Moderate	Moderate	High	Impounded	Natural	N	Direct
Mine Site	5	2	0.6	0.6	0.0	wet meadow	High	High	Low	N/A	Natural	Y	Direct
Mine Site	6	3	0.6	0.6	0.0	shallow marsh	Moderate	Moderate	High	Impounded	Natural	Y	Direct
Mine Site	7	2	0.1	0.1	0.0	wet meadow	Moderate	Moderate	High	Impounded	Natural	N	Direct
Mine Site	8	2	6.2	6.2	0.0	sedge meadow	Moderate	Moderate	High	Impounded/Fill	Natural	Y	Direct/Indirect
Mine Site	9	3	1.8	0.5	0.0	shallow marsh	High	High	Moderate	Impounded	Natural	Y	Direct
Mine Site	10	2	1.2	1.2	0.0	sedge meadow	High	High	Low	N/A	Natural	Y	Direct
Mine Site	11	8	8.9	0.0	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	12	6	0.1	0.0	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	13	2	5.0	0.3	0.0	wet meadow	High	High	High	Impounded	Natural	Y	Direct
Mine Site	14	2	0.3	0.3	0.0	wet meadow	High	High	Low	N/A	Natural	Y	Direct
Mine Site	15	8	2.8	0.0	2.8	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	16	3	0.3	0.2	0.1	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Mine Site	18	3	18.9	18.9	0.0	shallow marsh	High	High	Moderate	Impounded	Natural	Y	Direct
Mine Site	19	3	1.7	1.7	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Mine Site	20	2	21.9	21.3	0.6	sedge meadow	High	High	Low	N/A	Natural	N	Direct/Indirect
Mine Site	22	3	2.5	0.0	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Mine Site	24	6	0.8	0.8	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	25	8	2.0	0.0	2.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	27	8	1.1	1.1	0.0	coniferous bog	Moderate	Moderate	High	Road Fill	Natural	Y	Direct
Mine Site	29	3	12.0	2.3	9.7	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Mine Site	32	8	69.9	63.6	6.3	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	33	6	23.9	8.5	15.5	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	34	6	1.0	1.0	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	37	6	2.4	2.4	0.0	shrub carr	High	High	Low	N/A	Natural	N	Direct
Mine Site	43	6	8.3	8.3	0.1	alder thicket	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	44	6	3.3	2.0	1.3	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	45	6	30.6	20.6	10.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	47	8	0.5	0.5	0.0	open bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	48	8	98.4	40.2	58.2	cedar swamp	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	51	6	2.9	2.9	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	52	6	3.9	2.7	1.1	alder thicket	High	High	Low	N/A	Natural	Y	Direct

Mine Site	53	6	24.2	2.7	0.5	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	54	6	4.9	0.0	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	55	6	3.9	3.6	0.3	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	56	8	2.8	0.0	2.8	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	57	7	78.0	54.7	0.0	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	58	6	33.3	0.1	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	60	6	6.0	6.0	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct

Table 4.2-3 Total Projected Direct and Indirect Wetland Impact Detail (cont.)

Project Area	Wetland ID	Dominant Circular 39 Type	Total Wetland Area (acres)	Projected Direct Wetland Impacts (acres)	Projected Indirect Wetland Impacts (acres)	Dominant Community Type	Vegetative Diversity/ Integrity	Overall Wetland Quality	Existing Disturbance Level	Existing Disturbance Type	Wetland Origin	Field Delineated	Impact Type (Direct/Indirect)
Mine Site	61	7	0.5	0.0	0.0	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	62	8	12.1	0.0	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	64	7	0.3	0.0	0.0	hardwood swamp	High	High	Low	N/A	Natural	N	Direct
Mine Site	68	7	20.1	7.3	12.8	hardwood swamp	High	High	Low	N/A	Natural	N	Direct
Mine Site	72	7	1.4	0.6	0.8	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	74	7	6.1	6.1	0.0	hardwood swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	76	8	3.4	2.4	1.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	77	8	13.0	7.8	5.2	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	78	8	0.8	0.8	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	79	8	2.4	0.0	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	80	8	0.3	0.3	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	81	7	1.7	1.2	0.5	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	82	8	61.5	60.2	1.4	coniferous bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	83	8	4.0	3.7	0.3	open bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	84	8	1.3	1.3	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	85	8	1.4	1.4	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	86	8	2.5	2.5	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	88	8	5.6	4.0	1.6	coniferous bog	High	High	Low	N/A	Natural	N	Direct/Indirect
Mine Site	90	8	184.7	71.9	112.8	open bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	95	8	2.5	2.5	0.0	coniferous bog	High	High	Low	N/A	Natural	N	Direct
Mine Site	96	8	17.3	16.4	0.9	coniferous bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	97	8	3.5	1.7	1.9	coniferous bog	High	High	Low	N/A	Natural	N	Direct/Indirect
Mine Site	98	8	15.5	15.5	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	99	8	1.4	0.6	0.9	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	100	8	192.3	117.7	25.6	coniferous bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	101	8	15.1	7.2	7.9	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	103	8	125.9	116.4	9.5	coniferous bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	104	8	3.6	3.1	0.5	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	105	8	15.5	0.0	0.0	coniferous bog	High	High	Moderate	Logged	Natural	Y	Direct
Mine Site	107	8	65.8	42.1	23.7	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	109	6	6.0	6.0	0.0	alder thicket	High	High	Low	Partly cleared	Natural	Y	Direct
Mine Site	114	8	0.7	0.7	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	120	3	0.6	0.6	0.0	shallow marsh	Moderate	Moderate	Moderate	Impounded	Natural	Y	Direct
Mine Site	200	7	6.4	6.4	0.0	hardwood swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	201	2	13.5	13.5	0.0	wet meadow	High	High	Low	N/A	Natural	Y	Direct
Mine Site	202	7	5.7	5.7	0.0	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site Total	**76**		**1301.8**	**804.1**	**318.1**		**52High 7 Medium**	**52 High 7 Medium**					

Table 4.2-3 Total Projected Direct and Indirect Wetland Impact Detail (cont.)

Project Area	Wetland ID	Dominant Circular 39 Type	Total Wetland Area (acres)	Projected Direct Wetland Impacts (acres)	Projected Indirect Wetland Impacts (acres)	Dominant Community Type	Vegetative Diversity/ Integrity	Overall Wetland Quality	Existing Disturbance Level	Existing Disturbance Type	Wetland Origin	Field Delineated	Impact Type (Direct/Indirect)
Transportation Corridor													
Railroad	R-1	2	1.1	0.0	0.0	wet meadow	High	High	Moderate	Road fill	Natural	Y	None
Railroad	R-2	3	1.7	0.0	0.0	shallow marsh	High	High	Moderate	Road fill	Natural	Y	None
Railroad	R-3	7	0.6	0.1	0.0	hardwood swamp	High	High	Moderate	Road fill	Natural	Y	Direct
Railroad	R-4	6	3.5	0.2	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Railroad	R-5	3	24.4	0.0	0.0	shallow marsh	High	High	Moderate	Impounded	Natural	Y	None
Railroad	R-6	3	10.4	0.0	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	None
Railroad	R-7	6	12.1	0.0	0.0	shrub carr	High	High	Moderate	Impounded	Natural	Y	None
Railroad	R-8	6	3.0	0.0	0.0	shrub carr	High	High	Moderate	Impounded	Natural	Y	None
Railroad Subtotal	**8**		**56.8**	**0.3**	**0.0**		**8 High**	**8 High**					
Dunka Road & Water Pipeline	4000	3		0.8	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4001	3		0.5	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4002	3		0.3	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	22	3		0.5	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4004	3		0.0	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4005	4		0.3	0.0	deep marsh	Moderate	Moderate	Moderate	Impounded	Natural	Y	Direct
Dunka Road & Water Pipeline	4006	5		0.1	0.0	open water	Moderate	Moderate	Moderate	Impounded	Natural	Y	Direct
Dunka Road & Water Pipeline	4007	6		0.9	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4008	6		1.3	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4009	6		0.0	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4010	6		0.7	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4011	6		1.3	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4012	6		0.1	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4013	6		0.9	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4014	6		0.3	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4015	6		0.2	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	54	6		0.5	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct

Dunka Road & Water Pipeline	4017	6	0.0	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct

Table 4.2-3 Total Projected Direct and Indirect Wetland Impact Detail (cont.)

Project Area	Wetland ID	Dominant Circular 39 Type	Total Wetland Area (acres)	Projected Direct Wetland Impacts (acres)	Projected Indirect Wetland Impacts (acres)	Dominant Community Type	Vegetative Diversity/ Integrity	Overall Wetland Quality	Existing Disturbance Level	Existing Disturbance Type	Wetland Origin	Field Delineated	Impact Type (Direct/Indirect)
Dunka Road & Water Pipeline	4018	6		0.2	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4019	6		0.3	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4021	7		0.5	0.0	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline	4023	deepwater		0.5	0.0	deepwater	High	High	Low	N/A	Natural	Y	Direct
Dunka Road & Water Pipeline Subtotal	**22**			**9.8**	**0.0**		**2 Moderate 20 High**	**2 Moderate 20 High**					
Transportation Corridor Total				**10.1**	**0.0**								
Tailings Basin													
East Basin	T1	5		0.2	0.0	open water	Low	Low	High	Impounded	Natural	Y	Direct
East Basin	T2	5		0.9	0.0	open water	Low	Low	High	Impounded	Natural	Y	Direct
East Basin	T3	2		0.1	0.0	wet meadow	Low	Low	High	Ditch	Created	Y	Direct
East Basin	T4	2		1.0	0.0	wet meadow	Low	Low	High	Road Fill			
East Basin	T5	2		0.2	0.0	wet meadow	Low	Low	High	Road Fill	Created	Y	Direct
East Basin	T6	6		0.1	0.0	shrub carr	Low	Low	High	Road Fill	Created	Y	Direct
East Basin	T7	3		0.9	0.0	shallow marsh	Low	Low	High	Impounded	Created	Y	Direct
East Basin	T8	2		0.0	0.0	wet meadow	Low	Low	High	Seepage	Created	Y	Direct
East Basin	T9	2		0.4	0.0	wet meadow	Low	Low	High	Seepage	Created	Y	Direct
East Basin	T10	5		1.5	0.0	open water	Low	Low	High	Impounded	Natural	Y	Direct
East Basin	T11	5		1.0	0.0	open water	Low	Low	High	Impounded	Natural	Y	Direct
East Basin	T12	3		0.4	0.0	shallow marsh	Low	Low	High	Impounded	Created	Y	Direct
East Basin	T13	4		0.6	0.0	deep marsh	Low	Low	High	Impounded	Natural	Y	Direct
East Basin	T14	4		10.1	0.0	deep marsh	Low	Low	High	Impounded	Natural	Y	Direct
East Basin	T15	3		1.7	0.0	shallow marsh	Low	Low	High	Impounded	Created	Y	Direct
East Basin	T31	7		0.0	0.0	coniferous swamp	Low	Low	High	Impounded	Natural	Y	Direct
East Basin Subtotal	**16**			**19.1**	**0.0**		**16 Low**	**16 Low**					
Buttress Area	T16	4		4.5	0.0	deep marsh	Low	Low	High	Ditch	Created	Y	Direct
Buttress Area	T17	7		0.0	0.0	coniferous swamp	Low	Low	High	Impounded	Natural	Y	Direct
Buttress Area	T18	4		1.1	0.0	deep marsh	Low	Low	High	Impounded	Natural	Y	Direct
Buttress Area	T19	4		7.3	0.0	deep marsh	Low	Low	High	Ditch/Impounded	Natural	Y	Direct
Buttress Area	T20	7		0.5	0.0	coniferous swamp	Low	Low	High	N/A	Natural	Y	Direct
Buttress Area	T21	6		0.5	0.0	shrub carr	Low	Low	High	Impounded	Natural	Y	Direct
Buttress Area	T23	7		0.2	0.0	coniferous swamp	Low	Low	High	Impounded	Natural	Y	Direct
Buttress Area	T24	7		0.1	0.0	coniferous swamp	Low	Low	High	Impounded	Natural	Y	Direct
Buttress Area	T25	6		0.0	0.0	shrub carr	Low	Low	High	Impounded	Natural	Y	Direct
Buttress Area	T26	6		0.7	0.0	shrub carr	Low	Low	High	Impounded	Natural	Y	Direct
Buttress Area	T27	7		0.0	0.0	coniferous swamp	Low	Low	High	Impounded	Natural	Y	Direct
Buttress Area	T28	6		0.0	0.0	shrub carr	Low	Low	High	N/A	Natural	Y	Direct

Buttress Area	T29	2	<0.1	0.0	wet meadow	Low	Low	High	Ditch	Created	Y	None

Table 4.2-3 Total Projected Direct and Indirect Wetland Impact Detail (cont.)

Project Area	Wetland ID	Dominant Circular 39 Type	Total Wetland Area (acres)	Projected Direct Wetland Impacts (acres)	Projected Indirect Wetland Impacts (acres)	Dominant Community Type	Vegetative Diversity/ Integrity	Overall Wetland Quality	Existing Disturbance Level	Existing Disturbance Type	Wetland Origin	Field Delineated	Impact Type (Direct/Indirect)
Buttress Area	T30	4		0.0	0.0	deep marsh	Low	Low	High	Impounded	Natural	Y	Direct
Buttress Area	T32	4		1.3	0.0	deep marsh	Low	Low	High	Ditch/Impounded	Natural	Y	Direct
Buttress Area	T33	3		0.7	0.0	shallow marsh	Low	Low	High	Ditch/Impounded	Natural	Y	Direct
Buttress Area	T34	6		0.1	0.0	shrub carr	Low	Low	High	Ditch/Impounded	Natural	Y	Direct
Buttress Area Subtotal	**17**			**16.9**	**0.0**		**17 Low**	**17 Low**					
Tailings Basin Drain System	None	None	0.0	0.0	0.0								
Tailings Basin Indirect Impacts				0.0	319.7								
Tailings Basin Subtotal				36.0	319.7								
Project Total	**139**		**1358.6**	**850.2**	**637.8**								

Source: RS20T, Barr 2008, Wetlands Mitigation Plan Supplement

Table 4.2-4 Summary of Total Project Direct and Indirect Wetland Impacts by Eggers and Reed Classification[1]

Project Area	Circular 39 Eggers and Reed Wetland Classification	1 Seasonally Flooded	2 Fresh (Wet) Meadow	2 Sedge Meadow	3 Shallow Marsh	4 Deep Marsh	5 Shallow, Open Water	6 Shrub Carr	6 Alder Thicket	7 Hardwood Swamp	7 Coniferous Swamp	8 Open Bog	8 Coniferous Bog	NA Deepwater	Wetland Total
Mine Site	Direct (acres)	0.0	28.7	14.7	25.6	0.0	0.0	2.4	65.1	19.8	62.2	76.1	509.4	0.0	804.0
	Indirect (acres)	0.0	0.6	0.0	9.8	0.0	0.0	0.0	28.7	12.8	1.3	113.1	151.8	0.0	318.1
	Total (acres)	0.0	29.3	14.7	35.4	0.0	0.0	2.4	93.8	32.6	63.5	189.2	661.2	0.0	1,122.1
	# wetlands	0	3	5	9	0	0	1	13	3	4	3	23	0	64
Railroad	(acres)	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.3
	# wetlands	0	0	0	0	0	0	1	0	1	0	0	0	0	2
Dunka Road/Water Pipeline	(acres)	0.0	0.0	0.0	2.0	0.2	<0.1	6.1	0.5	0.0	0.4	0.0	0.0	0.5	9.7
	# wetlands	0	0	0	5	1	1	12	1	0	1	0	0	1	22
Tailings Basin Drain System	(acres)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	# wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tailings Basin - East Basin Expansion Area	(acres)	0.0	0.0	1.8	3.0	10.7	3.5	0.1	0.0	0.0	<0.1	0.0	0.0	0.0	19.1
	# wetlands	0	0	5	3	2	4	1	0	0	1		0	0	16
Tailings Basin - Buttress Area	(acres)	0.0	<0.1	0.0	0.7	14.2	0.0	1.3	0.0	0.0	0.8	0.0	0.0	0.0	16.9
	# wetlands	0	1	0	1	4	0	3	0	0	3	0	0	0	12
Tailings Basin – Indirect Impacts	Indirect (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	319.7
Total	(acres)	0.0	29.3	16.5	41.1	25.1	3.5	10.1	94.3	32.7	64.7	189.2	661.2	0.5	1,488.0

Source: Eggers and Reed 1997

Notes:

[1] This wetland summary is based on the predominant wetland type within each wetland. Acreage rounded to nearest tenth acre.

Coniferous swamp (62 acres of impact) and alder thicket (65 acres of impact) each comprise about 8% of the projected direct wetland impacts at the Mine Site. In addition, 15 acres of sedge meadow, 26 acres of shallow marsh, 20 acres of hardwood swamp, 29 acres of fresh (wet) meadow, and two acres of shrub carr would also be directly impacted at the Mine Site. At the Mine Site overall, approximately 99% of the directly impacted wetlands are rated as high quality wetlands, while the remaining 1% are rated as moderate quality.

At Post-Closure, the West Pit would fill with water and eventually discharge water to the south into a portion of wetland number 32, which is proposed to be used as a sedimentation pond during the Project (Figures 4.2-1 and 4.2-5), and through several other wetland areas before reaching the Partridge River. Currently, the existing flow path consists of wetlands that convey a flow equivalent to 1.3 cfs (570 gpm). The remains of wetland number 32 would be altered to accommodate a flow of 2.6 cfs (1,160 gpm). The direct impacts to wetland number 32 are included in the wetland impact direct totals (Table 4.2-3). Because a stream channel can be seen in aerial photographs, tribal cooperating agencies take the position that the discharge would follow a stream channel through the aforementioned wetlands.

PolyMet proposes to avoid and minimize wetland impacts by placing waste rock back into the East Pit and Central Pit after Year 11, thereby reducing the need for additional surface stockpile areas that would otherwise affect wetlands. In addition, PolyMet proposes to combine the overburden and Category 1 and 2 waste rock stockpiles. By doing so, the footprint of these stockpiles would be reduced, resulting in less direct wetland impacts.

Plant Site Direct Wetland Impacts

The Plant Site consists of the former LTVSMC Processing Plant and Tailings Basin. The processing area is situated on the top of a hill where no wetland resources are present, therefore, no direct wetland impacts are anticipated under the Proposed Action.

Reuse of the existing Tailings Basin would reduce direct wetland impacts as compared to construction of a new tailings basin. However, additional wetland disturbance would be required for the proposed Tailings Basin modifications.

Under the Proposed Action, the tailings embankment would be constructed using LTVSMC taconite tailings. This would require an approximately 140-foot-wide buttress area on the north side of Tailings Basin and an East Basin Expansion Area on the east and northeast sides of the Tailings Basin. Approximately 17 acres in 14 wetlands would be directly impacted by the north side buttress construction (Table 4.2-3 and Figure 4.2-2). All impacted wetlands, most of which are classified as deep marsh, are rated as low quality. This area has been historically impacted by seepage from the Tailings Basin and other drainage modifications made in the area. Approximately 19 acres in 11 wetlands would be directly impacted in the East Basin Expansion (Table 4.2-3 and Figure 4.2-2). Wetland types include deep marsh, shallow marsh, and wet meadow that are rated as low quality because of impoundment caused by past disturbances including beaver, roads, road ditches, railroad embankments, diversion of surface flow, and construction of the Tailings Basin. No wetland impacts are anticipated with the Tailings Basin drain system since the drains and pump station are planned to be constructed on the lower, existing tailings dam bench.

Transportation Corridor Direct Wetland Impacts

Approximately 0.3 acre of two wetlands would be directly affected by rail spur construction (Table 4.2-3 and Figure 4.2-3). The wetland impacts proposed in the spur connection area include a hardwood swamp dominated by aspen and a shrub carr wetland dominated by willow and speckled alder. The rail spur was designed to avoid wetlands to the extent possible within the requirements for rail construction based on a portion of the spur being located on an existing rail alignment.

The treated water pipeline corridor and improvements to Dunka Road would require that approximately 10 acres of wetlands be directly impacted by construction involving 19 wetlands (Table 4.2-3 and Figure 4.2-4). These wetlands include shallow marsh, deep marsh, open water, shrub carr, and coniferous swamp habitats.

Potential Indirect Wetland Impacts

Indirect wetland impacts considered in the analysis included the following conditions that could potentially result in indirect impacts to wetlands inside and outside the defined Mine and Plant Sites:

- Wetland hydrology changes that could result from surface water flow changes from the surrounding sub-watersheds or adjacent rivers or streams;
- Changes in groundwater flow to groundwater-fed wetlands that could result from mine pit dewatering and waste rock stockpile construction; or
- Non-hydrologic changes that could impair wetland functions, including wildlife loss/fragmentation, fugitive dust and vehicle emissions from haul vehicles.

For each area assessed for direct wetland impacts – Plant Site (including the Tailings Basin drainage system), Mine Site (including haul roads), and transportation corridor (i.e., rail line, treated water pipeline, and Dunka Road) – the potential for indirect impacts to wetlands located in and around the impact area was also assessed and summarized below.

Tribal cooperators note that the work needed to properly assess indirect wetland impacts at the mine site and at the plant site has not been completed. It is the position of the tribal cooperating agencies that the wetlands work group should finalize the indirect wetland impact workplan and that the results of that investigation be included in the DEIS to allow a full public review.

Mine Site Indirect Wetland Impacts

Tribal cooperating agencies note that there is no reliable groundwater model for groundwater drawdown impacts of the proposed project. The estimates of groundwater drawdown are currently based on anecdotal observations and analysis of historical aerial photography. Therefore, there is no quantitative assessment of mine related drawdown of the regional water table. This serious data gap has prevented an adequate indirect impact assessment for wetlands from being conducted.

The proposed mining activities include the mine pits and a dike and ditch system that minimizes lateral movement of surface water and shallow groundwater within surface deposits. This system was designed to minimize the amount of surface water flowing onto the Mine Site; eliminate process wastewater and non-contact storm water flowing uncontrolled off the Mine

Site; and minimize the amount of storm water flowing into the mine pits. Reactive waste rock stockpiles would be lined to prevent leachate from affecting adjacent wetlands. Where dikes intersect wetlands, seepage control measures would be installed to restrict groundwater movement through higher permeability areas with the intention of helping to prevent drawdown of wetland water levels near mine pits and reduce inflows to the mine pits, although hydrologic impacts to wetlands from pit dewatering are not expected to be significant, as discussed below.

Process water would include storm water and groundwater that has contacted disturbed surfaces and may not meet discharge limits. Process water would be collected and piped to the CPS, treated if necessary at the WWTF, and pumped to the Tailings Basin and eventually to the East/Central Pit. Post-Closure, the East/Central Pit would discharge to the West Pit and eventually to wetland number 32, which would be altered for use as a sedimentation pond during the Project as discussed above.

Haul roads at the Mine Site would be constructed to drain runoff to one or both sides by crowning (peaking) the road, either in the middle of the road or along one side. Depending on the height of these roads, a drainage ditch would either be built in the road section or adjacent to the road. These ditches would only collect runoff from the road cross-section, since storm water from adjacent areas would be intercepted and redirected before entering the road section. Haul road construction would include placement of large rocks as a foundation to allow shallow subsurface groundwater flow paths in the wetlands to be maintained within the active areas of the Mine Site between the pits and stockpiles. This measure would reduce the potential indirect hydrological impacts associated with these remaining wetlands since watershed areas would be maintained closer to the existing conditions.

Wetlands within the Project area and immediately adjacent to the impact areas are surface water wetlands, relying mostly on precipitation events and shallow subsurface flow. Based on a preliminary study, groundwater-supported wetlands are considered to be minimal in the area (Barr 2008, Memorandum: Indirect Wetland Impacts at the Mine Site). This is further substantiated based on a review of historic aerial photographs of the area near the Peter Mitchell Mine. This review indicated that mine pit dewatering activities at the Peter Mitchell Mine did not significantly impact nearby wetlands, indicating a lack of strong hydrologic connection between the wetlands and ground water aquifer (Adams 2009). Depending on the extent of the hydrological changes at specific wetlands, indirect wetland hydrology impacts may result in conversion of wetland types (i.e., conversions of alder thicket, hardwood swamp, or coniferous bog wetlands to sedge meadow or shallow marsh or other wetland types) or the conversion of wetlands to uplands.

As previously discussed, tribal cooperating agencies have reviewed the information in the Adams 2009 email and have concluded that the methods used are not sufficient for prediction of pit dewatering impacts to wetlands. Tribal cooperating agencies fail to see how the aerial photographs presented in the email substantiate the assumption that wetlands are not connected to groundwater particularly with regards to the Peter Mitchell Pit. Additional detail on this topic is available is section 4.1. In addition, based on the vegetation data collected from wetland delineations it appears that groundwater supported wetlands are common in the Project area. Indirect impacts to communities that require groundwater inflow have not been determined, but would likely be significantly different than expected impacts from the Project to perched bogs.

To analyze potential hydrologic changes and related effects on surface water wetlands, the Mine Site and surrounding lands were divided into 24 contributing watershed areas, or tributary areas, representing the existing, relatively undisturbed conditions at the Mine Site (Figure 4.2-6). During mining and Post-Closure, this number would be reduced to 22 watershed areas, and the size of the watersheds would change (Figure 4.2-7). In most of these watershed areas, the local, shallow groundwater flow recharging the remaining wetlands is predicted to be reduced by 6-8%, except for wetlands in the East-Central watersheds (sub watersheds Main 07e, PM 11, and PM 08). For the wetlands in this area, a 10% reduction in recharge flow is predicted during the Project followed by a 30% increase in flow Post-Closure (Barr 2008, Memorandum: Indirect Wetland Impacts at the Mine Site).

The hydrologic changes within the Mine Site as described above could indirectly impact wetlands by affecting wetland type. Approximately 28 acres of wetlands are estimated by PolyMet to be indirectly affected in and around the Mine Site. These indirect impacts are likely to occur in wetland areas between the stockpiles and pits where fragmented wetlands are not likely to remain sustainable in their current function.

Beyond these 28 acres, other wetland areas on the Mine Site are likely to experience indirect impacts due to additional hydrologic impacts as well as fragmentation, dust, vehicle emission, and noise effects on wetland functions and values. In addition to hydrologic changes, the functions of many of the remaining wetlands within the Mine Site would be adversely affected by fragmentation, dust, vehicle emissions and noise due to construction and use of haul roads, dikes, and stockpiles. It is expected that the wildlife habitat function of the fragmented wetland areas within the Mine Site would be compromised given the restricted access to these areas. Most of the remaining wetlands within the interior of the Mine Site that are located between or near the haul roads, open pits, and stockpiles are likely to be indirectly impacted. In addition to these areas, indirect impacts are likely to occur to wetlands located within 50 feet and outside of the ditch and dike system located next to the Category 1 and 2 and Category 3 stockpiles along the western, northern, and eastern exterior boundaries of the Mine Site. These indirect impacts would result from noise, dust, and general disturbance from construction and operation of the mine features. Some haul roads and dikes would be removed at Closure, thus partially restoring some wetland functions.

Based on these potential changes to wildlife habitat and site hydrology, as well as dust, vehicle emissions, and noise, it is estimated that an additional 290 acres of wetlands are likely to be indirectly impacted by the Proposed Action beyond the 28 acres estimated by PolyMet, for a total of 318 acres (Table 4.2-3 and Figure 4.2-5). The type, function, and/or value of these wetlands are likely to be adversely impacted over time. The additional 290 acres of predicted impacts that are beyond the 28 acres originally estimated have not been included in the wetland mitigation planning to date. Compulsory mitigation would be required for these additional indirect impacts. Tribal cooperating agencies take the position that indirect impact acreages would be greater if data and quantitative analysis of mine induced drawdown had been conducted. Additional detail on the inadequacies of the existing groundwater modeling are available in section 4.1.

In addition to these predicted indirect impacts to wetlands on the Mine Site, the potential exists for additional minor and localized indirect wetland impacts in areas outside of the Mine Site. Dewatering of wetlands associated with mine pits is anticipated to be minimal, with little to no dewatering of wetlands outside the Mine Site (Section 4.1.1). Tribal cooperating agencies take the position that this conclusion is faulty. Based on the vegetation data collected from wetland delineations it appears that groundwater supported wetlands are common in the Project area. Indirect impacts to communities that require groundwater inflow have not been determined, but would likely be significantly different than the expected impacts from the Project to perched bogs. This conclusion is based on empirical observations at taconite surface mining operations in the region, including the nearby Peter Mitchell Mine to the north of the Mine Site which shows little indirect hydrological impacts to adjacent wetlands from mine dewatering (Adams 2009). Observations of wetlands at other mining sites in the Iron Range further support this conclusion (AMEC 2007; Barr 2009, Northeastern Minnesota Wetland Mitigation Inventory). As previously discussed, tribal cooperating agencies have reviewed the information in the above referenced email (Adams 2009) and it is the Tribal cooperating agencies' position that the methods used are insufficient for prediction of indirect impacts to wetlands. For example, the projects listed above are located in upland areas of the range and are not proper reference sites for potential impacts at the PolyMet mine site. The Peter Mitchell Mine, although in close proximity, is very shallow compared to the proposed mine pits (Peter Michell pit is approximately 80 feet deep, PolyMet pit is aproximately 800 feet deep) However, the surrounding area outside the Mine Site is also included in the Hydrological Monitoring Plan (Barr 2005). Any additional impacts impairing wetland functions and values that may be detected during future monitoring would also need to be mitigated. Wetland permitting conditions should stipulate monitoring of this area for indirect impacts and require compensatory mitigation should adverse impacts occur. Tribal cooperating agencies disagree with this approach. Monitoring would only identify impacts after they have become apparent in the wetland. Tribal cooperating agencies take the position that the DEIS should provide a detailed description of reasonably foreseeable impacts to wetlands so that decision makers and the public can have a complete picture of the environmental consequences of this project.

Indirect impacts from water quality changes are not included in this estimate of indirect impacts as these impacts are not expected to occur. Data from monitoring wells in the surficial aquifer indicate that surficial ground water in the vicinity of the Mine Site currently indicates background concentrations of several constituents greater than water quality standards. Predictive groundwater modeling indicates exceedances of groundwater criteria for a number of parameters during operations and Post-Closure for the Proposed Action. Because of the existing exceedances, it is unlikely that water quality changes associated with the Proposed Action would have a significantly adverse effect on wetland function and values as these wetlands are currently rated as high quality and appear not to be adversely impacted by the existing exceedances.

Tribal cooperating agencies strongly disagree with this conclusion. As previously indicated, there is no data based evidence or analysis on which to conclude that wetlands would not be affected by mine related water quality changes. Existing exceedances do not predict plant community changes that may occur due to additional disturbance. The Project's discharges to groundwater and surface waters will have to comply with Minnesota water quality standards.

Transportation Corridor Indirect Wetland Impacts

No significant indirect impacts are anticipated from construction or operation of the new rail spur, the treated water pipeline, or the Dunka Road improvements. Minor indirect impacts from dust and vehicle emissions may occur during facility construction and operations.

Tribal cooperating agencies disagree with this conclusion. As indicated in section 3.1.3 it is likely that ore dust would spill from rail cars and be deposited in wetlands adjacent to the rail line. No analysis of any type has been conducted to determine if such impacts would be significant.

Plant Site and Tailings Basin Indirect Wetland Impacts

No wetlands are located within the Processing Plant area; therefore, no indirect wetland impacts would occur from its continued use.

Use of the existing LTVSMC tailings basin would involve the placement of PolyMet tailings in Cells 1E/2E of the existing basin. No surface water would be allowed to discharge. During and after basin operations, there would be insufficient water source to fill and overtop the basin into the adjacent wetlands as the tributary area for the basin is small. Adequate freeboard would be maintained through ongoing operational adjustments to avoid overtopping of the Tailings Basin; in addition, an emergency overflow spillway would be constructed as part of the basin Closure plan, which would direct spillage through a channel to a suitable discharge location (Figure 3.1-38).

Under the Proposed Action, management of water from horizontal drains and seepage barriers placed along the outside footer of the dams associated with Cells 1E/2E would occur during both operations and long term (Post-Closure). This surface seepage would be collected and returned back into the basin as long as seepage continued to occur. Tribal cooperating agencies take the position, based on the existing available contaminant modeling, that seepage capture would be needed for hundreds or thousands of years to avoid water quality and quantity impacts to wetlands.

Indirect impacts to wetlands from inundation due to increased seepage from Cell 2E are likely based on indications of such impact from historical operation of Cell 2W, as indicated by review of aerial photography (Figure 4.2-8). The predicted indirect wetland impacts north of the Tailings Basin were estimated from the historic impacts of Cell 2W using a comparison of estimated hydraulic head in the cells. The northern extent of the wetland impacts from Tailings Basin cells was assumed to be directly proportional to the head pressure in those cells, as indicated by the height of the cell. The ratio of the heights of Cells 2E and 2W were calculated, and that ratio was used to estimate the predicted extent of impacts north of Cell 2E relative to the observed historic impacts north of Cell 2W. The percentage of mapped wetlands north of Cell 2E that would be impacted was assumed to be equal to the percentage of mapped wetlands north of Cell 2W that were impacted (approximately 100 percent) and impacts to wetlands within the footprint of the expanded buttress area north of Cell 2E were excluded from the analysis as they were accounted for previously.

The final elevation of the pond in Cell 2E is approximately 1,722 feet mean sea level (MSL) (January 2007 PD), or approximately 222 feet above the local base elevation (approximately 1,500 feet MSL). The net difference in the height above grade for Cell 2E is approximately 3.3 percent greater than Cell 2W (215 feet above grade or 1,715 feet MSL). Based on the procedure described above, the northern extent of the seepage impacts from the toe of Cell 2E was estimated to be approximately 0.78 mile, or 3.3 percent further than the northern extent of the impacts from Cell 2W (0.75 mile). The lateral (east and west) extent of the estimated impacts was estimated using the evaluation area boundary identified by Barr Engineering in the technical memo *Lined Tailings Basin Alternative – EIS Data Request* (Barr 2008).

Tribal cooperating agencies take the position that the method presented above is inadequate to assess indirect wetland impacts. This method ignores the fact that there is an area of uplands north of cell 2W which has constrained the movement and direction of tailings basin seepage. Therefore, using the northern extent of wetland impacts of 2W for 2E, north of which there are no uplands, is unjustified. Ignoring the presence of the upland area north of cell 2W creates an underestimation in the extent of wetland impacts due to seepage.

Tribal cooperating agencies have suggested a more conventional method for indirect wetland impact estimation to the lead agencies (Methods for evaluating indirect hydrologic impacts to wetlands, March 26, 2009). This method could be applied at both the mine site and the plant site. The method proposed by tribal cooperating agencies was developed by a consultant for the Army Corps for use in another sulfide mine project EIS (Crandon Mine Project Environmental Impact Statement: Wetlands Technical Memorandum, 2003). In addition to having been developed by the Army Corps, this method has been presented by tribal technical staff at professional conferences (Society of Wetland Scientists Conference, 2009 and 55th Annual Meeting of the Institute of Lake Superior Geology, 2009). Tribal cooperating agencies do not agree that the unconventional method described above can produce defensible results for indirect hydrologic impacts to wetlands. A more robust method should be used and the analysis presented in the DEIS so the public can review a science-based assessment of potential impacts.

The wetland impacts were determined using NWI-mapped wetlands overlaid on a 2003 aerial photograph. The evaluation area for this analysis was bounded by the northern edge of the proposed buttress area, the east and west boundary of the April 2, 2008 technical memo evaluation area, and the estimated northern extent of the seepage as described above (Figure 4.2-8). There are approximately 488.3 acres of mapped wetlands within the evaluation area; however, some of the historic impacts from Cell 2W (approximately 168.6 acres) extended into the Cell 2E evaluation area. The remaining 319.7 acres of mapped wetlands do not appear to have been affected by the historic Tailings Basin operations. Based on the assumptions described above, 100 percent of the remaining 319.7 acres of mapped wetlands within the Cell 2E evaluation area are anticipated to be impacted by seepage from the toe of Cell 2E.

Data from five monitoring wells in the surficial aquifer have provided historical monitoring of water quality indicator constituents such as specific conductance, total dissolved solids, and sulfate. Additional sampling at the five monitoring wells for Project-specified constituents was also completed in 2007 (RS74A, Barr 2008). These data indicate that surficial ground water in the vicinity of the Tailings Basin has current concentrations of several constituents greater than water quality standards, some of which exceed only the secondary Maximum Contaminant Level (sMCL) based on aesthetics. The historical areal extent of this impact is unknown due to the lack of other downgradient monitoring wells.

Tribal cooperating agencies note that there is a serious inconsistency between this section and information presented in Section 4.1.3.1 of this document. Section 4.1.3.1 states:

> "Therefore, future impacts to the hydrology of the aquifer and wetlands downgradient of the Tailings Basin were estimated by comparing predicted seepage rates for the Proposed

> Action (Hinck 2009) with the estimated groundwater flux capacity of the aquifer (155 gpm)(Technical Memorandum: TB-2 and TB-14: Tailings Basin Seepage Groundwater Quality Impacts Modeling Methodology). The current seepage rate toward the Embarrass River from the Tailings Basin (Cells 1E/2E and 2W) is estimated at 1,795 gpm, which continues to result in the upwelling of seepage water into the wetlands as the seepage rate exceeds the aquifer flux capacity by over 1,600 gpm. Under the Proposed Action, the unrecovered seepage rate is predicted to increase to a maximum of approximately 3,800 gpm in Year 20, over 2,900 gpm of which would be attributable to PolyMet (Hinck 2009). Therefore, under the Proposed Action, a significant increase (>100%) in groundwater upwelling relative to existing conditions would be expected. Some of this seepage water would drain to existing streams, but because of the generally flat topography and extensive wetlands, much of this water would be expected to form ponds and inundate wetlands."

Tribal cooperating agencies take the position that the latest relevant information developed for the water resources section has not been incorporated into the wetland impact section. The presentation of two different methods is confusing and does not provide an adequate assessment of wetland impacts. A thorough hydrologic impact analysis that incorporates actual seepage rates from the tailings facility should be conducted. In addition, these seepage rates should be used, in conjunction with tailings basin water chemistry information, to assess the effects of this untreated discharge to the biota and functional values of the Embarrass River watershed wetlands.

Predictive modeling indicates that, as a result of seepage from the existing Tailings Basin, the groundwater flowing under the Tailings Basin and recharging to adjacent wetlands would continue to exceed Minnesota groundwater standards for some parameters near the Tailings Basin. During Project operations and Post-Closure of the Tailings Basin, modeling predicts exceedances of groundwater quality criteria for several metals, some of which will exceed only the sMCL based on aesthetics (Tables 4.1-23 and 4.1-32, Barr 2008, Plant Site Groundwater Impact Predictions). In some instances, such as with aluminum and manganese that currently exceed the sMCL, the modeling predicts continued exceedances of the standards, but the concentrations will be less than the existing reported averages (Barr 2008, Plant Site Groundwater Impact Predictions). In addition, these and the other water quality parameters are predicted to not exceed Minnesota surface and groundwater quality standards beyond PolyMet's property boundary (RS74B, Barr 2008). Based on the existing water quality standard exceedances of some constituents and the predicted concentrations, it is unlikely that wetlands would be indirectly impacted due to water quality beyond what has historically occurred.

Tribal cooperating agencies disagree with the logic of the previous paragraph. Should it receive permits for its project, PolyMet will assume responsibility for all legacy contamination caused by the tailings basin to surface water, groundwater and wetlands. Therefore, tribal cooperating agencies take the position that the current exceedances, which are the result of decades of untreated discharges from the tailings basin, must be addressed by PolyMet as part of its closure plan.

It is recommended that the Tailings Basin wetland area be included in the wetlands monitoring to be conducted during operations and Closure; in the event that the monitoring indicates adverse impact, appropriate mitigation would be implemented such as hydrologic controls or compensatory mitigation. Additional recommendations regarding the wetland monitoring plan are provided in Section 4.2.4.3.

Summary of Direct and Indirect Wetland Impacts

The Proposed Action would impact an estimated 1,168 acres of wetlands, including 850 acres of direct impacts at both the Mine Site and the Plant Site and 318 acres of indirect impacts at the Mine Site. In addition, approximately 320 wetland acres may be indirectly impacted north of the Tailings Basin, for a total impact of 1,488 acres. As previously stated, tribal cooperating agencies disagree with these conclusions and take the position that that acreage totals for indirect impacts are underestimated.

Of the 1,168 acres of impacted wetlands at the Mine Site and directly impacted wetlands at the Tailings Basin, bogs are the most prevalent impacted wetland type, with a total of 661 acres in coniferous bogs and 189 acres in open bogs (73% of total wetland impact). Tribal cooperating agencies take the position that data from the wetland delineations indicate that bogs are *not* the most prevalent wetland type. In fact, it appears that wetlands that require groundwater inputs: forested rich peatlands and poor fens are the most prevalent. A total of 94 acres of impacts are proposed in alder thicket communities and 10 acres in shrub carr communities (together constituting 9% of impacts). Swamp impacts include 65 acres of coniferous swamp and 33 acres of hardwood swamp (8% of impacts). Remaining impacts include 17 acres of sedge meadow communities and 29 acres of wet meadow communities; deep marsh impacts of 25 acres and shallow marsh impacts of 41 acres; and 4 acres of shallow/open water wetland communities along with less than one acre of deepwater habitat.

The quality of wetlands affected is a key factor in determining effects on wetland functional values. Section 4.2.1.4 and Table 4.2-2 provide an assessment of wetland functional values, including evaluation of applicable wetland functions and ratings of the vegetative diversity/integrity value based on MnRAM 3.0 guidelines. All the wetlands associated with the Mine Site are of natural origin; however, several wetlands associated with the Tailings Basin mitigation are a result of human activities. Approximately 96% of the total wetland areas to be affected, either directly or indirectly, are high quality wetlands with about 1% rated as moderate quality and the remaining 3% as low quality. The Mine Site wetlands typically have a high vegetative diversity/integrity score and a low disturbance score, representing high functions and values (MnRAM 3.0) while the wetlands at the Tailings Basin have generally been disturbed and are of lower quality. Tribal cooperating agencies note that potentially impacted wetlands that are part of the 100 Mile Swamp were identified by the forest biologist in 1997 as "lacking ecosystem representation in protected areas." (SNF 1997, January) Interest in protecting the unique character of these wetlands was based on their "watershed integrity, the presence of riverine ecosystems, and large amount of interior forest present." This information was further substantiated in a report by the MNDNR titled "Evaluation of Selected Potential Candidate Research and Natural Resource Areas." (SNF 1997, December) This document describes the 100 Mile Swamp wetlands as "these sites represent the highest quality remaining examples of characteristic ecosystems in each ecological Landtype Association on the Superior National Forest." Tribal cooperating agencies take the position that this information must be included in the functional assessment for this project and included in the development of mitigation requirements for this project.

It is the position of the tribal cooperators that the proposed action and the preferred alternative would likely not comply with the requirements of section 404(b)(1) guidelines, which do not allow a permit when there are practicable alternatives that would have less adverse effects, when the Project would lead to a violation of state water quality standards or when it would cause or contribute to significant degradation of waters of the United States. Other alternatives that were not considered in the DEIS (e.g. underground mining) would pose less harm to high quality wetlands, and may be less damaging to aquatic resources. As documented in Table 4.1-63, the Project would result in water quality standards violations.

The potential exists for other, minor localized indirect wetland impact areas as a result of the Proposed Action. Hydrological monitoring should be designed to provide information on future hydrological conditions within and outside the Mine Site, and mitigation for any additional minor indirect hydrological impacts occurring inside or outside the Mine Site should be addressed as a permit condition.

4.2.3.2 No Action Alternative

The No Action Alternative would avoid the direct and indirect wetland impacts associated with the Proposed Action. Existing disturbed wetlands associated with the Tailing Basin seepage areas may recover more quickly to a more natural hydrology and more natural wetland system under the No Action Alternative than under the Proposed Action.

4.2.3.3 Mine Site Alternative

Subaqueous disposal of Category 2, 3, and 4 waste rock into the East/Central Pit would slightly reduce the total areal footprint of the stockpiles at the Mine Site. The Category 3 waste rock and lean ore stockpiles under the Proposed Action would be replaced with Category 1 waste rock under this alternative. This Category 1 waste rock was originally to be placed in the East/Central Pit under the Proposed Action. The additional Category 1 stockpiles would be slightly smaller by approximately 33 acres, reducing impact to upland and wetland areas. There would be approximately 7.6 less acres of wetland impacts, most of which is open bog, under this alternative.

Under this alternative, waste water quality from stockpile leachate and runoff would be improved, reducing the potential of indirect impacts to wetlands in the vicinity of the Mine Site.

4.2.3.4 Tailings Basin Alternative

The Tailings Basin Alternative would consist of installation of vertical wells to capture and pump Tailings Basin seepage, Permeable Reactive Barrier (PRB) demonstration testing, partial dry capping of the NorthMet Tailings Basin, increased placement of rock buttress material, and placement of a water discharge pipeline from the Tailings Basin to the Partridge River. These elements, with the exception of the pipeline and potentially the PRB, would be located within the footprint of the Tailings Basin as designed under the Proposed Action, and would result in no discernible differences in direct wetland impacts as compared to the Proposed Action.

The water discharge pipeline would be routed approximately 8.4 miles from the Tailings Basin southerly to a discharge point on the Partridge River (Feigrum 2009). For 5.2 miles of its length, the pipeline would parallel an adjacent plant water supply pipeline. The pipeline would be placed within a 50-foot wide cleared construction corridor, and a berm would be placed over the pipeline's length contiguous with the existing berm over the water supply pipeline. The corridor would be kept cleared of woody vegetation to allow for pipeline inspection and maintenance. Pipeline construction would disturb a total of 50.6 acres, of which 5.2 acres were determined to be wetlands based on GIS analysis of aerial photography, NWI and existing wetland mapping, and Level 3 GAP habitat mapping. Most of these wetland impacts are Type 6 shrub swamp (4.5 acres) with the remainder being marsh or aquatic wetland types. Actual permanent wetland impacts would likely be less than 5.2 acres, as some of these wetlands are likely already impacted somewhat by the existing pipeline and berm. In addition, some of the wetland impacts would be temporary in nature as those wetlands not filled by the pipeline berm would be restored to some level of functionality. It is recommended that existing wetland acreages and impacts be delineated prior to issuance of the Final EIS. Tribal cooperating agencies take the position that this delineation should occur prior to the issuance of the DEIS so that the public can review a complete set of potential impacts from the project.

The extent of direct wetland disturbance from the PRB demonstration test, if any, is currently unknown and would be determined after the test was designed. Some wetlands may be impacted by the testing, which would occur in a location to the north of the Tailings Basin. Should the test be successful and a full scale system implemented across the northern edge of the basin, additional wetland impacts are likely. For both PRB testing and its full-scale implementation, it would be necessary to quantify wetland impacts and obtain wetland permitting and mitigation, as needed, prior to implementation.

4.2.4 Avoidance, Minimization, Mitigation and Monitoring Measures

This section discusses measures that were taken to avoid and minimize wetland impacts, evaluates PolyMet's proposed wetland mitigation, discusses other potential mitigation measures that may benefit wetlands, and identifies key elements of a wetland monitoring plan. A summary of wetland impacts and mitigation is provided in Section 4.2.4.5.

4.2.4.1 Wetland Avoidance and Minimization

PolyMet proposes to avoid and minimize wetland impacts through a number of measures that are incorporated into the proposed mine plan. These include measures at the Mine Site, at the Plant Site, and along the transportation corridor..

At the Mine Site, waste rock would be placed back into the East Pit and Central Pit after Year 11, thereby reducing the need for additional surface stockpile areas that would otherwise affect wetlands. In addition, PolyMet proposes to combine the overburden and Category 1 and 2 waste rock stockpiles, which were separate in the original Project design. By reducing the footprint of these stockpiles, direct wetland impacts are reduced by approximately 58 acres. Reactive waste rock stockpiles would be lined and stormwater runoff that contacted reactive rock would be contained to help prevent water quality-related impacts to adjacent wetlands. In addition, hydrologic impacts would be reduced by the use of seepage control measures, which would be installed at the mine pits to restrict shallow groundwater movement through higher permeability areas and help prevent drawdown of wetland water levels near mine pits. Haul road construction would include placement of large rocks as a foundation to allow shallow subsurface groundwater flow paths in the wetlands to be maintained within the active areas of the Mine Site between the pits and stockpiles.

At the Plant Site, reuse of the existing Tailings Basin would reduce direct wetland impacts as compared to construction of a new tailings basin. Reuse of the Plant Site buildings and surrounding area would eliminate wetland impacts associated with development of a new Plant Site.

The rail spur was designed to avoid wetlands to the extent possible within the requirements for rail construction based on a portion of the spur being located on an existing rail alignment.

4.2.4.2 Wetland Mitigation

The wetland mitigation planning process relied on the WCA wetland replacement siting rules, state compensatory mitigation requirements (*Minnesota Rules* part 7050.0186), and the USACE mitigation policy to first replace lost wetlands on-site, then within the same watershed or county, and finally within adjacent watersheds. The primary goal of the wetland mitigation plan was to restore high quality wetland communities of the same type, quality, function, and value as those to be impacted by the Project to the extent practicable. To achieve that goal, state and federal guidelines were followed during the wetland mitigation planning process, with a preference placed on restoring drained wetlands over creating wetlands. The four main categories of mitigation methods considered appropriate in northern Minnesota by state and federal agencies were 1) restoration of impacted wetlands; 2) enhancement of existing wetlands and buffers; 3) wetland preservation, and 4) wetland creation.

The USACE requires a basic compensation ratio of 1.5:1 (1.5 acres of compensatory mitigation for every one acre of wetland loss) in the northeastern portion of Minnesota where the Project would be located. This ratio can be reduced by qualifying for the following incentives, but can be no less than a minimum 1:1 ratio:

- In-place incentive: the project-specific mitigation site is located on-site or within the same 8-digit hydrologic unit code watershed as the authorized wetland impacts, or bank credits are purchased within the same Bank Service area – reduce ratio by 0.25
- In-advance incentive: the project-specific mitigation site must have wetland hydrology and initial hydrophytic vegetation established a full growing season in advance of the authorized wetland impacts, or bank credits are purchased – reduce ratio by 0.25
- In-kind incentive: the mitigation wetlands are of the same type (same wetland plant community) as the wetlands authorized to be impacted – reduce ratio by 0.25

If none of these incentives are met, the mitigation ratio required is 1.5:1. If one of the three incentives is met, the required mitigation ratio is 1.25:1; if two or three are met, the ratio is 1:1. According to USACE's Compensatory Wetland Mitigation policy (USACE 2009), requirements for mitigation can exceed the 1.5:1 mitigation ratio if the impacted wetlands provide rare or exceptional functions. Tribal cooperating agencies take the position that the large acreage of wetlands to be directly impacted and the high quality of the wetlands warrant a mitigation ratio of greater than 1.5:1.*Minnesota Rules*, part 7050.0186 requires compensatory mitigation to be sufficient to ensure replacement of the diminished or lost designated uses of the wetland that was physically altered. To the extent prudent and feasible, the same types of wetlands impacted are to be replaced in the same watershed, before or concurrent with the actual alteration of the wetland. The WCA states that for wetlands in counties where 80% or more of pre-settlement wetlands exist, including St. Louis County, minimum replacement ratio requirements are as determined by mitigation location, type, and timing (Table 4.2-5).

The actual replacement ratios required in permitting may be more than the minimums shown in Table 4.2-5, subject to the evaluation of wetland functions and values.

Table 4.2-5 Minnesota Wetland Mitigation Ratio Summary

Replacement Location (in place)	Type of Replacement Wetland (in type)	Replacement Process (in time)	Minimum Replacement Ratio
In-place	Same type as impact wetland	In advance	1:1
		Not in advance	1.25:1
	Different type	In advance	1.25:1
		Not in advance	1.5:1
Not in-place	Same type as impact wetland	In advance	1.25:1
		Not in advance	1.5:1
	Different type	In advance	1.5:1

Source: Wetland Conservation Act

PolyMet would ultimately need to satisfy both the federal and state mitigation requirements. The project is estimated to directly impact 850 acres. The project would indirectly impact an estimated 318 acres at the Mine Site and additional wetlands north of the Tailings Basin, estimated at 320 acres. Total impacts are therefore estimated at approximately 1,488 acres. Depending on the location, type, and timing of compensatory mitigation, the minimum required amount of replacement wetlands for direct impacts could potentially range from 850 to 1,275 acres. Although mitigation ratios may not be required at the same level for indirect impacts, additional mitigation for these impacts could range from 638 to 957 acres. Therefore, the minimum total compensatory mitigation for estimated impacts could potentially range from 1,488 to 2,232 acres of replacement wetlands. Actual mitigation would be determined in the permitting process based on replacement ratios used and on the results of wetland monitoring.

Wetland Mitigation Study Limits

The Project lies within the headwaters of the St. Louis River and is also within wetland mitigation Bank Service Area #1. Locations for wetland mitigation projects were evaluated in the following priority order:

1. on-site
2. off-site in the St. Louis River watershed and adjacent watersheds tributary to Lake Superior
3. off-site in watersheds adjacent to the St. Louis River watershed
4. off-site in watersheds neighboring adjacent watersheds

Each of these potential locations areas is described below.

On-Site Mitigation

In accordance with federal and state guidelines, the potential for creating wetlands on-site was considered first. It was determined that the only opportunities for on-site wetland mitigation would occur during Project Closure and reclamation.

The Closure plan for the Mine Site was designed to create and restore on-site wetlands for partial compensation, including 175 acres of wetland development (RS20T Supplement, Barr 2008). The plan includes:

- 30 acres of wetlands created at the existing emergency basin prior to Closure (the existing basin is not planned for NorthMet use) and after an assessment and any needed remediation of impacted sediment from LTVSMC mine operations;
- 75 acres of created wetlands in the Tailings Basin at Closure;
- 30 acres of created wetlands at the mine stockpile areas after removal of the temporarily stored lean ore surge stockpile and overburden storage area; and
- 40 acres of created wetlands within the East Pit after backfilling (additional wetlands beyond these 40 acres would be created in the East Pit, but these wetlands would be used for plant effluent waste water treatment and would not be eligible for mitigation credit).

Other possible methods of on-site mitigation that were evaluated included: 1) development of lacustrine, fringe wetland habitats in the areas adjacent to the mine pits; 2) development of wetlands in other Tailings Basin areas; 3) development of wetlands using in-pit stockpiling in existing taconite pits (an eliminated alternative to the Proposed Action); 4) reclamation of settling ponds to maximize the development of wetlands; 5) development of wetlands upstream of roads and stockpiles, and 6) development of wetlands adjacent to Dunka Road Area 2E. At the current stage of planning it is not possible to estimate the potential extent of wetland mitigation in these areas (RS20T Supplement, Barr 2008). The potential for these methods to provide additional on-site compensatory wetland mitigation would be evaluated as part of the final Closure plan.

Off-Site Mitigation

The initial wetland mitigation study scope focused on the areas containing greater than 80 percent of their historic wetland resources as defined in the WCA. This area was selected as the initial study area to comprehensively cover the priority mitigation areas, with the understanding that suitable opportunities may not be available within each priority area (Figure 4.2-9).

Available wetland mitigation banking credits which were available for purchase by PolyMet were evaluated in portions of Bank Service Areas 1 through 6 and found to be insufficient to satisfy the compensatory mitigation requirements for this Project. Subsequently, a GIS analysis was performed to identify potential wetland mitigation sites within the defined study area (Figure 4.2-10). The primary goal of the analysis was to identify large, potentially drained wetlands located primarily on private or tax-forfeit land within the study area to provide preliminary data for more detailed ground investigations to proceed. To achieve the goal of the mitigation plan, which is to replace lost wetland functions and values using compensatory wetland types in-kind to the degree practicable, areas where drained wetlands could be restored were preferable over areas where wetlands could be created (RS20T Supplement, Barr 2008). Other siting criteria used in the GIS analysis included potential wetland enhancement areas, potential wetland preservation areas, and potential wetland creation areas (RS20T Supplement, Barr 2008). Sites were identified by overlaying and evaluating numerous existing spatial data sources to locate those sites with the greatest mitigation potential. Some of the data sources utilized included:

- Geomorphology/soil types (Loesch 1997)
- Land ownership (separated by county/state/federal and private ownership) (MLMIC 1983)
- Land slope/Digital Elevation Model (MLMIC 1999)
- Streams/ditches (MnDNR 1980)
- Major watersheds
- Land cover (Loesch 1998)

The geomorphology data described a wide variety of conditions related to surficial geology within a hierarchical classification scheme that was devised for use within Minnesota (Loesch 1997). The land ownership data included federal, state, county, city, tax-forfeited, and private land by 40-acre parcels (MLMIC 1983). The digital elevation model was split into three slope classes: 0-1 percent (high likelihood of wetlands), 1-3 percent (moderate likelihood of wetlands), and >3 percent (diminished likelihood of wetlands) (MLMIC 1999). The stream data consisted of mapping of natural watercourses and ditches by the MnDNR (MnDNR 1980). The land cover data consisted of land use–land cover mapping divided into 16 classes based on satellite imagery from June 1995 to June 1996 (Loesch 1998).

The analysis was conducted by establishing specific filtering criteria to identify potential wetland mitigation sites. The general filtering criteria included the following:

- Land slopes of ≤ 1 percent slope
- Mapped areas as peat or lacustrine geomorphology
- Private or county tax-forfeit property
- Areas within 1.1 miles of a ditch, and ultimately
- Areas meeting all of the above criteria with at least 100 contiguous acres

The analysis was limited to sites with more than 100 acres of wetland mitigation potential due to the anticipated difficulties in planning numerous, small wetland mitigation projects, and the desire to identify opportunities that were feasible. In addition, the Project represented an opportunity to restore large wetland systems and provide greater public and ecological benefit that are typically not available to smaller projects.

This GIS analysis resulted in the development of a polygon data layer which contained nearly 900 areas with potential for mitigation in the study area. This analysis resulted in several findings.

First, a large proportion of the study area was in State, Federal, or Tribal ownership. Discussions with the various State and Federal entities regarding wetland mitigation on their respective properties resulted in the following conclusions:

- The US Forest Service was unable to provide assurances that they would be able to protect restored wetlands on Federal lands in perpetuity as required by wetland regulations.
- The State of Minnesota provided general criteria for restoring wetlands on State lands. The criteria required either a justification for how revenue production (i.e., peat mining, forest harvest) would not be affected or provide land in exchange that had a comparable value.

PolyMet determined that these were not acceptable criteria and the State provided no certainty that there would be a viable Project if PolyMet expended 1-2 years of effort to meet the imposed criteria. (This conclusion was supported in part by an effort to restore wetlands on Site 8362, a partially state-owned site, as discussed below.)

- The Board of Water and Soil Resources (BWSR) has oversight regarding the administration of the Minnesota WCA. The BWSR provides guidance and interpretation of the WCA rules and has the most extensive experience with application of the rules. The BWSR's experience with wetland restoration on tribal lands found that impressing permanent conservation easements granted to the State was not possible to protect the restored wetlands.
- PolyMet had a signed agreement with St. Louis County near Floodwood to restore wetlands as mitigation (see discussion on Site 8362 below) for the Project. The agreement was rescinded by another County agency. In addition, legal proceedings through the State legislature and State Court would have been required for ditch abandonment and for placement of a conservation easement on the land.

Therefore it was determined that, because of these uncertainties and risks, mitigation on State, Federal, and Tribal lands represented a minimal potential for a private enterprise to conduct compensatory wetland mitigation on these lands.

Second, many of the wetland systems within the study area have not been affected by historic drainage or other significant alteration. Wetlands that meet the criteria for wetland restoration credits include completely drained wetlands, partially drained wetlands, and wetlands with at least a 20-year history of agricultural production (RS20T Supplement, Barr 2008). Third, much of the study area was characterized by surface geology that is not indicative of large wetland systems prone to be easily drained. The majority of the Arrowhead region, including Cook, Lake, and much of St. Louis counties, is mapped with surface geology typified by steep, igneous bedrock terranes; rolling till plains; and rolling to undulating areas of supraglacial drift (Loesch 1997). These geo-morphological associations are also typically associated with steeper land slopes containing few drained or sufficiently altered wetlands.

St. Louis River Basin

Approximately 101 potential wetland mitigation areas were identified within the St. Louis River watershed and other watersheds tributary to Lake Superior (Figures 4.2-10 and 4.2-11). No potential mitigation sites were identified within the St. Louis River estuary or the Duluth Metropolitan area. The specific areas identified as having potential for wetland restoration were evaluated in more detail by reviewing National Wetland Inventory maps, plat maps, recent aerial photographs, and USGS topography, to find the sites with the highest potential.

The sites with the highest potential were further evaluated by conducting site visits and meetings with various regulatory agencies. The majority of these potential mitigation sites, however, were eliminated from further consideration due to issues that included: lack of wetland drainage or altered land uses that would satisfy the regulatory requirements for compensatory wetland mitigation; infeasibility of planning numerous small projects; potential flooding of private property, roads, or other infrastructure; upstream ditch drainage through the potential wetland restoration areas that would have to be maintained; potential soil contamination; regulatory applicability; complex land ownership; existing peat mining operations; and legal considerations.

The area around Meadowlands and Floodwood appeared to have the most suitable characteristics. Two contiguous areas in this region, covering approximately 270 square miles, were mapped as level peat. The one site found to be initially feasible was designated as site 8362.

Site 8362

Initially wetland mitigation site 8362 was the preferred and only feasible alternative in St. Louis River Watershed, based on the GIS and field investigations (Figure 4.2-11). The site was chosen for several reasons, including:

- Limited private land ownership within and adjacent to the primary area with wetland mitigation potential
- The lack of roads or other public infrastructure that could be affected by wetland mitigation
- The presence of multiple outlets from the wetland to the St. Louis River and the close proximity of the river
- The density of ditching within the wetland
- The apparent lack of flow through the wetland from upstream

Site 8362 was located within the same watershed as the Project, had the greatest potential for wetland restoration with limited peripheral issues, and contained the potential to restore bog wetlands similar to those proposed for impact. Thus site 8362 was initially selected for further study and PolyMet signed an agreement with St. Louis County. Site 8362 is a partially drained, 3,900-acre wetland site containing a combination of raised open bog and raised black spruce bog wetlands. The site is located northeast of the Town of Floodwood and west of the Town of Meadowlands in St. Louis County. Approximately 640 acres of the site are owned by the State of Minnesota with the remainder designated as tax-forfeit land.

Outlets from the site are either natural streams or ditches. In addition, the site has a pattern of ditches that are located one-half mile to one mile apart within the interior of the bog. It was determined that hydrologic restoration of this site would require blocking and filling ditches, logging of trees along the ditches and restoration of bog vegetation. The restoration potential of the site was discussed with Federal, State and local authorities on several occasions during the study period. Numerous site visits, town meetings, and agency meetings were held in order to better understand potential conflicts associated with the development of a restoration plan. The site is utilized by local residents for hunting, tree-topping, and recreation. Several potential issues were raised by local residents and peatland hydrology experts during these meetings and discussions. The agencies requested a more detailed study plan to better document the hydrology of the site, the specific extent of hydrologic drainage, the extent of soil subsidence along the ditches, the presence of demonstrable threats to supporting wetland preservation credits, and other issues raised by the agencies and the public.

Before implementation of a plan to restore wetlands at the site, the agreement with St. Louis County required the completion of several actions:

- The public ditch system would have to be abandoned through the ditch abandonment process, which included public hearings

- The State Legislature would have to pass special legislation allowing a permanent conservation easement to be placed over the restored and protected wetland area
- The State would have to enter into an agreement allowing wetland restoration activities to be conducted on the State-owned land

However, these required actions could not be undertaken until a wetland restoration plan was approved by State and Federal regulatory agencies. In order to complete sufficient planning to support the development of a wetland restoration plan suitable for regulatory approval, a 1-2 year study was going to be needed to develop the information requested by the regulatory authorities and determine the technical and regulatory feasibility.

Further pursuit of wetland restoration activities at Site 8362 was halted for a number of reasons that rendered the site impracticable:

- District court nullified PolyMet's agreement with St. Louis County in April 2007, thereby not allowing any further study of the site.
- Lack of local support, in fact, broad opposition from local residents.
- Extensive hydrologic monitoring and evaluation to document the degree of drainage at the site to support the proposed mitigation credits. This would have required long-term monitoring to adequately demonstrate the drainage and there was uncertainty regarding the outcome of such monitoring. Such monitoring activities were no longer allowed after April 2007 due to the District Court action.
- Preservation credits would only be allowed where there is a demonstrable threat that could be eliminated, i.e., peat mining, tree-topping, or ATV activity. There is only about 400 acres of documented minable peat and the County had indicated they were unlikely to agree to limit tree-topping activities. Therefore, the ability to show a demonstrable threat that would meet regulatory criteria appeared unlikely.
- Even if the agreement with the County was reestablished, that agreement required ditch abandonment proceedings in District Court with public hearings that would likely be opposed by local residents.
- The agreement with the County (if it was to be reinstated) also required receiving legislative authorization to place a permanent conservation easement over the restoration area. The likelihood of that was uncertain.

Watersheds Adjacent to the St. Louis River Watershed

With site 8362 no longer a feasible mitigation option, pursuit of the high priority sites identified in watersheds adjacent to the St. Louis River watershed was initiated along with the continued search for existing bank credits, wetland banks in various stages of planning, and various other potential wetland mitigation opportunities located in central and northwestern parts of Minnesota.

Fifteen sites were determined to have high potential for wetland mitigation in watersheds located adjacent to the St. Louis River watershed (Figure 4.2-11). Of these, 10 sites were evaluated in the Mississippi River–Grand Rapids watershed, three sites were evaluated in the Kettle River watershed, and two sites were evaluated in the Nemadji River watershed.

After further study, these sites were eliminated from further consideration due to issues that included: lack of wetland drainage or altered land uses that would fit the regulatory requirements for restoration credit; potential flooding of roads or other infrastructure; upstream ditch drainage through the wetland that would have to be maintained; regulatory applicability; complex land ownership; existing peat mining operations; and legal considerations.

Watersheds Neighboring Adjacent Watersheds

Ten potential wetland mitigation sites, initially determined to have some potential, were located in watersheds neighboring the watersheds adjacent to the St. Louis River. These sites were evaluated to determine the relative potential for mitigation, the level of risk and uncertainty, and the likely costs. These sites were primarily located in Aitkin County.

Eight of these 10 sites were eliminated from further consideration due to issues that included unwilling landowners, significant private properties that would be hydrologically impacted by wetland restoration, insufficient agricultural history, insufficient wetland drainage to qualify for restoration credit, considerable existing upstream drainage through the site, or active pursuit of the properties by others.

Proposed Off-Site Wetland Mitigation Projects

Two priority properties were identified with willing landowners that had the potential to accomplish compensatory wetland mitigation for nearly the entire Project. These sites are located in watersheds neighboring those adjacent to the St. Louis River and outside the 1854 Ceded Territory (Figure 4.2-11).

Aitkin Mitigation Site

The Aitkin wetland mitigation site is located in Aitkin County within the Mississippi River-Brainerd watershed. At this site, it is proposed to restore 810 acres of wetland and preserve 123 acres of upland buffer (Figure 4.2-12). The overall objective of the restoration plan is to restore the hydrology by removal of the internal drainage system and the construction of outlets that regulate the required hydrological conditions (RS20T Supplement, Barr 2008).

Once hydrology restoration has been achieved, an adaptive management program is proposed to guide development of the restored wetlands to achieve the targeted conditions. The vegetative restoration of each non-forested, non-bog community would be conducted to promote the establishment of characteristic native species that are present in the seed bank or that may be transported to the area from adjacent wetlands. General site preparation would be concurrent with hydrological restoration activities. Existing, non-native, and invasive vegetation would be removed through mechanical means or herbicide application. Diverse, native wetland vegetation is expected to develop in the restoration wetlands from the existing seedbank and from the wetland vegetation that surrounds the wetland restoration site through vegetative propagation and seed dispersal mechanisms. At the end of the second growing season these areas would be assessed to determine if additional seeding is required. These areas include sedge and wet meadows, shallow and deep marsh, emergent fringes, shrub carr and alder thicket.

Hardwood and coniferous swamp along with open and coniferous bogs would require herbaceous and woody species seeding as well as some woody seedling installation. Open and coniferous bogs would also require the installation of a sphagnum moss layer. The Mine Site may provide up to half the donor soil material (i.e., sphagnum) for this mitigation site.

Vegetation in the existing upland areas would be managed to promote natural succession of the existing plant communities. The primary maintenance activity would be control of non-native invasive species such as buckthorn, honeysuckle, and garlic mustard.

Hinckley Mitigation Site

The Hinckley wetland mitigation site is located in Pine County within the Snake River watershed. This site is the proposed location for the restoration of 313 acres of wetlands and the preservation of 79 acres of upland buffer on an existing sod farm (Figure 4.2-13). The overall objective of the Hinckley restoration plan is to restore the hydrologic connection between upstream watersheds and the restoration site and to disable the internal drainage system on site. The restoration process would start with activities to restore site hydrology (RS20T, Barr 2007).

The vegetative restoration of each non-forested, non-bog community would be conducted to promote the establishment of characteristic native species that are present in the seed bank or that may be transported to the area from adjacent wetlands. General site preparation would be concurrent with hydrological restoration activities. Existing, non-native and invasive vegetation would be removed through mechanical means or herbicide application. Diverse, native wetland vegetation is expected to develop in the restoration wetlands from the existing seedbank and from the wetland vegetation that surrounds the wetland restoration site through vegetative propagation and seed dispersal mechanisms. At the end of the second growing season these areas would be assessed to determine if additional seeding is required. These areas include sedge and wet meadows, shallow and deep marsh, emergent fringes, shrub carr and alder thickets.

Hardwood and coniferous swamp along with open and coniferous bogs would require herbaceous and woody species seeding as well as some woody seedling installation. Open and coniferous bogs would also require the installation of a sphagnum moss layer. The Mine Site may provide up to half the donor soil material (i.e., sphagnum) for this mitigation site.

Vegetation in the existing upland areas would be managed to promote natural succession of the existing plant communities. The primary maintenance activity would be control of non-native invasive species such as buckthorn, honeysuckle, and garlic mustard.

4.2.4.3 Other Mitigation Measures

In addition to compensatory wetland mitigation and monitoring, an additional measure was identified with the potential to affect wetlands and is discussed below.

- Maximize the elevation of the Category 1/2 stockpile – This measure would minimize the stockpile footprint, thereby decreasing the area of wetland disturbance from the Project.

4.2.4.4 Monitoring

As discussed earlier in this section, a wetland monitoring plan should be implemented to identify and characterize any indirect effects on wetlands in addition to the predicted impacts described above and provide for appropriate mitigation, including additional compensatory mitigation, as needed. A hydrological monitoring plan for the Project has already been initiated (Barr 2005c) and may need to be expanded. In developing the wetland monitoring plan, the following factors should be considered:

- The monitoring plan should include wetland areas outside both the Mine Site and the Tailings Basin.
- The extent of the monitoring area should be defined in part on the characteristics of and potential impacts to existing wetland areas. Wetlands that should be monitored include those within areas predicted to experience more than 0.25 feet of glacial aquifer drawdown or where there is predicted flooding. Specific monitoring locations within this area should be selected taking into account the degree of dependence of wetlands on groundwater versus precipitation as can be ascertained by existing information, and locations of potential wetlands based on wetland delineations, NWI maps, and aerial photographs.
- Monitoring should include both hydrologic observations (for impacts from inundation and water table reduction) and vegetation impacts (e.g., conversion from wetland to upland species or from one wetland type to another) including a comparison to baseline (pre-mining) conditions. The wetland monitoring plan should be designed, to the extent possible, to differentiate hydrologic impacts from the Project versus non-related actions (e.g., Peter Mitchell Mine expansion) or climate change.
- Monitoring locations should be chosen to include a representative sample that provides a statistically valid interpolation of the various wetland types that occur within the monitoring area as can be ascertained by existing information.
- Reference wetland sites should be monitored for comparison to potentially impacted wetlands.

4.2.4.5 Mitigation Summary

The Proposed Action would impact an estimated 1,488 acres of wetlands, including 850 acres of directly impacts and 638 acres potential indirect impacts. Wetland impacts associated with the various proposed activities are summarized in Table 4.2-4.

The anticipated wetland types to be restored off-site include a combination of the same and different types as the affected wetlands. Some off-site wetlands would be restored in advance of impacts, while other wetlands would be restored after the impacts, including the 175 acres of wetlands proposed to be restored or created on-site at Closure. The first five years of mining activity impact the most wetland acreage (Table 4.2-6); the mitigation plan specifically addresses mitigating impacts from this first operating phase. The entire Aitkin site and the northern half of the Hinckley site would be restored in the first 5 years of the Project (Table 4.2-7). The unavoidable wetland impacts projected during the first five years total 1,038 acres (excluding any potential indirect impacts at the Tailings Basin that may happen within the first five years). Within operating years 6 to 20, an additional 450 acres of wetlands (1,488 total acres over the 20-year life of the Project) would be directly or would likely be indirectly affected by open-pit mining, stock piling, and associated activities (Table 4.2-8).

Table 4.2-6 Summary of Project Direct and Indirect Wetland Impacts by Eggers and Reed (1997)—First 5 Years [1]

Project Area	Circular 39	1	2	2	3	4	5	6	6	7	7	8	8	NA	
	Eggers and Reed Wetland Classification	**Seasonally Flooded**	**Fresh (Wet) Meadow**	**Sedge Meadow**	**Shallow Marsh**	**Deep Marsh**	**Shallow Open Water**	**Shrub -Carr**	**Alder Thicket**	**Hardwood Swamp**	**Coniferous Swamp**	**Open Bog**	**Coniferous Bog**	**Deepwater**	**Wetland Total**
Mine Site	Direct (acres)	0.0	27.4	14.7	21.0	0.0	0.0	2.4	58.4	14.9	62.2	46.5	426.0	0.0	673.5
	Indirect (acres)	0.0	0.6	0.0	9.8	0.0	0.0	0.0	28.7	12.8	1.3	113.1	151.8	0.0	318.1
	Total (acres)	0.0	28.0	14.7	30.8	0.0	0.0	2.4	87.1	27.7	63.5	159.6	577.8	0.0	991.6
	# wetlands	0	3	5	9	0	0	1	12	3	4	3	22	0	62
Raillroad	(acres)	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.3
	# wetlands	0	0	0	0	0	0	1	0	1	0	0	0	0	2
Tailings Basin Drain System	(acres)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	# wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dunka Road/Water Pipeline	(acres)	0.0	0.0	0.0	2.0	0.2	<0.1	6.1	0.5	0.0	0.4	0.0	0.0	0.5	9.7
	# wetlands	0	0	0	5	1	1	12	1	0	1	0	0	1	22
Tailings Basin - East Basin Expansion Area	(acres)	0.0	0.0	1.8	3.0	10.7	3.5	0.1	0.0	0.0	<0.1	0.0	0.0	0.0	19.1
	# wetlands	0	0	5	3	2	4	1	0	0	1	0	0	0	16
Tailings Basin - Buttress Area	(acres)	0.0	<0.1	0.0	0.7	14.2	0.00	1.3	0.0	0.0	0.8	0.0	0.0	0.0	16.9
	# wetlands	0	1	0	1	4	0	3	0	0	3	0	0	0	12
Total	(acres)	0.0	28.0	16.5	36.5	25.1	3.5	10.1	87.6	27.8	64.7	159.6	578.3	0.5	1,037.6

Source: Eggers and Reed 1997

[1] This wetland summary is based on the predominant wetland type within each wetland with acreage rounded to nearest tenth acre. Excludes any indirect impacts that may occur at the Tailings Basin in the first five years.

Table 4.2-7 Summary of 5-Year Wetland Impacts and Mitigation by Eggers and Reed Classification[1]

Wetland Type	Aitkin Wetland Mitigation Area (acres)	Hinckley Wetland Mitigation Area (acres)	Wetland Mitigation Total (acres)	Proposed 5-Year Wetland Impacts (acres)	5-Year Wetland Impacts Compensated[2] (acres)
Deepwater	0.0	0.0	0.0	0.5	0.0
Type 1 Seasonally Flooded	0.0	20.1	0.0	0.0	0.0
Type 2 Fresh (Wet) Meadow	21.8	14.3	36.1	28.0	27.8
Type 2 Sedge Meadow[3]	47.1	5.4	52.5	16.5	37.2
Type 3 Shallow marsh	86.9	0.0	86.9	36.5	62.7
Type 4 Deep marsh	33.6	0.0	33.6	25.1	26.9
Type 5 Shallow, Open Water	0.0	0.0	0.0	3.5	0.0
Type 6 Shrub-Carr	83.9	38.9	122.8	10.1	83.3
Type 6 Alder Thicket	82.8	27.4	110.2	87.6	85.2
Type 7 hardwood Swamp[4]	52.6	0.0	52.6	27.8	38.8
Type 7 Coniferous Swamp	89.1	0.0	89.1	64.7	68.2
Type 8 Open Bog	74.2	0.0	74.2	159.6	59.4
Type 8 Coniferous Bog	238.2	101.2	339.4	578.3	271.5
Wetland Total	**810.2**	**187.2**	**997.4**	**1,037.6**	**761.0**
Upland Buffer	123.1	11.4	134.5	NA	33.6
Total	**933.3**	**198.6**	**1,131.9**	**1,037.6**	**764.16**

Source: Eggers and Reed

[1] Assumes restoration of the entire Aitkin site and the northern half of the Hinckley site within the first 5 years of the Project. Excludes any indirect impacts that may occur at the Tailings Basin in the first five years.

[2] Assumes 1.25:1 replacement for the same wetland types and 1.5:1 for different types. Permitted ratios may vary.

[3] The total restoration area includes 0.8 acres of partially drained wetland at Hinckley, credited at 50 percent of the area.

[4] The total restoration area includes 6.1 acres of partially drained wetland at Hinckley, credited at 50 percent of the area.

Table 4.2-8 Summary of Proposed Wetland Mitigation

Wetland Type	Aitkin Wetland Mitigation Area (acres)	Hinckley Wetland Mitigation Area (acres)	Wetland Mitigation Total (acres)	Proposed Total Project Wetland Impacts (acres)	Total Wetland Impacts Compensated[1] (acres)
Off-Site Wetlands					
Deepwater	0	0	0	0.5	0.0
Type 1 Seasonally Flooded	0	20.1	20.1	0.0	13.4
Type 2 Fresh (Wet) Meadow	21.8	14.3	36.1	29.3	28.0
Type 2 Sedge Meadow[2]	47.1	39.9	87.0	16.5	60.2
Type 3 Shallow marsh	86.9	1.4	88.3	41.1	64.3
Type 4 Deep marsh	33.6	0.0	33.6	25.1	26.9
Type 5 Shallow, Open Water	0.0	0.0	0.0	3.5	0.0
Type 6 Shrub-Carr	83.9	87.1	171.0	10.1	115.4
Type 6 Alder Thicket	82.8	27.4	110.2	94.3	86.0
Type 7 hardwood Swamp[3]	52.6	13.2	65.8	32.7	46.2
Type 7 Coniferous Swamp	89.1	8.4	97.5	64.7	73.8
Type 8 Open Bog	74.2	0.0	74.2	189.2	59.4
Type 8 Coniferous Bog	238.2	101.2	339.4	661.2	271.5
Off-Site Wetland Total	**810.2**	**313.0**	**1,123.2**	**1.168.1**	**845.1**
Upland Buffer	123.1	79.2	202.3	-	50.6
Off-Site Upland Total	**123.1**	**79.2**	**202.3**	**-**	**50.6**
Off-Site Mitigation Total	**933.3**	**392.2**	**1,325.5**	**1,168.1**	**895.7**
On-Site Wetland Mitigation Total	**-**	**-**	**175**	**-**	**117**
Tailings Basin Indirect Impacts	**-**	**-**	**-**	**319.7**	**-**
Totals	**-**	**-**	**-**	**1,487.8**	**1,012.7**

Source:
[1] Assumes 1.25:1 replacement for the same wetland types and 1.5:1 for different types. Permitted ratios may vary.
[2] The total restoration area includes 0.8 acres of partially drained wetland at Hinckley, credited at 50 percent of the area.
[3] The total restoration area includes 6.1 acres of partially drained wetland at Hinckley, credited at 50 percent of the area.

Because the two primary wetland mitigation sites included in this plan are located outside of the Project watershed and the on-site mitigation is planned for completion at the end of the Project, all mitigation for directly impacted wetlands associated with this plan would need to be conducted at a minimum ratio of 1.25:1 or 1.5:1 in accordance with USACE guidance and Minnesota Rules. Assuming the restoration is successfully conducted one full growing season ahead of the impacts, replacement in-kind would be credited at a 1.25:1 ratio. Restoration monitoring would continue over the 20-year life of the Project, with performance standards established at 5 and 20 years (RS20T, Barr 2007). Should in-kind compensatory mitigation be deemed unsuccessful such that an equal area of in-kind replacement is not provided for the impacts, those impacts would be replaced at a 1.5:1 ratio. This would meet the minimum replacement ratio requirements. However, given the high quality of the wetlands that would be impacted by the Project, additional wetland mitigation resulting in higher compensatory ratios may be required by state permitting processes. Conversely, compensatory ratios for indirect impacts may be less than those required for direct impacts.

Off-site wetland restoration of 1,123 acres would provide 845 acres of compensatory wetland mitigation at the applicable mitigation ratios. In addition, a total of 202 acres of upland buffer areas are proposed to be established with native vegetation around the wetland restoration areas. In accordance with USACE guidelines, credit for the upland buffer areas is proposed at a 1:4 ratio, resulting in an additional 51 acres of wetland credits. Assuming a 1.25:1 replacement for the same wetland types and 1.5:1 for different types and including the proposed upland buffer, the proposed off-site wetland mitigation would compensate for 896 acres of the 1,488 acres of proposed wetland impacts, or 60.2% of the total impacts. Compensatory ratios determined in permitting may vary from these assumptions, which would result in a different percentage of mitigated impacts under this plan.

Finally, the Closure plan for the site is designed to create or restore 175 acres of wetlands, not included in the mitigation discussed above. It is planned that the additional wetland mitigation would provide 117 additional compensatory mitigation acres (at an assumed 1.5:1 ratio), for a total wetland credit of 1,013 acres. The on-site mitigation plan includes:

- 30 acres of created wetlands at the emergency basin;
- 75 acres of created wetlands in the Tailings Basin at Closure;
- 30 acres of created wetlands at the mine stockpile areas after removal of the temporarily stored lean ore surge stockpile and overburden storage area; and
- 40 acres of created wetlands within the East Pit after backfilling.

The overall wetland mitigation strategy for the Project is to replace unavoidable wetland impacts in-kind where possible and in advance of impacts when feasible. Due to both on-site and off-site limitations and technical feasibility, it was not found to be practicable to replace all impacted wetland types with an equivalent area of in-kind wetlands. For instance, for the overall Project wetland impacts, the coniferous bog community acreage directly and indirectly impacted will be 661.2 acres and the total coniferous bog wetlands compensated for will be 339.4 acres (based on assumed ratios), a 321.8 acre compensation deficit (Table 4.2-8). Most other wetland community types proposed to be directly impacted will be replaced with comparable wetland communities.

Total proposed on-site and offsite wetland mitigation would compensate for 1,013 of the 1,488 acres, or 68%, of the proposed wetland direct and indirect impacts at the stated mitigation ratios. Compensatory mitigation for the remaining 475 impacted acres, plus or minus any adjustments for higher or lower mitigation ratios that may be required, would need to be addressed through permit conditions. Tribal cooperating agencies take the position that unless the mitigation for the additional 475 wetland acres is identified in the DEIS, or there is a detailed statement of how the permit conditions would address the needed acres, the impacts must be considered unmitigated for purposes of the DEIS.

4.2.5 Cumulative Wetland Impacts

4.2.5.1 Introduction

A semi-quantitative analysis of cumulative wetland impacts was performed. Because several of the primary functions performed by wetlands are directly related to watershed processes, the analysis was performed on the Partridge River Watershed (Figure 4.2-14) that includes the Mine Site, railroad, and haul roads, accounting for approximately 97% of anticipated wetland impacts. The consideration of past, present, and reasonable foreseeable actions provides the context for assessing the wetland cumulative impacts within the Partridge River watershed.

4.2.5.2 Study Area

The Partridge River watershed extends from the City of Babbitt, Minnesota to the mouth of the Whitewater Reservoir near Hoyt Lakes, Minnesota. The MnDNR Census of the Land (1996) identifies the primary land uses in the watershed as bog/marsh/fen, brushed land, forests, water, cultivated land, hay/pasture/grassland, mining, and urban and rural development. The latter four of these land cover classes were assumed to be associated with human impacts; therefore, the areas classified with any of these four land cover classes were identified as areas in which pre-settlement Trygg wetland data would be used (Trygg 1996). While the primary land use classification bog/marsh/fen combines a variety of wetland types, no fens are known to occur in the Project area. Tribal cooperating agencies disagree. Tribal cooperating agencies take the position that, based on the data from the wetland delineations, there are fens in the project area.

Tribal cooperating agencies disagree that limiting the analysis of cumulative wetland impacts to the Partridge River is appropriate. Tribal cooperating agencies take the position that wetland impacts related to regional mining operations throughout the area as well as large wetland impacts of the proposed PolyMet project to the Embarrass River watershed must be included. In addition, the analysis must include impacts related to changes in wetland functional values, only impacts related to direct fill.

At a local scale, PolyMet is likely to impact wetlands in the Embarrass River watershed as water that percolates through the bottom of the tailings facility enters that shallow aquifer. This water, which is likely to have degraded quality, will re-emerge at the surface within wetlands of the Embarrass River watershed. The high chemical load of this water will affect wetlands by degrading water quality and altering the wetland functional values. In addition, PolyMet air emissions may deposit contaminants in the watershed of the Embarrass River and further degrade wetland quality. The full extent of wetland impact resulting from 20 years of emissions from the proposed PolyMet project via air and water must be quantitatively characterized. This quantitative analysis should be done using model output (air, surface and groundwater). A quantitative assessment of changes to functional values should include an analysis of the effects of 20 years of surface and groundwater emissions along with the additive effects of air emissions for Embarrass River Wetlands. Finally, the PolyMet project as proposed includes a possibility of post-closure contamination of surface and groundwater. The wetland cumulative impact analysis must include a quantitative analysis of the long-term effects of mine effluent on wetlands of the Embarrass River. If mine related effluent is to be perpetual, this section must discuss the effects of perpetual mine discharge on wetlands.

In regards to the Partridge River watershed, the analysis correctly focuses on 3 timeframes of analysis; Pre Settlement Resources, Existing Resources, and Future Resources. However, the cumulative impact discussion includes only wetland loss due to direct fill. There is no attempt in the document to assess cumulative impacts that result in changes to functional values. The issue of changes to wetland functional value has been highlighted to the Army Corps of Engineers (ACE) and the Minnesota Department of Natural Resources (MDNR) during technical meetings. The DEIS should provide a quantitative analysis of the cumulative changes in wetland functional values for the Partridge River. This analysis must include the functional value changes related to maintenance of features of the closed mine (e.g. changes in water quality of mine site wetlands, changes in water flow through mine site wetlands, etc.).

At a regional scale, Iron Range taconite mining has impacted wetlands through direct wetland fill as well as indirect impacts due to air deposition of mine related contaminants, water quality degradation, and the flooding/de-watering of wetlands which lead to changes in wetland functional values. There are two additional geographic scales at which wetland cumulative impacts should be characterized:

St. Louis River Watershed. The Fond du Lac band of Lake Superior Chippewa has identified this watershed as an area of concern. The cumulative impact analysis should quantitatively characterize the following:

1. The additive effect of PolyMet related air and water emissions to the Partridge and Embarrass River watershed wetlands and their impact on water quality of the St. Louis River.
2. The loss of wetlands and changes in wetland functional values in the St. Louis River watershed during the 3 timeframes, including a characterization of the potential for future mining impacts and the long-term maintenance requirements of the PolyMet mine as currently proposed.

1854 Ceded Territory. The Fond du Lac, Grand Portage, and Bois Forte tribes retains treaty guaranteed rights to harvest natural resources within the 1854 ceded territory. The cumulative impact analysis should quantitatively characterize the following:

1. The additive effect of PolyMet related air and water emissions to the wetlands of the 1854 ceded territory.
2. The loss of wetlands and changes in wetland functional values in the 1854 ceded territory during the 3 timeframes.
3. Loss of tribal access to wetlands in the 1854 ceded territory due to either the changes documented in 2. above, or due to mitigation of wetland impacts occurring outside of the ceded territory.

Three additional data layers were used to identify human-affected areas, including:

- Minnesota Department of Transportation (MnDOT) road layer for St. Louis County – all roads identified within the study area were buffered at 33 feet on each side of center (for a total width of 66 feet).
- MnDOT railroad layer for Minnesota – all rail lines identified within the watershed were buffered at 15 feet on each side of center (for a total width of 30 feet).

- MnDNR mining features layer (2003) – all areas located within the mining feature area were conservatively assumed to be affected.

Urban areas identified in the watershed include Babbitt and Allen Junction, which are not experiencing growth. The primary area of growth in the watershed is around Colby Lake.

The major highways that connect the cities within the area include State Highways 135, 21, and 110. Several County and Forest Roads are found within the watershed, including CR 680 (FR113), CR 666, FR 420, FR 120, FR 238, and FR 117, along with numerous other unnamed logging roads. Dunka Road, a private road that runs through the Mine Site, runs from east to west across the watershed.

Water resources other than wetlands in the watershed include:

- Several water-filled abandoned pits associated with the west half of the Peter Mitchell mine, as well as several named lakes (Mud Lake, Iron Lake, Big Lake, and Cranberry Lake);
- A number of shallow unnamed waterbodies; and
- Several streams and rivers including the Partridge River, South Branch of the Partridge River, Colvin Creek, Wetlegs Creek, Wyman Creek, and Longnose Creek, Knox Creek, and Second Creek, as well as some unnamed stream reaches.

Historical activities within the Partridge River watershed that have affected wetland resources consist primarily of mining activities that started on a large scale in the early 1950s, along with limited urban development. The remainder and majority of the watershed has had limited disturbance except for logging with some associated loss of wetlands. A more detailed description of the baseline condition for wetland resources within the study area is provided below.

4.2.5.3 Study Methods

Pre-Settlement Wetland Resources and Past Impacts

The wetland area estimated for the pre-settlement time period was developed using historical mapping and the NWI. The process was completed in four steps, as follows:

1. The areas of the watershed with significant human impact prior to development of the NWI were identified. The NWI data was used to help establish the baseline wetland condition in the undisturbed areas of the watershed in and around the 1970s, since it is the best data representing the extent of wetland resources in the Partridge River watershed.
2. The area of pre-settlement wetlands within the areas with significant human impact were estimated using historical wetland mapping (Trygg maps) based on the original government land survey notes (Trygg 1996). The original land survey notes and records were used to produce an original land cover type map of the area (Trygg 1996). This map provides a broad base of upland and wetland conditions prior to significant European settlement.
3. The total acreage of pre-settlement wetlands was estimated. The Trygg maps were used to identify wetlands in areas with significant human impact. The NWI was used to identify wetlands in areas with insignificant human impact.

4. Selected representative historic aerial photographs dating from the 1930s were reviewed for human impact in the watershed.

The Trygg maps use data from the original government land surveys along with other historical surveys and sources. These historical maps included water features that were identified in the original land surveys such as marshes, bottoms, swamps, lakes or ponds, and rivers. These water features were digitized from the Trygg maps in the Partridge River watershed.

A relationship was developed between the "wetlands" and water features shown on the Trygg maps and the NWI wetlands to account for the differences in map scale, mapping methods, and human disturbance. Because the scale of the Trygg maps is relatively small (1:250,000) it is assumed to be less accurate than the larger-scale and more detailed mapping effort used in developing the NWI (1:24,000). Other reasons for the range of difference may be human impacts on wetlands between the time of the original land survey and compilation of the NWI map in the 1970s as well as differences in the purpose and methods utilized in each mapping effort.

The comparison of Trygg and NWI data was initially conducted within 23 townships located within or adjacent to the Partridge River watershed. The land uses within those townships were evaluated using the criteria described above ("Areas of Human Impact") to identify those minimally affected townships in which less than 5% of the land area was classified in the categories associated with human impacts. A total of eight of the 23 townships were identified as minimally affected.

It is assumed that due to the minimal amount of impact on these eight townships, the NWI mapping in these townships is representative of pre-settlement wetland conditions. The data for these eight townships were used to develop a relationship between the NWI and Trygg wetlands. The total wetland acreage for the two data sets was compiled, and the ratio of NWI to Trygg wetlands was calculated to be 1.13 for these townships. This ratio indicates that there are 13 percent fewer wetlands identified using the Trygg maps as compared to the NWI maps. The ratio was used as an adjustment factor to "normalize" the Trygg data to the standards and scales of the NWI data.

Existing Wetland Resources

Wetland areas estimated for the existing conditions were developed by compiling the following data:

- Field wetland delineations completed by PolyMet (RS14, Barr 2006), including the PolyMet Mine Area wetland delineations; railroad connection wetland delineations; Dunka Road/Tailings Basin wetland delineations; 1995-98 wetland delineations conducted at the former LTVSMC site; and the 2003 wetland delineations conducted within the study area.
- The extent of mine pit water bodies was developed using a combination of MnDNR Public Water Inventory maps and interpretation of the 2003 Farm Service Area aerial photography. The extent of open water observed on the 2003 FSA aerial photography was used for pits not covered by the Public Water Inventory maps.
- The NWI was used to identify wetlands in all areas not covered in the above items.

A "composite" wetlands layer was developed by deleting all the NWI wetlands from the areas in which more detailed mapping was completed. These wetlands were replaced with the delineated wetlands and mine pit water bodies as discussed above. This wetland mapping was compared to the historic wetland (baseline) mapping to quantify the effects of past activities on wetland resources within the analysis area.

Projected Future Wetland Resources

The extent of future wetlands was estimated by using the existing conditions wetland mapping and deleting projected future impacts from the map. Wetland losses from the following reasonably foreseeable actions in the Partridge River watershed were forecasted:

- NorthMet Mine
- Portions of the proposed Cliffs Erie Railroad Pellet Transfer Facility in the Partridge River Watershed
- Future expansion of Northshore Mining Company's Peter Mitchell Mine Pits
- Proposed Mesabi Nugget Phase II
- Proposed St. Louis County Highway Connection from Hoyt Lakes to Babbitt

The former LTVSMC mine affected approximately 344 acres of wetlands before the mine closed in 2001. The Peter Mitchell Mine area to the north of the NorthMet site and within the Partridge River watershed has approval to impact 73.6 acres of wetlands incrementally through 2016, of which 16 acres have currently been impacted. The Proposed Mesabi Nugget Phase II Project would impact 254 acres of wetland (Barr 2008, Wetland Delineation and Functional Assessment Report). The St. Louis Highway connector from Hoyt Lakes to Babbitt currently has several proposed alternative routes under consideration. Wetland impacts would most likely occur in the Partridge River watershed for the preferred alternative. Impacts from alternative routes are currently being evaluated and are unavailable at this time.

4.2.5.4 Results: Cumulative Effects Analysis

Impacts related to past, present, and reasonably foreseeable future actions were evaluated through a quantitative summary of the number of acres of various wetland types that were affected in the past and may be affected in the future, and the magnitude of those effects within the Partridge River watershed (Table 4.2-9).

Table 4.2-9 Partridge River Watershed Cumulative Wetlands and Deep Water Habitat Analysis Data Summary

Pre-Settlement Conditions (by Data Source)	**Area (Acres)**
Remote Sensing Wetland Mapping	33
National Wetlands Inventory	30,981
Trygg Map	4,378
Total Pre-Settlement Wetland Acreage	**35,392**
Existing (2007) Conditions (by Data Source)	
Various Wetland Delineations	3,226
Remote Sensing Wetland Mapping	2,331

Pre-Settlement Conditions (by Data Source)	**Area (Acres)**
National Wetlands Inventory	28,323
Total Existing Wetland Acreage	**33,880**
Existing Deep Water Habitat (Pit Water 2003 Aerial Photography)	2,686

Future Conditions (by Type)	
Lacustrine	2,351
Palustrine	30,106
Post Mining Reclamation Wetland	67
Riverine	201
Total Future Wetland Acreage	**32,725**
Future Deep Water Habitat	3,098

Alternative configurations of the Project were evaluated to determine whether the projected impacts can be minimized. Unavoidable wetland impacts would be mitigated in accordance with the state and federal wetland permitting programs.

The analysis for this study indicated that more than 95% of the existing wetlands in the Partridge River watershed would remain in the foreseeable future with or without the NorthMet Project (Table 4.2-9). The northeastern wetlands of Minnesota are unique within the state as well as most of the other parts of the United States, in that the loss of wetlands has remained relatively small. For instance, it has been estimated that the 48 lower states have lost about 53% of pre-settlement wetland habitat (http://www.epa.gov), compared to a minimal loss (estimated at less than 1%) in northeastern Minnesota.

Most wetland impacts in the Partridge River watershed have resulted from past LTVSMC and continuing Peter Mitchell Mine operations and would result from the NorthMet Project. The largest wetland impact that has occurred or is proposed to occur is the projected direct loss of 850 wetland acres with the likelihood for an additional 638 acres indirectly impacted by the NorthMet Project; however, even these impacts are small compared to the estimated 33,880 wetland acres currently present. Wetlands in the study area are similar in type and function to wetlands found throughout this portion of northeastern Minnesota; most are high quality wetlands and consist of black spruce bog/open bog, forested swamp, and alder thicket/shrub carr. No fens have been identified in the Project area. Tribal cooperating agencies disagree. Based on the data from the wetland delineations, fens have been identified in the project area. Many of the wetlands that have classified as open bogs are poor fens and the wetlands classified as black spruce bogs are rich forested peatlands.

The NorthMet Project and other proposed projects within the Partridge River watershed would primarily impact high quality wetlands with significant functions and values because of the relative isolation and lack of human disturbance in the watershed. Mining activities would cause additional habitat fragmentation as well as loss of wetland functions and values. Relative to the 33,880 wetland acres estimated to occur in the Partridge River watershed (Table 4.2-9), the overall proportion of impacted wetlands from these Projects would be about 4.4%. However, because most of the directly and indirectly impacted wetlands are of high quality, the function and values served by the wetlands in the watershed would be expected to be significantly affected by the approximately 850 acres of direct Project wetland impacts and 638 acres of indirect wetland impacts from the Project. Tribal cooperating agencies take the position that the impacts to these wetland acres is significant.

The mitigation plan as described in Section 4.2.5 addresses the compensatory plans to offset the proposed wetland impacts if the mitigation sites are permitted and achieve the required performance levels, but most of the proposed mitigation would occur outside of the Partridge River watershed and outside the 1854 Ceded Territory. In addition, 475 acres of required mitigation has not been addressed.

4.3 VEGETATION

The section describes the existing vegetation conditions in the Project area and evaluates the direct, indirect, and cumulative effects of the Project on cover types, invasive non-native species, and threatened and endangered plant species. We evaluate Project effects on several, partially overlapping categories of critical plant species: federal and state listed endangered, threatened, and species of special concern (ETSC – nine species) and the USFS's Regional Foresters Sensitive Species (RFSS – seven species).

Several plant species have been identified as being of significant tribal concern including wild rice, cedar, and sage. These species are relatively common to northeastern Minnesota; therefore, loss of access to these areas is not anticipated to have a significant impact on tribal use of these plant species. There is no documented tribal use of the Plant and Mine Sites for harvesting these resources. It is the tribal cooperating agencies' position that while there is no current documented tribal use of said resources, most band members do not report their harvest sites. Therefore, it should not be assumed that there is no use of resources in these areas. Additionally, Tribal cooperating agencies note that the Area of Potential Effect for the Project was not determined until August 11th, 2009, and tribal consultation is ongoing. Therefore, historic and current Tribal harvest has not been determined for either the Plant or Mine Sites.

4.3.1 Existing Conditions

4.3.1.1 Cover Types

The Project is in the Laurentian Mixed Forest Province ecoregion, corresponding roughly to the Arrowhead Region of northeastern Minnesota. Because of differences in the level of disturbance, permitting, and mapping, the Mine Site and Plant Site are discussed separately. Detailed ground-verified land cover mapping exists for the Mine Site (ENSR 2005). For the Plant Site, a coarser-scale land cover map was prepared using data from MnDNR. Little native vegetation exists at the Plant Site so detailed land cover mapping was not conducted. Native Plant Community (NPC) rankings for the Plant Site are not available.

Plant Site

The Plant Site is in the Nashwauk Uplands subsection of the Laurentian Mixed Forest Province ecoregion (MnDNR 2003). Most of the vegetative cover types in this subsection grow in acid to neutral glacial materials over Precambrian bedrock. The Plant Site was extensively disturbed by the former LTVSMC taconite mining operation and contains an 80-acre processing plant; an approximately 3,000-acre Tailings Basin; repair shops; office space; and loading and transportation areas totaling approximately 4,425 acres (Table 4.3-1).

Table 4.3-1 NorthMet Plant Site Cover Types

Cover Types	Total Acres	Percent of Area
Disturbed	2,768	62.6
Grass/brushland	263	5.9
Aspen forest/aspen-birch forest	538	12.2
Mixed pine-hardwood forest[1]	122	2.6
Black spruce swamp/bog	182	4.1
Open Water	552	12.5
Total	4,425	99.9[2]

Source: GAP-Land Use Land Cover Data, 1991-1993, Level 3 Descriptions

1 Includes all upland coniferous and deciduous forest cover (pine, spruce/fir, tamarack, maple/basswood, and upland deciduous)

2 Total less than 100 percent due to rounding.

Mine Site

The Mine Site is located in the Laurentian Uplands subsection of the Laurentian Mixed Forest Province ecoregion. Most of the vegetative cover types in this subsection grow in acid to neutral glacial materials over Precambrian bedrock.

The Mine Site consists almost entirely of native vegetation covering 3,016 acres and a majority of the site has been characterized by the Minnesota County Biological Survey (MCBS) as a Site of High Biodiversity Significance[1]. Sites of High Biodiversity Significance contain very good quality occurrences of the rarest species, high quality examples of the rare native plant communities, and/or important functional landscapes (MnDNR 2009, Data Deli). There are also no lands designated, or nominated for designation, as scientific and natural areas (SNAs) in the Project area (Joyal 2009, Personal Communication). The primary cover types at the Mine Site are mixed pine-hardwood forest on the uplands and black spruce swamp/bog in wetlands (Table 4.3-2, Figure 4.3-1). Aspen, aspen-birch, jack pine, and mixed hardwood swamp comprise the remaining forest on the site. The relatively small amount of grass/brushland habitat present is land recovering from past logging through natural succession. Small areas of disturbed ground and open water also occur. Disturbed land was cleared for logging roads and landings. Two vegetation communities, black spruce – Jack pine woodlands and rich black spruce swamp, have been characterized by the MCBS as imperiled/rare and rare/uncommon NPCs, respectively. Aspen-birch forests, alder swamps, poor black spruce swamps, and poor low shrub fens are all considered widespread and secure; however, poor tamarack-black spruce swamps are ranked as secure but may have cause for long-term concern (MnDNR 2009, Data Deli).

Most of the upland forests were harvested in the last 20 to 60 years and are in fair to fair-good condition (ENSR 2005). The oldest forest on the site includes 297 acres of 40 to 80-year-old trees within the mixed pine-hardwood forest in the southwest portion of the Mine Site. Wetlands at the Mine Site were rated as fair to good-excellent (ENSR 2005). A separate wetland delineation by Barr Engineering reported that 99 percent of the wetlands were of high quality (Section 4.2).

1 The MCBS utilizes a four-tiered ranking system (from highest to lowest): Outstanding, High, Moderate, and Below. Characterization data for the Mine Site is preliminary and has not been finalized by MnDNR.

Table 4.3-2 NorthMet Mine Site Cover Types

Cover Types	Total Acres	Percent of Area	Condition Ranking[1]
Disturbed	66	2.2	N/A
Grass/brushland	293	9.7	N/A
Aspen forest/Aspen-birch forest	165	5.5	B, BC, C
Jack pine forest	183	6.1	BC
Mixed pine-hardwood forest	1,003	33.3	B, BC
Mixed hardwood swamp	460	15.3	AB, B, C
Black spruce swamp/bog	843	28.0	AB, B, C
Open water	3	0.1	N/A
Total	3,016	100.2[2]	N/A

Source: Table derived from ENSR 2005.

1 Condition Ranking is a standardized approach to evaluating the ecological condition of vegetation used by the Minnesota Natural Heritage Program. A = excellent, B = good, C = fair, and D = poor ecological condition. Multiple stands of each cover type occur, and each stand has a separate rank.

2 Total exceeds 100 percent due to rounding.

Invasive Non-Native Plants

Invasive non-native[2] plants are a concern because they can quickly form self-sustaining monocultures that out-compete native plants or reduce the quality of wildlife habitat, particularly in disturbed areas. There are few invasive non-native plants at the Mine Site because wetland disturbance has been minimal, upland disturbance has been restricted to timber harvest, and human access has been limited reducing the spread of these plants (Pomroy 2004; ENSR 2005; PolyMet 2006, DPD; Chapman 2007; Larson 2007; Greenlee 2007). The Tailings Basin at the Plant Site is severely disturbed and already contains non-native invasive plants (e.g., smooth brome grass, reed canary-grass, and yellow sweet clover).

A vegetation survey of mines in the Mesabi Iron Range (Apfelbaum 1995) identified a large number of invasive non-native species that could invade the Mine Site (Table 4.3-3). Some of these species are grasses and legumes that were planted on mines and other sites to reduce erosion and to fix nitrogen into the soil as part of the reclamation process (e.g., redtop, smooth brome, birdsfoot trefoil, yellow sweetclover, white sweetclover, alfalfa, timothy, Kentucky bluegrass, Canada bluegrass, and white clover). In addition, a survey by the Superior National Forest (unpublished data from 2002-2003) documented several invasive species (species tracked by the USFS and Minnesota Class 1 and Class 2 invasive species) within three miles of the Plant and Mine Sites, primarily along roadways (Table 4.3-4). Species with a high percentage of occurrences in the surveys (e.g., common tansy) are likely to invade the Mine Site following disturbance and may displace native species and degrade ecosystem quality.

The footnote below should state that an “invasive” species can also be a native plant and still form monocultures especially on disturbed ground. Examples of such plants include Reed Canarygrass (*Phalaris arundinacea*) and Giant Reed (*Phragmites communis*), but others may exist.

2 “Non-native” species are those species that have been introduced, or moved, by human activities to a location where they do not naturally occur. “Invasive” species are non-native species that cause ecological or economic problems (e.g., outcompeting indigenous species and altering the existing ecological community) (MnDNR 2009, Invasive Species).

Table 4.3-3 Invasive Non-Native Plant Species Found on Mine Sites in the Mesabi Iron Range

Scientific Name	Common Name	Percent Occurrence[1]	Wetland/ Upland	Estimated Abundance at NorthMet Mine Site
Bromus inermis	Smooth brome	60	U	Uncommon
Tanacetum vulgare	Common tansy	60	U	Uncommon
Taraxacum officinale	Dandelion	60	U	Common
Medicago sativa	Alfalfa	50	U	Not Seen
Cirsium arvense	Canada thistle	40	U	Uncommon
Phleum pretense	Timothy	40	U	Common
Poa pratensis	Kentucky bluegrass	40	U	Common
Phalaris arundinacea	Reed canary-grass	30	W	Rare
Chrysanthemum leaucanthemum	Oxeye daisy	30	U	Common
Lotus corniculatus	Birdsfoot trefoil	30	U	Common
Poa compressa	Canada bluegrass	30	U	Not Seen
Trapogon dubius	Goat's beard	30	U	Not Seen
Trifolium hybridicum	Hybrid clover	30	U	Not Seen
Hieracium pretense	Yellow hawkweed	20	U	Uncommon
Silene lychnis	Bladder campion	20	U	Uncommon
Barbarea vulgaris	Yellow rocket	20	U	Not Seen
Berteroa incana	Hoary alyssum	20	U	Not Seen
Hieraceum canadense	Canada hawkweed	20	U	Not Seen
Hordeum jubatum	Foxtail barley	20	U	Not Seen
Melilotus officinalis	Yellow sweetclover	20	U	Uncommon
Rumex crispus	Curly dock	20	U	Not Seen
Salsola kali	Russian thistle	20	U	Not Seen
Verbascum thapsus	Common mullein	20	U	Not Seen
Agrostis alba	Redtop	10	W/U	Uncommon
Cirsium vulgare	Bull thistle	10	U	Uncommon
Hieracium aurantiacum	Devil's hawkweed	10	U	Common
Medicago lupulina	Black medic	10	U	Common
Melilotus alba	White sweetclover	10	U	Not Seen
Polygonum persicaria	Spotted ladysthumb	10	W/U	Not Seen
Potentilla norvegica	Norwegian cinquefoil	10	U	Not Seen
Robinia psuedoacacia	Black locust	10	U	Not Seen
Silene vulgaris	Maidenstears	10	U	Not Seen
Trifolium pretense	White clover	10	U	Common

Source: Apfelbaum 1995

[1] Percent occurrence is the percentage of mine areas in the Mesabi Iron Range with reported observations based on three-minute surveys at 10 mine areas. Three-minute surveys report the most abundant plant species observed during a three minute time period and provide a rough estimate of species abundance.

Table 4.3-4 Invasive, Non-Native Plant Species Found Within Approximately Three Miles of the Plant and Mine Sites by the U.S. Forest Service 2002-2003 Road Weed Survey

Scientific name	Common Name	Percent Occurrence Near Plant and Mine Sites[1]	Wetland/ Upland
Caragana arborescens[2]	Siberian peabush	0.5	U
Centaurea stoebe (C. maculata)[3]	Spotted knapweed	19	U
Cirsium arvense[4]	Canada thistle	14	U
Cirsium vulgare[4]	Bull thistle	9	U
Euphorbia esula[4]	Leafy spurge	2	U
Hypericum perforatum[2]	Spotted St. Johns-wort	14	U
Rhamnus cathartica[2]	European or common buckthorn	0.5	U
Tanacetum vulgare[3]	Common tansy	42	U

1 Percent occurrence is the number of populations of the plant divided by the 206 total plant populations identified within three miles of the Plant and Mine Sites.
2 Tracked by US Forest Service.
3 Minnesota Class 2 noxious weed as identified by the Minnesota Noxious Weed Law.
4 Minnesota Class 1 noxious weed as identified by the Minnesota Noxious Weed Law.
5 Minnesota restricted noxious weed as identified by the Minnesota Noxious Weed Law.

4.3.1.2 Threatened and Endangered Plant Species

Endangered, Threatened, and Species of Special Concern

No federally-listed threatened or endangered plant species occur at the Plant and Mine Sites. Nine State-listed ETSC plant species have been found at or near the Mine Site. A detailed ETSC plant species survey was not conducted at the Plant Site because suitable habitat for these species is not present at this predominantly disturbed and developed site. ETSC species that are disturbance-adapted may exist along the rail line, roads, and Tailings Basin, but would not be expected to be adversely affected in the long term by the Proposed Action. Consequently, the Mine Site is the focus of this analysis.

Based on a review of the Minnesota Natural Heritage Information System (NHIS) and field investigations (Johnson-Groh 2004; Pomroy 2004; Walton 2004), two state endangered species, two state threatened species, and five state species of special concern were identified at or adjacent to the Mine Site (Table 4.3-5 and Figure 4.3-2). No other listed state species are known to occur and no appropriate habitat for other species occurs at the Mine Site. Minnesota's endangered species law (*Minnesota Statute*, section 84.0895) and associated rules (*Minnesota Rules*, part 6212.1800 to 6212.2300 and 6134) impose a variety of restrictions, permits, and exemptions pertaining to ETSC species.

Table 4.3-5 Endangered, Threatened, and Special Concern Plant Species Identified at the NorthMet Mine Site and Road and Pipeline Alignments

Common Name	Scientific Name	State Status[1]	No. of Populations[2]	No. of Individuals[3]	Habitat and Location
Prairie moonwort	Botrychium campestre	SC	1	Unknown	Dry soils along the Dunka Road.
Pale Moonwort[4]	*Botrychium pallidum*	E	10[(2,5)]	58	Full to shady exposure, edge of alder thicket, along Dunka Road, and railroad and powerline rights-of-way.
Ternate grape-fern[4]	*Botrychium rugulosum (=ternatum)*	T	1[(2)]	4	Disturbed habitats, fields, open woods, forests, and along Dunka Road.
Least grapefern[4]	*Botrychium simplex*	SC	24[(2)]	>1,337	Full to shady exposure, edge of alder thicket, forest roads, along Dunka Road, and railroad and power line rights-of-way.
Floating marsh Marigold[4]	*Caltha natans*	E	5	~150+	Shallow water in ditches and streams, alder swamps, shallow marshes, beaver ponds, and Partridge River mudflat.
Neat spikerush[4]	*Eleocharis nitida*	T	13[(2,5)]	~1,450 sq.ft.	Full exposure, moist ditches along Dunka Road, wet area between railroad grades, and railroad ditch.
Lapland buttercup	*Ranunculus lapponicus*	SC	7	~825 sq.ft	On and adjacent to Sphagnum hummocks in black spruce stands, up to 60% shaded with alder also dominant.
Clustered bur-reed[4]	*Sparganium glomeratum*	SC	13	>100	Shallow pools and channels up to 1.5 feet deep in Sphagnum at edge of black spruce swamps, beaver ponds, wet ditches, shallow marshes.
Torrey's manna- grass	*Torreyochloa pallida*	SC	8	~800 sq.ft	In muddy soil along shore and in water within shallow channels, beaver ponds, shallow marshes, along Partridge River.

Sources: MnDNR 2007, NHIS; MnDNR 2009, NHIS; Barr 2007, Results of Autumn 2007 Field Surveys for *Botrychium rugulosum*; MnDNR 2005, Final SDD; Johnson-Groh 2004; Pomroy 2004; Walton 2004

1 E - Endangered, T - Threatened, SC - Species of Concern

2 Note that the number of populations differ from those given in the PD and NHIS data because of populations found during other surveys.

3 Where the number of individuals cannot be determined without damaging the population, then patch size is used as a representative abundance measure.

4 These species are also Regional Foresters Sensitive Species as tracked by the U.S. Forest Service.

5 Number based on site survey; additional populations may be present in more marginal, secondary habitat that was not surveyed or in wetter areas.

Species Life Histories

The following summary provides descriptions of the life histories, state-wide distributions, and sensitivity to disturbance for each of the nine ETSC species found at the Mine Site.

Botrychium campestre (Prairie moonwort) is listed as a species of special concern in Minnesota; it is not listed as a RFSS in the Superior National Forest. It occurs primarily in prairies, dunes, grassy railroad sidings, and fields over limestone. *B. campestre* emerges in early spring and senesces in late spring to early summer (eFlora 2009). This species is among the smallest moonworts and is difficult to observe among prairie vegetation; therefore, it is likely more widespread and abundant within its range than is typically apparent. *B. campestre* is less frequently associated with disturbance than many moonwort species. In Minnesota, *B. campestre* has been found growing abundantly on sparsely vegetated mineral soil developed from sediments of iron mine tailings ponds. Individuals have also been found on railroad embankments (USFS 2009).

Botrychium pallidum (Pale moonwort) is listed as an endangered species in Minnesota and as a RFSS in the Superior National Forest. *B. pallidum* was only first identified in Minnesota in 1990 (FNA 2007) and new populations are documented each year. It occurs in open disturbed habitats, log landings, roadsides, sandy gravel pits, and mine tailings within the Iron Range of northeastern Minnesota. This diminutive perennial fern emerges in the late spring, produces spores, and senesces within 3 to 4 weeks. Like many of the moonworts, *B. pallidum* may be sensitive to changes in soil mychorrhizae; herbivory from introduced earthworms; vegetative cover (i.e., increased vegetative competition and shading); soil moisture; or other environmental factors affecting suitable microhabitats. Disturbance (e.g., vegetation clearing, mining, soil scarification, reduction of vegetative competition, decreased canopy cover, fire) likely plays an important role in the preservation and proliferation of this species.

Botrychium rugulosum (Synonym: *B. ternatum;* Ternate grape-fern) is listed as a threatened species in Minnesota and as a RFSS in the Superior National Forest. The name “rugulosum” refers to the tendency of the segments to become wrinkled and convex. Relatively little is known about the overall distribution, genetics, and life history requirements of *B. rugulosum*, and some taxonomists question whether *B. rugulosum* is a distinct species. In Minnesota, *B. rugulosum* occurs in the northern and south central portions of the state. In northern Minnesota, *B. rugulosum* prefers partially shaded mine tailings, sandy conifer forests and plantations, and shaded vernal pool margins in rich deciduous hardwood forests. *B. rugulosum* is similar morphologically and in its life history requirements to *B. multifidum*, and these two species are often confused in the field. *B. rugulosum* is most easily distinguished from similar species in the late summer and early autumn, when the tropophore (i.e., photosynthetic branch) has matured. Like *B. pallidum, B. rugulosum* may be associated with soil mychorrhizae and may be sensitive to increased competition, shading, earthworms, changes in soil moisture, and other environmental factors affecting micro-habitats. Disturbance also likely plays an important role in the proliferation of this species.

Botrychium simplex (Least grape-fern) is listed as a species of special concern in Minnesota and as an RFSS in the Superior National Forest. Least grape-fern occurs throughout northern and central Minnesota, with no occurrences documented in southern Minnesota (Bell Museum of Natural History 2007). Least grape-fern was first described as a species in 1823 (FNA 2007) and has been extensively surveyed and studied for over a century. *B. simplex* was first collected in Minnesota in 1993 from a Jack pine forest in Clearwater County (Bell Museum of Natural History 2007). *B. simplex* is a perennial fern that occurs in a variety of natural and disturbed habitats, including brushy fields (often with other species of *Botrychium*); moist or dry woods; edges of forested vernal pools and swamps; mine tailings; and edges of sand/gravel/exposed forest roads. The morphology of the species is quite variable, and the many environmental forms and juvenile stages of *Botrychium simplex* have resulted in the naming of numerous, apparently mostly taxonomically meaningless, intraspecific taxa (FNA 2007). Like the other *Botrychium* species, disturbance likely plays an important role in the proliferation of this species.

Caltha natans (Floating marsh marigold) is listed as an endangered species in Minnesota and as an RFSS in the Superior National Forest. *C. natans* was first collected in Minnesota in 1889 from Vermilion Lake in St. Louis County (Coffin and Pfannmuller 1988). All subsequent collections have been from St. Louis County (Bell Museum Herbarium Database 2007). Very few populations are known in Minnesota. Floating marsh marigold occurs within shallow open water or on moist mud within northern ponds, lakes, slow-moving rivers, streams, and ditches. The species flowers in late spring-summer (i.e., June to August). *C. natans* is found in relatively stable aquatic systems and may be sensitive to dramatic changes in hydrology or hydro-period, water quality, and water chemistry, although a few populations are found in disturbed habitats.

Eleocharis nitida (Neat spike-rush) is listed as a threatened species in Minnesota and as an RFSS in the Superior National Forest. Neat spike-rush's distribution in Minnesota is limited to the northeastern counties of the Arrowhead region and west to Itasca County. *E. nitida* was first collected in Minnesota in 1946 from various wetland habitats in Cook and St. Louis counties. Despite the long collection record for this species in Minnesota, relatively few populations have been documented and little is known about the overall distribution of the species throughout the state. *E. nitida* occurs within various wetland habitats of northern Minnesota, including acid bog pools; streams; areas of seasonal water drawdown (mucky/peaty flats); disturbed wetland edges, and along roads and trails. *E. nitida* is a perennial plant that flowers in late spring and develops fruit in early to mid summer. Mature achenes (i.e., seed-containing fruit) are often necessary to positively identify *E. nitida* to species (both in the field and herbarium). This rooted perennial species may be intolerant of hydrologic fluctuations and alterations to water quality and chemistry associated with landscape and wetland alteration and development. However, roadside distributions suggest the species is tolerant of disturbance and at least mild alterations in water quality.

Geocaulon lividum (Northern comandra) is listed as a species of special concern in Minnesota; it is not listed as a RFSS in the Superior National Forest. This rooted perennial wetland species occurs in specific microhabitats within open bog mats and wet coniferous woods. In Minnesota, *G. lividum* has been collected and documented in two major areas: the northeastern Arrowhead counties west to Itasca County (including St. Louis County), and within Lake of the Woods and Roseau counties in extreme north-central Minnesota. Northern comandra is parasitic, relying on nutrients from the roots of a variety of other plants such as bearberry (*Arctostaphylis*) and asters (*Aster* spp.). No populations have been found in heavily disturbed habitats; thus, this plant is likely to be negatively affected by disturbance. Suitable habitats and microhabitats are likely to be sensitive to altered hydrology, water quality, and water chemistry commonly associated with landscape disturbance and development, and may be sensitive to competition from introduced invasive wetland species (e.g., *Typha angustifolia, Typha x glauca, Lythrum salicaria, Phragmites australis, Phalaris arundinacea*).

Ranunculus lapponicus (Lapland buttercup) is listed as a species of special concern in Minnesota; it is not listed as a RFSS in the Superior National Forest. Lapland buttercup occurs throughout much of northern Minnesota, with the exception of extreme northwestern Minnesota. This species was first documented in 1949 in Minnesota from a tamarack-spruce bog in St. Louis County (Bell Museum of Natural History 2007). *R. lapponicus* is a perennial forb species that occurs within hummocks and pools in conifer swamps in Minnesota. No populations have been found on disturbed sites. Lapland buttercup is sensitive to changes in conifer forest canopy, wetland hydrology/hydro-period, water chemistry, and other environmental factors affecting optimal conifer forest pools and hummock micro-sites.

Sparganium glomeratum (Clustered burr-reed) is listed as a species of special concern in Minnesota and as a RFSS in the Superior National Forest. This species was originally listed as endangered by the MnDNR in the mid-1980s (Coffin and Pfannmuller 1988); however, numerous new populations have since been documented and the species was down-listed from Endangered to Special Concern in the mid-1990s. Within Minnesota, clustered burr-reed is distributed throughout the northeastern Arrowhead counties (including the Chippewa and Superior National Forests); west to north central Minnesota (Becker County); and in central Minnesota (Todd County) (Bell Museum of Natural History 2007). *S. glomeratum* is a perennial wetland macrophyte that occurs in partial to full sun within a variety of northern wetland habitats, including edges of floating bog mats in emergent wetland habitats; ephemeral emergent stream channels, along beaver-impounded wetland edges, and disturbed emergent wetland edges. A significant proportion of known populations occur along roadsides and this plant may thus be somewhat tolerant of disturbance. *S. glomeratum* is a rooted emergent perennial species that may be sensitive to pronounced water level fluctuations and prolonged inundation, changes in water chemistry, competition from introduced/invasive species (e.g., *Typha angustifolia, Typha x glauca*, *Lythrum salicaria, Phragmites australis, Phalaris arundinacea*), and other environmental factors affecting suitable wetland microhabitats.

Torreyochloa pallida (Synonym: *Puccinellia pallida*; Torrey’s manna grass) is listed as a species of special concern in Minnesota; it is not listed as a RFSS in the Superior National Forest. Torrey’s manna grass was first collected in 1886 from Vermilion Lake in St. Louis County (Bell Museum of Natural History 2007). Within Minnesota, *T. pallida* occurs throughout the Arrowhead Region south to Chisago County (along the St. Croix River drainage). Torrey’s manna grass is a perennial graminoid species that occurs in various wetland habitats in northern Minnesota. Habitats include shallow muck-bottomed pond and stream shores, bogs, and beaver meadows. Some populations occur within roadside ditches, suggesting the species may be somewhat tolerant of disturbance; however, this rooted perennial wetland species is sensitive to alterations in wetland hydro-period; water level fluctuations; sedimentation; changes in water chemistry associated with landscape alteration and development; and competition from introduced invasive wetland species (e.g., *Typha angustifolia*, *Typha x glauca*, *Lythrum salicaria*, *Phragmites australis*, *Phalaris arundinacea*).

4.3.2 Impact Criteria

Direct impacts to vegetative cover types and species occur through clearing, filling, and other construction activities. A direct impact to an ETSC species occurs when the action results in the removal or loss of an individual plant or plant populations. Direct impacts are a result of the Project are immediate and often last for years.

An indirect impact occurs when a cover type experiences a change in vegetation composition; occurs over time or after the action is completed; and can occur on or off site. Indirect impacts to plant species may include changes in hydrology, deposition of particulate matter (dust), changes in successional stage, alteration of microclimate (e.g., tree removal resulting in drier soil conditions, rise or fall in water table, loss of pollinators, or loss of fungal associates in the rooting zone), and invasion of non-native species.

Cumulative impacts to ETSC plant species are evaluated by considering the Proposed Action together with other similar actions that have occurred or may be reasonably expected to occur. Cumulative impacts to cover types can also affect wildlife, which are discussed in Section 4.4.4.

4.3.3 Environmental Consequences

4.3.3.1 Proposed Action

This section describes the effects of Project construction, operation, and closure on vegetation cover types and ETSC species at the Plant and Mine Sites. Potential effects from non-native invasive species that are common to both the Plant and Mine Sites are discussed separately.

Plant Site

Effects on Cover Types

Project construction, operation, and closure at the Plant Site would have minimal effects on native vegetation because most of the Plant Site (62 percent) has already been heavily disturbed or is barren (Table 4.3-6). Most of proposed impacts are to isolated stands of forest characterized as being in fair condition. Other impacts to cover types at the Plant Site are minor. The tribal cooperating agencies' position is that although this area is significantly disturbed and will be for the foreseeable future, the closure and reclamation plans should have a significant effect on native vegetation as it is reintroduced. The prevalence of invasive, non-native species and their ability to out-compete native plants in disturbed areas, coupled with PolyMet's plan to introduce non-native and invasive species to this area, would result in significant impacts.

Seepage from north toe of Tailings Basin Cell 2E has the potential to indirectly impact 319.7 acres of wetlands north of the Tailings Basin. The seepage would not result in a loss of wetland cover; however, the increased surface flow would contribute to a potential conversion of wetland types (i.e., forested wetlands to scrub/shrub or open water). For a full description of the potential indirect wetland impacts north of the Tailings Basin, refer to Section 4.2.3.1.

Table 4.3-6 Direct Effects on Cover Types at the Plant Site[1]

Cover Types	Affected Acres	Non-Affected Acres[2]	Total Cover Type Acres	Percent of Cover Type Affected
Developed	896	1,691	2,587	34.6
Barren	50	131	181	27.6
Grassland	0	1	1	0.0
Upland Shrub	55	207	262	21.0
Aspen/White Birch	117	421	538	21.7
Maple/Basswood	3	7	10	30.0
Upland Deciduous	0	2	2	0.0
Pine	17	10	27.	63.0
Spruce/Fir	14	62	76	18.4
Tamarack	0	7	7	0.0
Lowland Black Spruce	0	27	27	0.0
Lowland Northern White-Cedar	0	4	4	0.0
Lowland Shrub	39	36	75	52.0
Marsh	24	52	76	31.6
Aquatic	539	13	552	97.6
Total Plant Site Effects	**1,754**	**2,671**	**4,425**	**39.6**
Indirect Impacts to Wetlands North of the Tailings Basin	319.7	0.00	319.7	100

Derived from GAP-Land Use Land Cover Data, 1991-1993, Level 3 Descriptions

[1] This table reflects only those impacts occurring within the boundaries of the Plant Site. The potential indirect impacts to the wetland north of the Tailings Basin due to seepage are not included.

[2] Areas of cover types not within a 50 foot buffer of buildings, tailings basin/spillway reclamation area, railroad connection or treated water pipeline.

At Closure, the building foundations and other infrastructure at the Plant Site would be removed or buried to a depth of two feet and the Tailings Basin would be graded to promote wetlands creation. The exterior dam faces, dam top, and coarse beach would be revegetated pursuant to *Minnesota Rules*, part 6132.2700 by a qualified professional. Reclamation areas would be inspected in spring and fall, with areas identified for erosion and failed seeding repaired, until MnDNR determines that the areas are stable and self-sustaining.

Effects of Invasive Non-Native Plant Species

PolyMet proposes to temporarily vegetatively stabilize disturbed areas during operation, and permanently reclaim during Closure, by applying seeds or planting seedlings. Species proposed for revegetation include sweet clover, redtop, alsike clover, Canada bluegrass, Cicer milkvetch, birdsfoot trefoil, perennial ryegrass, smooth brome grass, and red fescue. These species are known to establish quickly and form a nearly complete groundcover, which can help prevent erosion, maintain water quality, and increase dam stability. The legume species listed would also fix nitrogen that helps to re-establish soil nutrients. All of these species with the exception of Canada bluegrass, however, are non-native and some of the proposed species are considered invasive (e.g., birdsfoot trefoil, redtop, smooth brome grass, Canada bluegrass, sweet clover). In addition, hay and agricultural grasses are specified as mulch, which may contain propagules or seeds of invasive species such as reed canary-grass.

Use of the proposed seed mix and mulch would introduce invasive non-native species to an area of primarily natural vegetation. These species, once introduced, are difficult to remove and could spread to and colonize susceptible areas following future disturbance (e.g., blowdown, logging, fire). These species may reduce diversity, out-compete native vegetation, and provide lower quality habitat for some specialist animal species. Dominance of invasive non-native species would reduce the quality of native cover types and habitat remaining at the Project.

It is the Tribal cooperating agencies position that native plant species have evolved over millennium and thus have adapted to local climatic conditions. Therefore, these native species should be used in any re-vegetation efforts. The use of non-native plants should be avoided. Seed mixes using native plants can be developed with the desired establishment and groundcover capabilities.

Effects on ETSC Species

The Project would have no effect on federal or state ETSC species at the Plant Site because none are known to occur within the Plant Site boundary.

Mine Site

Effects on Cover Types

Project construction and operation at the Mine Site would impact approximately 1,454 acres of native vegetation as a result of excavating the mine pits (approximately 450 acres) and creating overburden and waste rock stockpiles and associated internal haul roads and drainage ditches (approximately 1,004 acres) (Table 4.3-7). These impacts would include approximately 46 percent (459 acres) of the mixed pine-hardwood forest at the Mine Site. Approximately 1,562 acres, or about 52 percent of the Mine Site, would not be disturbed. Although a majority of the Mine Site is considered a Site of High Biodiversity Significance, the area represents a small portion of the mapped Sites of High Biodiversity Significance in St. Louis County and the State of Minnesota and habitat impacts associated with the Project would not result in a significant decline in those areas ranked as "High" by the MCBS (MnDNR 2009, NHIS).

Table 4.3-7 Direct Effects on Cover Types at the Mine Site

Cover Types	Affected Acres	Non-Affected Acres[1]	Total Cover Type Acres	Percent of Cover Type Affected
Disturbed	0	66	66	0
Grass/brushland	245	48	293	84
Aspen forest/Aspen-birch forest	68	97	165	41
Jack pine forest[2]	86	99	183	46
Mixed pine-hardwood forest	459	544	1,003	46
Mixed hardwood swamp[3]	195	265	460	42
Black spruce forest/bog[3]	402	441	843	48
Open water	1	2	3	33
Total	1,456	1,562	3,016	48

1 Areas of cover types not directly affected by mine pits and stockpiles.
2 Includes an estimated additional 1-2 acres for the Wastewater Treatment Plant and Central Pumping Station facilities at the mine area.
3 Cover type acreage, including wetlands acreage for mixed hardwood swamp and black spruce forest/bog, was derived from aerial photo interpretation and therefore differs from wetland acreage resulting from wetland delineation in the field.

Nearly all of the upland forests that would be directly affected by proposed activities at the Mine Site are in fair to good condition according to the Minnesota NHIS condition ranking system (MnDNR 2009, NHIS). Approximately 470 acres of the imperiled or rare/uncommon NPCs, Jack pine and black spruce forests, would also be impacted. Most of the forested wetlands affected by the Project are in good to excellent condition; the wetland field assessment also indicates a high level of wetland quality.

Minor impacts in already disturbed areas would occur along Dunka Road at the Mine Site. A water pipeline for treated water would be constructed along Dunka Road in previously disturbed land. Construction of the pipeline would expose soil during construction and bury vegetation under rock fill. About 10 acres of wetlands would be affected by pipeline construction and improvement of Dunka Road.

Indirect effects on vegetative cover types at the Mine Site are expected to result from dust from road traffic and mining operations and changes in hydrology. Dust on leaves can affect the rate of photosynthesis and respiration that influence plant growth. The greatest effect, if any, of fugitive dust is likely to occur near the East and West Pits where haul roads are concentrated and the rail transfer hopper and other facilities are located. The distance dust travels depends on wind speed, antecedent weather conditions, dust particle size, and vegetation density near the source. PolyMet proposes to implement various dust control measures such as stabilizing disturbed soils and water spraying during dry periods. These measures should be adequate to minimize potential indirect impacts from fugitive dust.

The local hydrology of wetlands at the Mine Site may also be affected by haul roads, drainage controls, and mine dewatering. A system of dikes and ditches is proposed to minimize the amount of surface water flowing onto the site, eliminate process water and non-contact storm water flowing uncontrolled off the Mine Site, and minimize the amount of storm water flowing into the mine pits. PolyMet proposes to construct a drainage system to carry excess surface water away from the Mine Site. Where dikes intersect wetlands, seepage control measures would be installed to restrict groundwater movement through higher permeability areas with the intention of helping to prevent drawdown of wetland water levels near mine pits and reduce inflows to the mine pits, although hydrologic impacts to wetlands from pit dewatering are not expected to be significant. Further discussion of potential indirect impacts to wetlands from hydrologic changes is provided in Section 4.2.3.

Reclamation and revegetation at the Mine Site would initiate vegetative succession on stockpiles and at the East Pit. The stockpiles would be planted with red pine on the slopes and seeded with grasses/forbs at the tops and bench flats (to minimize the potential for deep-rooted trees from penetrating the cap). Within a few decades, the slopes should be occupied by forest. The tribal cooperating agencies' position is that the use of mono-culture red pine plantations to mitigate should be avoided. The importance of a variety in tree species in the ecosystem to provide suitable habitat for a greater variety of wildlife species cannot be understated. The West Pit would remain open water, while the Central and East Pits would support wetland vegetation (see Section 4.2 for further discussion of wetland creation).

Table 4.3-8 Proposed Vegetation Types and Acreages for Reclaimed Stockpiles and Pits at the Mine Site

Type	Proposed Reclamation Vegetation	Acres
Cat. 1/2 Stockpile	Red Pine	563
Cat. 3 Lean Ore Stockpile	Red Pine	157
Cat. 3 Stockpile	Red Pine	72
Overburden Storage (Removed)	Herbaceous	94
Cat. 4 Lean Ore Surge (Removed)	Herbaceous	55
Cat. 4 Stockpile	Grassland	63
East and Central Pits	Wetland	172
West Pit	Open Water	278
Total		**1,454**

The most significant direct Project effect on vegetation is to wetland cover types in good/excellent condition (e.g., mixed hardwood swamp, black spruce swamp/bog), which are fairly common cover types in the region. Combined on and off-site wetland mitigation would replace most wetland vegetation, although with some changes to the cover type composition. For example, cattail-dominated plant communities, which disturbed wetlands in this area typically develop into, would represent the likely future plant community that would occupy the reclaimed Central and East Pits at the Mine Site (refer to Section 4.2.4 for a detailed discussion of wetland type impacts and mitigation).

Effects of Invasive Non-Native Species

The revegetation plan for Closure at the Mine Site is the same as the Plant Site. Therefore, the general effects of invasive non-native plant species at the Mine Site would be the same as the

Plant Site, although the consequences of introducing invasive non-native species would be more significant at the relatively high quality Mine Site.

Effects on ETSC Species

No federally-listed threatened or endangered plant species occur at the Mine Site. The Project, however, would have both direct and indirect effects on State ETSC plant species. Table 4.3-9 summarizes the direct and indirect Project effects on each of the ETSC plant species. These numbers may overestimate the actual impacts as a proportion of the number of actual populations in the State. Intensive surveys, such as those performed at the Mine Site, have not been performed throughout the State; therefore the number of actual populations may be larger than that identified in the NHIS.

The Project would directly affect six of the nine listed ETSC plant species, all of which are found at the Mine Site or along the Dunka Road, railroad, and power line rights-of-way. Most of the direct impacts involve the complete loss of populations as a result of excavation of the mine pits, burial under stockpiles, or disturbance during infrastructure construction.

The Project may result in indirect impacts to many of the remaining ETSC plant populations at the Mine Site (Table 4.3-9). These indirect impacts may occur as a result of changes in hydrology or water quality, deposition of particulate matter (dust), application of road salts, or weed incursion. The magnitude of the potential effects could range from almost no effect to potentially significant effects on reproduction and/or population persistence. Individual species appear to differ in their response to these indirect effects. For example, several of the listed species typically occur in old tailings ponds or along roadsides where disturbance and dust are frequent. To a certain extent, each species' sensitivity to disturbance can be inferred from currently occupied habitats. Habitats were considered "disturbed" if they consisted of tailings ponds, gravel pits, landing pads, logging roads, ditches, or roadsides. Disturbance tolerant species may in some cases actually be disturbance-dependent.

Table 4.3-9 Impacts to Known ETSC Plant Populations at the Mine Site

	Mine Site					Statewide Populations			
Plant Species (state status/ global status[1])	**Total Populations**	**Total Individuals**	**Direct Impacts[2] (Populations)**	**Indirect Impacts[3] (Populations)**	**Unaffected Populations**	**Total Populations[4]**	**Average Individuals per Population[5]**	**Percent Directly Affected (Populations)**	**Percent Indirectly Affected (Populations)**
Botrychium campestre (SC/G3)	1	1	1	0	0	64	unknown	2	0
Botrychium pallidum (E/G3)	10	58	8	2	0	68	15	12	3
Botrychium rugulosum (T/G3)	1	4	0	1	0	61	14	0	2
Botrychium simplex (SC/G5)	24	>1,337	11	13	0	128	25	9	7
Caltha natans (E/G5)	5	~150	0	5	0	12	unknown	0	42
Eleocharis nitida (T/G4)	13	~1,450 sq. ft.	4	9	0	44	450	9	20
Ranunculus lapponicus (SC/G5)	7	~825 sq. ft	3	4	0	65	51	5	6
Sparganium glomeratum (SC/G4?)	13	>100	3	10	0	144	82	2	7
Torreyochloa pallida (SC/G5)	8	~800 sq.ft	2	0	6	78	unknown	3	0
Total	**82**	**NA**	**26**	**40**	**6**	**664**	**NA**	**4**	**6**

1 The global ranks range from G1 to G5. A lower global ranking (e.g., G3) indicates a species at higher global risk than higher ranking (e.g., G5) (NatureServe 2007).
2 Direct impacts are expected for those populations that would be removed or buried by mine activities. Impacts are calculated for populations rather than individuals because of the large variation and inaccuracies in the estimates of number of individuals per population.
3 Indirect impacts may occur to those populations within or near the Mine Site. These populations may be affected by changes in hydrology, water quality, dust, or inadvertent activities. As above, impacts are given for populations rather than individuals.
4 Statewide population data provided by Lisa Joyal (MnDNR) on March 27, 2009. Population data for *B. pallidum* includes additional populations found during project-specific surveys
5 Population estimates are approximate and used for comparative purposes only. The number of individuals is based upon populations for which data exists; many localities did not report population sizes.

Tribal cooperators note that Cumulative (direct and indirect) percentages should be placed within the table to help illustrate the significance of the impacts to these species within the state as a whole.

Botrychium campestre (Prairie moonwort) populations are commonly observed on sparsely vegetated mineral soil from sediments of iron mine tailings ponds and railroad embankments. Of the 64 known populations statewide, the Project may directly impact the one population along the Dunka Road from pipeline construction and road improvements/maintenance. This subspecies is less tolerant of disturbance than other *Botrychium* species; however, it prefers sparsely vegetated areas and may actually expand into disturbed areas along Dunka Road.

Botrychium pallidum (Pale moonwort) populations are most commonly observed on mine tailings basins and along roadsides. Of the 68 known populations statewide, the Project may directly impact eight populations along Dunka Road from pipeline construction and road improvements/maintenance, and may have indirect impacts on the other two populations at the Project from dust or changes in hydrology. This species, however, appears to be tolerant of disturbance and populations may actually expand into newly disturbed areas along Dunka Road around the Tailings Basin and at the Mine Site.

Botrychium rugulosum (Ternate grape-fern) frequently occurs on tailings basins and along roadsides. Of the 61 known extant populations in Minnesota, one (with four individuals) occurs along Dunka Road. No direct impacts to this species are anticipated. Possible indirect impacts may occur from changes in site hydrology, increased dust, or from vehicle operation or maintenance along the roadside. This species also appears to be tolerant of disturbance and populations may actually expand into newly disturbed areas along Dunka Road, around the Tailings Basin, and at the Mine Site.

Botrychium simplex (Least moonwort) frequently occurs on tailings basins and along roadsides. Of the 128 known populations statewide, 24 occur on the Mine Site. Of these, 11 are expected to be directly affected, six from stockpiles and mine pits and another five from pipeline and ditch construction. The populations affected by pipelines and ditches may be reduced in the short term by construction, but would likely recover, as this species appears to be tolerant of disturbance. The remaining populations occur primarily along Dunka Road, with a few in relatively undisturbed habitats. These populations may face indirect impacts from changes in hydrology, water quality, or dust. Overall, long-term impacts may be minimal as this species appears to be tolerant of disturbance and populations may expand along Dunka Road, around the Tailings Basin, and at the Mine Site Post-Closure.

Caltha natans (Floating Marsh-marigold) is found primarily in relatively undisturbed habitats and is not likely to be tolerant of disturbance. Of 12 known populations statewide, 42 percent (i.e., five populations) occur within or near the Mine Site. None of these populations are expected to be directly affected, although one population is close to a proposed ditch along Dunka Road and may be indirectly affected. Four other populations are located downgradient from the Mine Site and could be indirectly affected by changes in hydrology or water chemistry. The remaining eight populations are located outside, but near, the Mine Site. These eight populations are generally found along the Partridge River and are believed to be sufficiently removed from potential direct and indirect affects of the Project so as not to be affected.

Eleocharis nitida (Neat Spike-rush) is primarily observed in roadside ditches with gravel or sandy substrates along Dunka Road. Of the 44 known populations in the state, 13 occur at the Mine Site. Of these, nine populations are found along the Dunka Road, three along the rail tracks and one elsewhere. Four of the Dunka Road populations are likely to be directly affected by ditch construction. The other nine populations may incur indirect impacts from changes in hydrology or water quality. This species, however, seems to be tolerant of disturbance; therefore, ditching and road maintenance may have no long-term adverse impacts on this species.

Ranunculus lapponicus (Lapland buttercup) is found in conifer/sphagnum bogs. Of 65 known populations statewide, seven occur at the Mine Site. Of these, three populations are expected to be directly affected - two would be covered by a waste rock stockpile and one would be excavated for a planned drainage ditch. The other four populations may face indirect impacts from changes in hydrology, water chemistry, or dust.

Sparganium glomeratum (Cluster Bur-reed) is observed along roadsides as well as in hardwood forests. This plant may be tolerant of some disturbance. Of the 144 known populations statewide, 13 occur at the Project. Of these, three would likely be directly affected - two populations would be eliminated by construction of the West Pit and one population along Dunka Road may be affected by a proposed ditch. The remaining 10 populations, including several populations along Dunka Road, may be indirectly impacted from changes in hydrology, water quality, or dust. This species, however, appears to be tolerant of disturbance.

Torreyochloa pallida (Torrey's Manna-grass) is often seen along roadsides and may be tolerant of disturbance. Of the 78 known populations statewide, eight occur at or near the Mine Site. Of these, two are along Dunka Road and may be affected by a proposed ditch. The remaining six populations are located away from any proposed construction and several are found along the Partridge River. These six populations are believed to be sufficiently removed from potential direct and indirect effects of the Project so as not to be affected.

4.3.3.2 No Action Alternative

Cover Types

Under the No Action Alternative, forest harvesting would continue to occur in portions of the Mine Site under the Land and Resource Management Plan for the Superior National Forest. While timber harvest would result in the immediate loss of some habitat types, permanent changes are not expected. The plan does call for an increase in older-age stands, which would likely come at the expense of younger age stands in the long term. At the Plant Site, the former LTVSMC process facility would be reclaimed and areas revegetated in accordance with the Closure Plan much sooner than under the Proposed Action. Revegetation under the Closure Plan would be expected to use standard non-native seed mixes.

Direct and indirect effects of the No Action Alternative on cover types are considered minimal. Non-native species may still invade the Mine Site as a result of logging, exploration, vehicle traffic, and natural disturbances, but are likely to do so much more slowly than under the Proposed Action.

ETSC Plant Species

Under the No Action Alternative, timber harvests are expected to continue to occur on site. The Project area, however, has historically been logged and the ETSC species present on site have survived. It is unlikely that continued logging, which now is more likely to employ best management practices to minimize detrimental effects, would adversely affect the ETSC species. Potential indirect impacts under the No Action Alternative could come from increased competition as succession proceeds. Effects of increased competition due to succession include reduced spore production and consequent reduced population size in the early successional plant species (e.g., *Botrychium* spp.). Continued maintenance, however, would likely occur along Dunka Road and the railroad where several of the *Botrychium* populations occur, so succession at these locations is unlikely and these populations would persist.

4.3.3.3 Mine Site Alternative

Subaqueous disposal of Category 2, 3, and 4 waste rock and lean ore would have similar affects on vegetative cover types and ETSC plant species at the Mine Site as the Proposed Action. Subaqueous disposal, rather than long-term surface stockpiling, of the more reactive waste rock would reduce the risk of ARD, which could indirectly benefit ETSC species at the Mine Site relative to the Proposed Action. This alternative does not involve any modifications to the Plant Site; therefore, the impacts to the Plant Site would be the same as the Proposed Action.

4.3.3.4 Tailings Basin Alternative

The impacts of the Tailings Basin alternative would be comparable to the Proposed Action; however, would also involve the construction of an 8.4-mile water discharge pipeline from the Tailings Basin to the Partridge River downstream of Colby Lake. Construction of the pipeline would impact approximately 50.6 acres of vegetation cover through the clearing and routine maintenance activities associated with the expanded berm. While portions of the pipeline ROW are already maintained, clearing and maintenance would convert some upland forests to grassland/shrublands cover types. Approximately 45.4 acres of upland vegetation would be impacted including disturbed, grass/brushland, aspen/birch forest, and upland deciduous and mixed pine-hardwood forests cover types. Construction-related disturbance would create opportunities for invasive, non-native species to colonize the pipeline ROW.

Wetlands comprise the remaining 5.2 acres of vegetation impacts with predominantly lowland shrub communities occurring within the corridor. For a full description of the wetland impacts associated with this alternative refer to Section 4.2.4.3. The MCBS and NPC data are not available for the discharge pipeline corridor; however, none of the affected cover types are considered rare or imperiled at the state level. No ETSC species are known to occur along the discharge pipeline corridor; therefore, this alternative would not affect ETSC species.

4.3.3.5 Other Mitigation Measures

PolyMet currently proposes to stabilize disturbed areas during Project operations and at the time of mine Closure using a seed mix that includes several non-native and potentially invasive species. This seed mix has been selected in order to quickly and effectively stabilize disturbed areas and re-establish soil nutrients. A recommended mitigation measure would be to reseed with native non-invasive species as long as they can perform as effectively as the non-native species. In some areas (e.g., tailings dam and dikes) where erosion control is critical to prevent slope failures, non-native species may be needed. In the event invasive non-native species are used, an additional mitigation measure would be to implement an invasive species monitoring and control program to ensure these species do not overtake surrounding native communities.

Widening of the Dunka Road and construction of the mine infrastructure (e.g., haul roads, stockpiles) would likely impact several ETSC plant species that are near, but outside, the footprint of these facilities. In several cases, these potential impacts could be avoided or reduced by fencing or flagging ETSC populations to prevent disturbance. Transplantation is not considered to be acceptable mitigation for taking of endangered or threatened species by MnDNR. Typical compensatory mitigation for taking endangered or threatened species in Minnesota includes:

- funding state acquisition of another site where the species occurs that is currently unprotected and vulnerable to destruction,
- funding additional survey work to locate other sites, and/or
- funding research to improve our understanding of the habitat requirements or protection needs of the species.

The following potential mitigation measures may also indirectly benefit vegetation:

- Monitoring of Waste Rock Stockpiles and Tailing Basin – would help ensure that water quality would meet state standards and not adversely affect cover types or ETSC species at the Project.
- Maximize the Elevation of the Category 1 and 2 Stockpile – maximizing the height of the Category 1 and 2 stockpile would reduce the footprint of this stockpile and thereby minimize direct impacts to native cover types, although it is expected that the reduction in direct impacts would be small (e.g., a few acres) because the stockpile height is already at or close to its maximum height from a geotechnical engineering perspective.

4.3.4 Cumulative Effects

The cumulative impact analysis for vegetation focuses on potential losses of ETSC plant species. The Project would contribute to a loss of vegetative cover; however, implementation of the mitigation measures described above would minimize the impacts such that Project-related losses would not jeopardize the existence of these communities. Therefore, there are no significant impacts to vegetation cover and a cumulative impact analysis is not warranted. Refer to Section 4.4.4 for a discussion of potential cumulative impacts from loss of wildlife habitat.

4.3.4.1 Summary of Issue

ETSC plant species are protected under the Minnesota endangered species law (*Minnesota Statute*, section 84.0895) and associated rules (*Minnesota Rule*, part 6212.1800 to 6212.2300 and 6212.6134). Project-related impacts to the nine ETSC plant species were identified and evaluated in Section 4.3.3. This section evaluates the potential cumulative effects of the Project, as well as other past, present, and reasonably foreseeable future activities, on these nine ETSC plant species.

4.3.4.2 Approach to Analysis

The nine ETSC plant species found at the Mine Site were evaluated for potential cumulative effects using a semi-quantitative evaluation. Existing information from the Minnesota NHIS and other existing data sources were used to create a distribution map for each species. The data were compiled and mapped to analyze the number of known populations, approximate numbers of plants, proportion of statewide populations expected to be affected, habitat preference, role of disturbance in each species' life history, sensitivity to disturbance, species distribution (i.e., range), current level of understanding for each species, and potential mitigation. Much of this information is summarized in Table 4-3.9.

The entire state of Minnesota was used as the geographic boundary for the analysis, with a focus on the Laurentian Mixed Forest section as representative of the approximate statewide range of all nine ETSC plant species, although their North American distribution and abundance are also presented to provide context. Data for the Laurentian Uplands subsection were analyzed to assess impacts from the Project.

Cumulative effects related to past, present, and reasonably foreseeable future actions were evaluated. Past and present conditions were derived from *Tomorrow's Habitat for the Wild and Rare: an Action Plan for Minnesota Wildlife* (MnDNR 2006). Land use changes (including logging and development) were described by Emmons and Olivier Resource (2006) in a cumulative effects assessment of wildlife habitat in the Mesabi Iron Range[3]. Impacts in the reasonably foreseeable future (e.g., approximately 27 years, which is generally consistent with the proposed life of the Project, including construction, operations, and Closure) were also evaluated. Potential future impacts were identified by analyzing takings permits[4] as well as GIS information from the MnDNR to determine the extent of expected losses from recently permitted projects. Species losses from the following reasonably foreseeable actions were considered:

- Proposed Minnesota Steel DRI/Steel Plant
- Proposed Minnesota Steel taconite mine and tailings basin
- Proposed Cliffs Erie railroad pellet transfer facility
- Proposed Mesabi Nugget Phase I processing facility
- Proposed Mesabi Nugget Phase II mining operation
- Proposed expansion of Peter Mitchell Mine Pits
- Proposed Mesaba Energy Power Generation (coal gasification) Station
- Proposed Minnesota Power Great River Energy Transmission Project
- Proposed Hoyt Lakes – Babbitt Connection, St. Louis County Highway Project
- ArcelorMittal East Reserve Project
- U.S. Steel Keewatin Taconite Mine and plant expansion
- LTVSMC Mine Closure
- Community growth and development
- Forestry practices on public and private lands

The Tribal cooperating agencies note that the list above is incomplete. The future development of mining by Franconia Minerals, Duluth Metals, and Encampment Resources should also be

3 A subsequent study was completed by Barr Engineering in 2009. This study went beyond the EOR study by accounting for effects of human revegetation efforts and succession. However, this study focused on wildlife species and corridors and did not address ETSC vegetation species. Cumulative effects to wildlife corridors are discussed in Section 4.4.4.

4 A "takings permit" can issued by the USFWS or MnDNR to authorize activities that would result in the loss of federal or state-listed species.

considered in this analysis. All three of these companies have already conducted drilling operations.

4.3.4.3 Existing Baseline Conditions and Past Losses

Past changes in cover types show a mixed pattern of gains and losses from the 1890s to 1990s (Table 4.3-10). In the Laurentian Uplands subsection, no cover type containing ETSC plant species has decreased. In the Laurentian Mixed Forest Province, lowland coniferous and upland coniferous forests experienced significant declines over this period. Among ETSC plant species, *Botrychium rugulosum* is most likely to occur in the upland coniferous type (Table 4.3-11). *Caltha natans*, *Geocaulon lividum*, and *Ranunculus lapponicus* are most likely to occur in the lowland coniferous type. *C. natans* occupies edges of ponds and lakes in the lowland coniferous type; consequently, losses in lowland coniferous types less accurately reflect trends in this species habitat. While there appears to be no habitat loss locally, habitat appears to have decreased statewide for these species.

Table 4.3-10 Changes in Habitat Acreage since European Settlement

Habitat Type	Laurentian Uplands Gain/Loss 1000's of acres (%)	Laurentian Mixed Forest Gain/Loss 1000's of acres (%)	Statewide Gain/Loss 1000's of acres
Lowland Coniferous	+ 40 (7.1%)	- 1300 (-6%)	- 1330
Lowland Deciduous	+ 1.7 (0.3%)	+ 300 (1%)	- 94
Upland Deciduous	+ 1.7 (0.3%)	- 635 (-8%)	-2180
Upland Coniferous	+ 24 (4.2%)	-1473 (-47%)	-1327
Wetland	+ 6.2 (1.1%)	+ 410 (53%)	-14,200[2]
Disturbed[1]	N/A	N/A	N/A
Shoreline[1]	N/A	N/A	N/A

[1] Information not available
[2] Source: Dahl 1990

This conclusion should be qualified by the understanding that the mapped habitat type does not precisely match the habitat actually used by an ETSC plant species. Because ETSC plant species occupy preferred habitats within larger mapped habitat types, the impact of habitat loss may not directly correlate on a 1:1 basis to the effect on a plant species. A reasonable assumption is that significant losses in mapped habitat types represent a trend in losses of preferred habitat types for these ETSC species.

Table 4.3-11 Preferred Habitat for ETSC Plant Species and Most Likely Associated Habitat Types (MnDNR 2009, NHIS; MnDNR 2006, Rare Species Inventory)

Species	Preferred Plant Species Habitat	Corresponding Mappable Habitat Type
Botrychium campestre	Prairies, dunes, railroad sidings, fields	Disturbed
Botrychium pallidum	Disturbed areas	Disturbed
Botrychium rugulosum	Conifer forests/openings/Disturbed areas	Upland Coniferous
Botrychium simplex	Disturbed areas/lowland hardwood forest	Lowland Deciduous and Disturbed
Caltha natans	Lakeshores and pond edges in deciduous and	Lowland Coniferous and

Species	Preferred Plant Species Habitat	Corresponding Mappable Habitat Type
	coniferous forests	Lowland Deciduous
Eleocharis nitida	Mineral soil of wetlands with open canopy	Disturbed
Ranunculus lapponicus	Lowland conifer forests and peat bogs	Lowland Coniferous
Sparganium glomeratum	Sedge meadow/poor fen/lakeshore	Wetlands
Torreyochloa pallida	Pond/lake margins/lowland hardwood forest	Lowland Deciduous

4.3.4.4 Environmental Consequences of Reasonably Foreseeable Actions on ETSC Plant Species

Future impacts to ETSC plants were evaluated by overlaying the MnDNR Division of Minerals GIS mining layer on all known populations of ETSC plant species. These populations can contain from a few to thousands of individual plants. Of the nine ETSC species found at the Project, only four species (Table 4.3-12) have the potential to be impacted from the reasonably foreseeable activities. Cumulative effects on each of the ETSC species known to occur at the Mine Site are discussed below.

Table 4.3-12 Potential Future Impacts to ETSC Plant Species Populations Occurring From Reasonably Foreseeable Activities[1]

Species	Other Projects Direct Impact (Populations)	Other Projects Indirect Impact (Populations)	NorthMet Project Total Impact (Populations)	Total Known Statewide Populations	Percent of Known Statewide Populations Affected
Botrychium pallidum	5	2	10	68	25
Botrychium rugulosum	5	0	1	61	10
Botrychium simplex	4	3	20	128	21
Sparganium glomeratum	1	0	13	144	10

1 Species for which no other projects are expected to have impacts are discussed in the “Proposed Action” section.

In addition to past, present, and reasonably foreseeable activities, future changes in habitat types may affect ETSC plant populations. Forestry management has a much greater effect on habitat acreage within the range of these ETSC plant species than does mining and other land development. The forestry impact in a single year exceeds the expected acreage loss to habitat from all permitted mining projects and land development. Although it should be noted that forestry management offers a greater range of options for ETSC species to co-exist, whereas mining represents a complete land conversion. Future timber harvest in the Arrowhead Region from government and private actions may affect over 42,000 acres annually. However, it is the Tribal cooperating agencies position that forestry practices are not as destructive of habitat as mining. Best forest management practices can enhance biodiversity whereas the impacts of mine pits, stockpiles and tailings basins do not promote diversity.

Botrychium pallidum is widely distributed across five Canadian provinces and four border states (ME, MI, MN, MT) as well as Colorado. This species is considered “vulnerable” by NatureServe (NatureServe 2007 and 2009) and to be of conservation concern (eFlora 2009), although Minnesota is the only state to list it as threatened or endangered. Given that Minnesota is at the southern edge of its historical range, *B. pallidum* was probably never common in Minnesota. The Project would directly impact two populations and may indirectly impact two more populations. Other activities would directly impact five and indirectly affect two additional populations. In total, approximately 16% of the known populations in Minnesota would be directly or indirectly affected by these activities. Due to its small size, the species is easily overlooked and additional populations may yet be located. *B. pallidum* was listed as a state endangered species in 1996 when there were just six documented occurrences in Minnesota. By 2008, the number had risen to 41. Its relatively short lifespan (approximately 4 weeks from emergence to senescence) may account for the few populations documented to date. Given its preference for disturbed sites, the cumulative effects of the Project and other reasonably foreseeable activities are not expected to jeopardize the presence of *B. pallidum* in Minnesota or in North America.

Botrychium rugulosum is widely distributed across three Canadian provinces and four border states (MI, MN, NY, VT) as well as Connecticut, and is only listed as threatened (Minnesota) or endangered (New York) in two states. This species is considered “vulnerable” by NatureServe (NatureServe 2007 and 2009). Given that Minnesota is at the southern edge of its historical range, *B. rugulosum* was probably never common in Minnesota. The Project may indirectly impact one population of the species. Other reasonably foreseeable activities would directly impact five additional populations; no additional populations would be indirectly affected. In total, approximately 25 percent of the known populations in Minnesota would be directly or indirectly affected. Given its tolerance for disturbance, the cumulative effects of the Project and other reasonably foreseeable activities are not expected to jeopardize the presence of *B. rugulosum* in Minnesota or in North America.

Botrychium simplex is widely distributed across 34 states and 10 Canadian provinces. This species is considered “secure” by NatureServe (NatureServe 2007 and 2009). The Project would directly impact 11 populations and may indirectly impact nine populations of the species. Other reasonably foreseeable activities would directly impact four populations and indirectly affect three additional populations. In total, approximately 21 percent of the known populations in Minnesota would be directly or indirectly affected. Given its tolerance for disturbance and that the species is considered “secure,” the cumulative effects of the Project and other reasonably foreseeable activities are not expected to jeopardize the presence of *B. simplex* in Minnesota or in North America.

Caltha natans is more common to the Canadian provinces and Alaska with a southern range that extends into northeastern Minnesota and northwestern Wisconsin. It is considered “secure” by NatureServe (NatureServe 2007 and 2009). The Project would not directly impact any populations, but may indirectly affect five populations, which represent 42% of the known populations in Minnesota. No other reasonably foreseeable activities are known to impact this species. Further, the large number of populations discovered during the intensive surveys at the Project site suggests that either populations of this species may be under-reported overall, or that the Project site has exceptionally good habitat for unknown reasons. The lowland/wetland habitats in which *C. natans* occurs are not considered rare or declining in the Laurentian Uplands region, although they are declining in the Laurentian Mixed Forest subsection (Arrowhead) and state of Minnesota overall (Table 4.3-10). Given that the Project would not directly impact any populations, that no other reasonably foreseeable activities would impact the remaining populations, and that the species is considered “secure,” the Project and other reasonably foreseeable activities are not expected to jeopardize the presence of *C. natans* in Minnesota or North America.

Eleocharis nitida is widely distributed across eight Canadian provinces and six border states (AK, MI, MN, NH, VT, and WI). It is considered "apparently secure" by NatureServe (NatureServe 2007 and 2009). Given that Minnesota is at the southern edge of its historical range, *E. nitida* was probably never common in Minnesota. The Project would directly impact four populations and may indirectly affect nine additional populations, which collectively represent approximately 29% of the known populations in Minnesota. No other reasonably foreseeable activities are known to impact this species. Given its tolerance for disturbance, the cumulative effects of the Project and other reasonably foreseeable activities are not expected to jeopardize the presence of *E. nitida* in Minnesota or North America.

It is the Tribal cooperating agencies position that too much emphasis is being placed on this species' tolerance for disturbance "ability." Given the fact that the Project could affect nearly one-third of populations of this species, this could jeopardize the presence of the species in Minnesota.

Sparganium glomeratum is found in four Canadian provinces and two border states (MN and WI). This species is considered "apparently secure" by NatureServe (NatureServe 2007 and 2009), although it is considered rare or only rarely collected in North America and is most abundant in sedge marshes and black ash swamps in Wisconsin and Minnesota near the western end of Lake Superior (eFlora 2009). The Project would directly impact three and may indirectly affect 10 populations of this species. Other reasonably foreseeable activities would directly impact one population and would not indirectly affect any populations. Collectively, approximately 10 percent of the known populations in Minnesota would be directly or indirectly affected. This species inhabits non-forested wetlands (e.g., sedge meadow, poor fen, and lakeshore). Forest harvesting would not affect the non-forested wetland habitat of this species. Given its tolerance for disturbance, the cumulative effects of the Project and other reasonably foreseeable activities are not expected to jeopardize the presence of *S. glomeratum* in Minnesota or in North America.

Again, too much emphasis is placed on the species' "tolerance for disturbance."

Ranunculus lapponicus, and *Torreyochloa pallida* are all widely distributed across North America. They are all considered Species of Concern in Minnesota, but their populations are all considered "secure" by NatureServe (NatureServe 2007 and 2009). These species are all at either the southern or western edges of their historic ranges in Minnesota and were likely never common in the state. The Project would affect (directly and indirectly) between 3 percent and 9 percent of the known populations of these species in Minnesota. No other reasonably foreseeable activities are known to impact these species. For these reasons, the Project and other reasonably foreseeable activities are not expected to jeopardize the presence of these species in Minnesota or North America.

4.4 WILDLIFE

The section describes the existing wildlife conditions in the Project area and evaluates the direct, indirect, and cumulative effects of the Project on wildlife, wildlife habitat and potentially significant wildlife travel corridors traversing the Mesabi Iron Range. We evaluate Project effects on three, somewhat overlapping, categories of critical wildlife: federally and state listed endangered, threatened, and species of special concern (ETSC – seven species); the Minnesota Species of Greatest Conservation Need (SGCN - 58 species), and the USFS's Regional Foresters Sensitive Species (RFSS – 23 species).

Several other species have been identified as being of significant tribal concern including moose, deer, grouse, and furbearing species. Most of these species are relatively common in Northern Minnesota and would likely relocate to other, nearby habitat; therefore, loss of tribal access to Project lands would not affect use of these species. Moose populations are generally declining state-wide, and are relatively uncommon at the Mine Site. There is no documented tribal use of the Plant and Mine Sites for hunting/trapping of these species.

Tribal cooperating agencies note that the Area of Potential Effect for the Project was not determined until August 11th, 2009, and consultation under Section 106 of the National Historic Preservation Act is still ongoing between the USACOE and the Tribes. Therefore, historic and current Tribal harvest has not been determined for either the Plant or Mine Sites yet. The tribal cooperators' position is that while there is no current documented tribal use of said resources, most band members don't formally report their harvest sites at the scale that would allow identification of proximity to the mine site. If species of tribal concern 'relocated' to other lands and these other lands were private lands, there would be a loss of opportunity to harvest.

Recent studies from the MN DNR, the Natural Resources Research Institute at University of Minnesota-Duluth and Tribal natural resource management staff indicate that preservation of wetlands may be one of most important factors in maintaining the moose population in NE MN.

4.4.1 Existing Conditions

4.4.1.1 Endangered, Threatened, and Special Concern Animal Species

Seven federally- and state-listed endangered, threatened, and special concern animal species may be present in the Project area and are briefly described below.

Canada Lynx

Canada Lynx (*Lynx canadensis*) populations in the United States are protected under the ESA as a federally-listed threatened species, although it is not state-listed as an ETSC species in Minnesota and is considered globally secure by NatureServe (NatureServe 2009). Lynx population cycles are related to snowshoe hare populations, and therefore are predominantly found in boreal (specifically spruce and fir) forests (USFWS 2009). Mortality due to starvation has been documented during periods of hare scarcity (Poole 1994; Slough and Mowat 1996) and hunger-related stress, which induces dispersal, may increase exposure of lynx to other forms of mortality such as trapping and vehicle collisions (Brand and Keith 1979; Carbyn and Patriquin 1983; Ward and Krebs 1985; Bailey et al. 1986). Since 2000, the USFWS and USFS documented five road-killed lynx in Minnesota (DelGuidice et al. 2007). Lynx may also be subject to competition (Buskirk et al. 2000) and predation.

Tribal cooperators note that reproduction fails as well during these times (periods of hare scarcity), thus resulting in a decline in population density.

Staples (1995) described lynx as generally tolerant of humans. Other anecdotal reports suggest that lynx are not displaced by human activity, including moderate levels of snowmobile traffic (Mowat et al. 2000) and ski resort activities (Roe et al. 1999 in RS62, ENSR 2006). In an area with sparse roads in north-central Washington State, logging roads did not appear to affect habitat use by lynx (McKelvey et al. 2000 in RS62, ENSR 2006). By contrast, lynx in the more heavily roaded southern Canadian Rocky Mountains crossed highways within their home ranges less than would be expected (Apps 2000).

Current conditions for this species in the Project area were determined through review of existing data sources, including various lynx sighting databases (NRRI 2006; MnDNR 2009, Canada Lynx sightings in Minnesota) and general reports (Foth and Van Dyke 1999) as well as project-specific studies during the summer season (ENSR 2000; ENSR 2005) and a winter tracking survey (RS62, ENSR 2006). The winter tracking survey (RS62, ENSR 2006) also includes interviews with experts, private conservation groups, and the public, who are familiar with lynx use of the survey area.

Over three-quarters of lynx records in Minnesota are from the northeastern portion of the state (McKelvey et al. 2000 in RS62, ENSR 2006). Recent research in Minnesota confirmed a resident breeding population of lynx. Of the 426 sightings reported to the Minnesota Natural Heritage and Nongame Research Program since 2000, 76 percent were in St. Louis, Lake, and Cook County. Approximately 113 lynx have been sighted in St. Louis County since 2000 and 8 percent of these lynx showed evidence of reproductive activity (MnDNR 2009, Canada Lynx sightings in Minnesota).

On February 25, 2009, the USFWS published Final Rule for Revised Designation of Critical Habitat for the Contiguous United States Distinct Population Segment of the Canada Lynx (50 CFR 17). Portions of the Mine Site lie within the revised boundaries of federally designated lynx critical habitat. A recovery plan has not yet been issued for the Canada Lynx.

At least 20 different individual lynx occur within 18 miles of the Project area (NRRI 2006), including several radio-collared and reproductive individuals. The nearest reported sighting was approximately six miles from the Mine Site. The majority of sightings are clustered along roads and other places frequented by people.

The lynx winter tracking survey (RS62, ENSR 2006) covered a 250-square-mile area centered on the Project. The survey did not find any signs of lynx at the Plant or Mine Sites, but DNA analysis of scat indicates four unrelated females within the 250-square-mile survey area. Track surveys suggest that two individuals made most of the trails found. Although preferred cover types for the snowshoe hare exist on the Mine Site (e.g., Jack pine, fir-aspen-birch, aspen-birch), the forest may be too old or too young for high hare densities (Moen et al. 2005). Lynx density may increase as snowshoe hare populations cycle from a low point.

Gray Wolf

A July 1, 2009 federal judge's ruling rescinded an April 2009 USFWS decision to delist the western Great Lakes population of gray wolves. As a result, the Gray Wolf (*Canis lupus*) is again a federally listed threatened species. The Gray wolf is listed as a Minnesota Species of Special Concern. The Project is located within designated critical habitat for the Gray Wolf (43 FR 9607, March 9, 1978).

Populations of gray wolves have become re-established in several western states from their low point in the mid-1970s when only northeast Minnesota, among the lower 48 states, had a reproducing population. Gray Wolf populations in the western Great Lakes Region (i.e., Minnesota, Wisconsin, and Michigan) are expanding and have exceeded recovery goals for several years (Erb and Benson 2004). A 2007 to 2008 winter survey by the MnDNR (Erb 2008) estimated that 2,921 gray wolves live in Minnesota, which is second only to Alaska in wolf populations among the U.S. states. The MnDNR considers the Gray Wolf population fully recovered as it surpassed the federal delisting goal of 1,251 to 1,400 wolves (MnDNR 2009, News Release).

In northern Minnesota, the principal prey of the Gray Wolf includes white-tailed deer, moose, beaver, hare, and muskrat, with occasional small mammals, birds, and large invertebrates. Most wolves live in 2 to 12 member family packs and defend territories of 20 to 214 square miles. In Minnesota, the average pack size is 5.5 individuals (Erb and Benson 2004). The forest and brush habitats at the Mine Site are typical wolf habitat.

Radio-collared wolves were documented to the north and northeast of the Mine Site (International Wolf Center 2008); wolf tracks were observed on the Mine Site in 2000, 2005, and 2008; and calling surveys located wolves south of the Mine Site in 2004 (ENSR 2000; 2005; and 2009). Because of typical wolf territory size, these reports likely represent a single pack.

Bald Eagle

The Bald Eagle (*Haliaeetus leucocephalus)* was removed from the federal threatened species list on June 28, 2007. After a period of decline due to hunting and widespread use of Dichloro-Diphenyl-Trichloroethane (DDT), Bald Eagle populations in the lower 48 states rose dramatically beginning in 1972. It continues to be listed by the State of Minnesota as a Species of Special Concern, as a RFSS by the USFS, and is globally secure according to NatureServe (NatureServe 2009). In addition, the Bald Eagle is federally protected by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

The Minnesota NHIS (MnDNR 2007, NHIS) contains records of 35 nests within 12 miles of the Mine and Plant Sites. These nests occurred in five groups, with each group assumed to represent nests in close proximity used by a single pair (Guinn 2004). No nests were recorded at the Plant and Mine Sites and field surveys found no evidence of any nests (ENSR 2005). The five nearest Bald Eagle nesting territories ranged from 2.4 to 7.3 miles from the Mine or Plant Sites (averaging 5.7 miles apart). Bald Eagles are typically associated with large lakes surrounded by mature forest where large trees provide suitable nest sites and eagles perch while searching for fish and other prey. No large lakes or large nesting trees are located at the Mine or Plant Sites and it is unlikely that Bald Eagles would use these areas.

The Project area was also reviewed to evaluate whether it may provide wintering habitat for Bald Eagles. Eagles generally winter where there is available food at or near open water and where carrion is available. There are no large water bodies within the Project area that are likely to remain open in the winter. Animal-vehicle collisions on Dunka Road and/or natural deer mortality are not likely to produce sufficient carrion to sustain bald eagles at the Mine or Plant Sites (ENSR 2005).

Wood Turtle

The Wood Turtle (*Clemmys insculpta*) is listed as a threatened animal species in Minnesota and as a RFSS by the USFS. The Wood Turtle is not federally listed and is considered apparently secure according to NatureServe (NatureServe 2009). The species range extends from Virginia to Nova Scotia and westward to Minnesota and northeast Iowa. The Project area is located at the western edge of its range in Minnesota; populations are restricted to the eastern third of the state. Significant populations of Wood Turtle, however, are unlikely to be found at the Mine or Plant Sites because its preferred habitat of sandy-gravelly streams and bars, which are used for hibernating, mating, and nesting (Bradley et al. 2002), are not present. The Minnesota NHIS records indicate the northernmost population in the state was observed in the Partridge River and, given its proximity to the Mine Site, it is possible that wood turtles may potentially occur along the southern fringes of the Mine Site.

Heather Vole

The Heather Vole (*Phenacomys intermedius)* is listed as a species of special concern by Minnesota and as a RFSS by the USFS, but is not federally listed or globally sensitive according to NatureServe (NatureServe 2009). The Heather Vole is a habitat generalist, but generally inhabits the montane to alpine zone in upland forests, brushlands and meadows with low shrub species, and usually near water. Habitats of this type may occur at the Mine or Plant Sites; however, current Minnesota NHIS inventories did not identify any Heather Vole records within 10 miles of the Project. It was also not found in nearby surveys of small mammals on the Chippewa National Forest (Christian 1999) and in Cook County (Jannett 1998). The Project area is at the southern edge of the heather vole’s home range in far northern Minnesota and only a few collections of the species occur within Minnesota.

Yellow Rail

The Yellow Rail (*Coturnicops noveboracensis*) is a state listed Species of Special Concern and as a RFSS by the USFS. It is not federally listed, although its global rank is considered apparently secure (NatureServe 2009). Habitat for Yellow Rail includes lowland sedge meadows. Several small patches totaling 49 acres of wet meadow/sedge meadow occur at the

Mine Site. The Minnesota NHIS, however, has no records of the Yellow Rail occurring within 10 miles of the Project and field surveys did not find any Yellow Rail (ENSR 2005).

Tiger Beetle

A species of Tiger Beetle (*Cicindela denikei*) is listed as a threatened species by Minnesota and as a RFSS by the USFS. Although it was not searched for during field surveys, the NHIS has no records of Tiger Beetle occurring within 10 miles of the Project. This species inhabits openings in northern coniferous forests, specifically abandoned gravel and sand pits, undisturbed corners of active gravel and sand pits, sand and gravel roads, and sparsely vegetated rock outcrops (MnDNR 2009, *Cicindela denikei*). Conifer forests occur on the Mine Site, but field surveys did not detect sandy or rocky openings in the forest. Rock exposures are evident in areas disturbed by past mining, but conifer forests do not surround these areas.

4.4.1.2 Species of Greatest Conservation Need

The Minnesota Comprehensive Wildlife Conservation Strategy (MCWCS), an ecoregion-based wildlife management approach (MnDNR 2006, Tomorrow's Habitat for the Wild and Rare) identifies SGCN by ecoregion subsections based on a statewide approach. The MCWCS was created with input from multiple stakeholders and expert panels to cover issues of regional as well as statewide concern. The Mine and Plant Sites are located within the Nashwauk and Laurentian Upland subsection and includes six key habitat types. The SGCN species associated with these habitat types are identified in Table 4.4-1.

Table 4.4-1 Key Habitat Types and Species in Greatest Conservation Need in the Nashwauk and Laurentian Uplands Subsections which Occur or May Occur in the Project Area

Key Habitat Type	Cover Types at the Plant and Mine Sites in the Key Habitat Types	Associated Species of Greatest Conservation Need[1]	Plant Site (Acres)	Mine Site (Acres)
1. Mature Upland Forest, Continuous Upland/Lowland Forest	Aspen forest/Aspen-birch forest, Jack pine forest, Mixed pine-hardwood forest	Veery, Whip-poor-will, Eastern Wood-pewee, Yellow-bellied Sapsucker, Ovenbird, Canada Warbler, ***Northern Goshawk***, Cape May Warbler, ***Spruce Grouse***, Winter Wren, Boreal Chickadee, Wood thrush, ***Black-backed Woodpecker***, *Bald Eagle*[2], ***Boreal Owl***, *Bay-breasted Warbler*, *Black-throated Blue Warbler*	653	1,351
2.Open Ground, Bare Soils	Disturbed/Developed	None	2,768	66
3.Grassland/Brushland, Early Successional Forest	Brush/Grassland	Eastern Meadowlark, Franklin's Ground Squirrel, Brown Thrasher, White-throated Sparrow, Sharp-tailed Grouse, Golden-winged Warbler, *American Woodcock*, Northern Harrier, Sedge Wren, LeConte's Sparrow, Common Nighthawk, Black-billed Cuckoo, Red-headed Woodpecker, Tawny Crescent, *Least Weasel*	263	293
4.Open Water	Tailings Basin, Partridge River, Embarrass River, former LTVSMC mine pits	Common Loon, Red-necked Grebe, Common Snapping Turtle, Northern Rough-winged Swallow, American White Pelican, Common Tern, Wilson's Phalarope, Black Tern, Trumpeter Swan	552	3

Key Habitat Type	Cover Types at the Plant and Mine Sites in the Key Habitat Types	Associated Species of Greatest Conservation Need[1]	Plant Site (Acres)	Mine Site (Acres)
5.Wetland	Mixed hardwood swamp (Hardwood swamp, Eggers and Reed 1997), Black spruce swamp/bog (Coniferous swamp and Open bog, Eggers and Reed 1997)	Black Duck, American Bittern, Swamp Sparrow, Eastern Red-backed Salamander, Bog Copper, Disa Alpine, *Marbled Godwit*	189	1,302
6. Multiple Habitats	Combinations of Habitat Types	***Gray Wolf***[2] (1-3, 5[3]), ***Canada Lynx***[2] (1-3, 5), Rose-breasted Grosbeak (1, 3), Macoun's Arctic (1, 3), ***Least Flycatcher*** (1, 3), *Connecticut Warbler* (1, 3), *Olive-sided Flycatcher (1, 4)*, Grizzled Skipper (2, 3), Nabokov's Blue (2, 5), Wood Turtle (1, 3, 4)[2]		
Total			**4,425**	**3,016**

Source: MnDNR 2006, Tomorrow's Habitat for the Wild and Rare

[1] Bold italicized text indicates SGCN species observed at Plant and Mine Sites (ENSR 2005); italicized text indicates SGCN species targeted by ENSR (2005) that were not found; plain text indicates SGCN species identified as likely to be present at the Plant or Mine Sites but not targeted in surveys.

[2] Bald Eagle, Gray Wolf, Canada Lynx, and Wood Turtle are or have recently been listed as ETSC species as discussed in detail in the ETSC species section.

[3] Numbers refer to the Key Habitat Types (1-5) where those species may occur or are known to occur.

Mature upland and lowland forest is the most common habitat type at the Project (primarily at the Mine Site), with the majority of the forest currently in the 5 to 12 inch diameter at breast height (dbh) class. Northern Goshawk, Spruce Grouse, Black-backed Woodpecker, and Boreal Owl were observed in these forests (ENSR 2005). These species represent a group of species that generally requires large forested blocks and/or minimal human intrusion.

Areas of open ground/bare soils are rare at the Mine Site, but abundant at the Plant Site in areas disturbed by the LTVSMC operations or deposition in the Tailings Basin, both non-natural habitats. No SGCN are associated with this habitat type.

Brush/grassland and very early successional forest (trees less than five inches dbh) are uncommon at the Plant and Mine Sites (ENSR 2005) and where present are typically small patches resulting from recent logging. The USFS has indicated that American Woodcock has been observed at the Mine Site and the Least Weasel may occur as well. Most of the other SGCN species in Table 4.4-1 are generally associated with large patches of grassland and savanna habitats that are not present at the Plant and Mine Sites.

Open water and aquatic communities are confined to the LTVSMC Tailings Basin at the Plant Site. The Tailings Basin attracts Canada Geese and other waterfowl during migration and may at other times as well; however, the Project does not appear to provide good waterfowl or waterbird habitat. Common Loon, American White Pelican, Common Tern, Wilson's Phalarope, Black Tern, and Trumpeter Swan were searched for, but not found (ENSR 2000 and 2005). The Common Loon is common in the nearby area (e.g., Partridge and Embarrass rivers), but was not observed at the Tailings Basin.

The Project area, especially the Mine Site, contains a large expanse of wetland habitat consisting primarily of coniferous and open bog. No wetland SGCN species, however, were observed. Marbled Godwit, which was surveyed for, was not found probably because its preferred habitat is graminoid wetlands and shallow marshes near extensive upland grassland, which are not present at the Mine or Plant Sites.

Multiple habitats are not mapped as such, but made up of combinations of other key habitat types. This category is used for SGCN species that are known to use multiple habitats during a season. The Gray Wolf, Canada Lynx, Least Flycatcher, and Wood Turtle were observed in the general vicinity of the Mine or Plant Sites and are known to utilize multiple key habitat types, including mature and early-successional upland forest and wetlands. The Connecticut Warbler, which also uses mature and early-successional upland forest and wetlands, was searched for, but not found. Similarly, the Olive-sided Flycatcher was searched for in both lowland forest and wetlands, but was not found, probably because it prefers more open and mature conifer and mixed conifer-deciduous stands. The butterfly species Grizzled Skipper and Nabakov’s Blue are not found within 12 miles of the Mine or Plant Sites and are unlikely to occur on the Plant and Mine Sites as suitable habitat is not present.

4.4.1.3 Regional Foresters Sensitive Species

The Mine Site is located within the current boundaries of the Superior National Forest; however, the U.S. Forest Service and PolyMet are currently working to complete a land exchange whereby the Project lands would no longer be part of the National Forest System. The U.S. Forest Service manages 23 RFSS of terrestrial wildlife on this forest. Five of these species are state ETSC species (i.e., gray wolf, bald eagle, wood turtle, heather vole, yellow rail, and tiger beetle) and are discussed above. 12 other species are on the SGCN list and are discussed by habitat type in Table 4.4-1. These species are Northern Goshawk (*Accipiter gentilis*), Boreal Owl (*Aegolias funereus*), Olive-sided Flycatcher (*Contopus borealis*), Black-throated Blue Warbler (*Dendroica caerulescens*), Bay-breasted Warbler (*Dendroica castanea*), Connecticut Warbler (*Oporornis agilis*), LeConte’s Sparrow (*Ammodramus leconteii*), Peregrine Falcon (*Falco peregrinus*), Disa Alpine (*Erebia disa mancinus*), Sharp-tailed Grouse (*Tympanuchus phasianellus*), Freija’s Grizzled Skipper (*Pyrgus centaureae freija*), and the Nabokov’s Blue (*Lycaeides idas nabokovi*). The remaining five species are discussed briefly below.

The Great Gray Owl (*Strix nebulosa*) is not state or federally listed nor is it tracked in the Minnesota NHIS. It is considered globally secure by NatureServe (NatureServe 2009). Its preferred habitat includes coniferous and mixed forests and boreal bogs. These habitats are found in the Project area. Calling surveys did not identify any Great Gray Owls at the Mine Sites (ENSR 2000 and 2005); however, the USFS has records of a Great Gray Owl nesting unsuccessfully in the Project area in 2006.

The Three-toed Woodpecker (*Picoides tridactylus*) is not state or federally listed and is globally secure according to NatureServe (NatureServe 2009). This species was identified during winter field surveys (ENSR 2000); however, it was not identified during summer field surveys (ENSR 2005) nor is it tracked in the Minnesota NHIS. A limiting factor for this species is foraging habitat where sufficient insects can be found to feed its young during the breeding season. Three-toed Woodpeckers prefer and are most abundant in large tracts of old growth coniferous forest near recent burns where they forage on dead and dying trees for bark beetles (Burdett and Niemi 2002). No old growth coniferous habitat or recent burns exist at the Mine Site. A Three-toed Woodpecker was observed at the Mine Site by USFS personnel in 2007; however, the birds are unlikely to be common due to a lack of suitable habitat.

The Red-disked Alpine (*Erebia discoidalis discoidalis*), a butterfly, is not state or federally listed and is globally secure according to NatureServe (NatureServe 2009). This species was not searched for during field surveys, nor is it tracked in the Minnesota NHIS. It was found in 1979 and 1982 at Greenwood Lake, about 12 miles from the Project area. Its preferred habitat is acidic open bogs, of which there are 189 acres present at the Mine Site (Table 4.4-1), so this species may occur at the Mine Site.

The Jutta Arctic (*Oeneis jutta ascerta*), a butterfly, is not state or federally listed and is globally secure according to NatureServe (NatureServe 2009). This species was not searched for during field surveys nor is it tracked in the Minnesota NHIS. However, 749 acres of its preferred habitat of spruce bogs is present at the Mine Site (Table 4.4-1), so this species may occur at the Mine Site.

The Quebec Emerald *(Somatochlora brevicincta)*, a dragonfly, is not state or federally-listed, however, it is considered vulnerable globally by NatureServe (NatureServe 2009). This species was not searched for during field surveys, nor is it tracked in the Minnesota NHIS. However, the Minnesota Odonata Survey Project (2009) found an individual in northern Lake County approximately 30 miles north of the Project area in 2006. This species' habitat requirements are not well understood in Minnesota, although reports suggest it that it inhabits poor fens. This habitat type is not found in the Project area, but it is similar to the wet meadow/sedge meadow habitat at the Mine Site.

4.4.2 Impact Criteria

The following criteria are considered in evaluating Project effects on wildlife:

- Direct effects to federal or state listed species including the taking (removal or loss) of an individual or population due to traffic collisions or habitat destruction, a change in an individual or population's habitat use due to noise, or visual disturbance from lights, mining, and transportation activity.

- Indirect effects to federal or state listed species such as increased competition for resources or habitat due to displacement of individuals from the affected area into the territory of other animals, or other indirect effects which cause mortality or reduced breeding and recruitment in the future population.

- Direct or indirect effects on habitat types that affect population size and long-term viability for federal and state listed species and other species potentially at risk (SGCN or RFSS species). Direct effects include vegetation removal by clearing, burial, or other destructive activity. Indirect effects include changes within larger ecological units (e.g., the Laurentian Uplands or Partridge River Watershed), but not necessarily at the Plant or Mine Sites, that could occur at a later point in time such as a change in long-term vegetation composition or dominance, habitat conversion due to hydrologic changes; invasion by non-native species, or disruption of natural disturbance regimes (e.g., the annual natural hydrological cycle).

Tribal cooperating agencies note that this list of impact criteria is incomplete. This section should also analyze the effects of the project on species harvested and gathered by tribal members on public lands. Furthermore, the USACOE has not completed consultation with the potentially affected tribes.

4.4.3 Environmental Consequences

4.4.3.1 Proposed Action

Endangered, Threatened, and Special Concern Animal Species

Canada Lynx

The Project area is currently within designated critical habitat for the Canada Lynx (USFWS 2009). Surveys did not find any evidence of lynx use at the Plant or Mine Sites, but at least 20 different individual lynx were identified within 18 miles of the Plant or Mine Sites.

Site clearing and mining activities associated with the Project would potentially adversely affect lynx by reducing available habitat and increasing habitat fragmentation. The total impact from increased activity is not known, as lynx may habituate to increased activity. The Project would, however, result in the destruction of approximately two square miles (1,454 acres) of suitable lynx habitat, a mix of upland forest and lowland forest and bog. Assuming that the territory size of a resident lynx pair is 28 and 58 mi^2 (female and male territory size, respectively), this corresponds to a loss of three to seven percent of the territory for a single pair of lynx (RS62, ENSR 2006). Any lynx currently using the Mine Site could expand their territory into surrounding areas since lynx density in the vicinity is considered low relative to the rest of the Minnesota lynx range (RS62, ENSR 2006). Although the Proposed Action would result in a loss and fragmentation of lynx habitat at the Mine Site, the effect on statewide lynx populations would be insignificant since no individual lynx or pair of lynx would be significantly affected by the habitat loss. Habitat loss at the Mine Site, however, would result in fragmentation of lynx habitat in a portion of its current range.

Tribal cooperating agencies disagree with the conclusion that the effect on statewide lynx populations would be insignificant; this analysis does not consider the possibility that the Mine Site might include critical components of lynx habitat present, such as den sites.

The increased vehicle traffic associated with the Project, including train and small vehicle traffic between the Plant and Mine Sites, could potentially result in vehicle collisions with lynx (Table 4.4-2). The Project would generate approximately 970 (948 vehicle and 22 rail) trips per day, totaling about 3,989 miles, between the Plant and Mine Sites. This traffic would consist primarily of light trucks and maintenance vehicles traveling between 30 to 45 mph, and a few large fuel trucks, waste/supply trucks, and trains traveling between 25 to 40 mph. An additional 3,930 miles per day of vehicular traffic are expected within the Mine Site itself, primarily to haul ore to the rail siding and waste rock to stockpiles (Table 4.4-3).

Table 4.4-2 Vehicular and Train Traffic Volume Between the Plant and Mine Sites.

Vehicle Type	Vehicle Weight (tons)	Speed (min – max mph)	Road Segment	Trips per Day	Roundtrip Miles per Trip	Total Miles (per day)
Light Cars and Trucks	2	30-45	A, B, C	90	16.8	1,512
Light Cars and Trucks	2	30-45	H	390	4.4	1,716
Light Cars and Trucks	2	30-45	D	456	0.4	182
Light Vans	2	30-45	E-F	6	3.2	19
Fuel Trucks	40	25-40	A, B, C, H	3	21.2	64
Supply & Waste Trucks	40	25-40	B, C, D, F	2.4	25.2	60
Haul Trucks	81.5-425	15-25	A, B, J	1	17.6	18
Trains	3,000	15-25	Train track from Mine Site to Plant Site	22	19.0	418
Total				970	3.96	3,989

Source: Barr 2007, Requested Traffic Information, AQ01

Table 4.4-3 Vehicle Traffic Within The Mine Site Only

Vehicle type	Vehicle Weight (Tons)	Speed (max-min mph)	Road Segment	Total Road Miles in Mine Site	Total Miles (per day)
Haul Trucks and Construction Vehicles	81.5-425	12-14	Mine area only	4.44	3,930

Source: Barr 2007, Requested Traffic Information, AQ01

Although there is the potential for incidental take as a result of vehicle collisions with lynx, haul traffic at the Mine Site would likely have little direct impact on lynx, since lynx use of the Mine Site appears to be very low and the area would be heavily affected by mining operations and not likely to be used by lynx during the active mining phase. State and federal forest lands near the Mine or Plant Sites would continue to provide refuge for lynx, and it is likely lynx would favor these areas over those affected by mining for the duration of mine operations.

Restoration of disturbed areas as part of Mine Closure would eventually create a complex of upland forest, wetlands, and open water at the Mine Site, which would likely serve as lynx habitat, but this successional process would likely take decades. Potential lynx habitat would be lost for the duration of mine operations (over 20 years) and an additional 20 years or more after Mine Closure before suitable lynx habitat would again occur at the Mine Site.

Tribal cooperating agencies note that this restoration of ‘lynx habitat’ initially creates good bobcat habitat. Bobcats are superior competitors to lynx and thus may prevent lynx from returning to the site.

Therefore, the Project would be likely to adversely affect, but not significantly affect the Canada Lynx because of the direct loss of designated critical habitat, fragmentation of additional habitat within the critical habitat boundaries, and the increased potential (albeit low) for incidental take resulting from vehicular collisions.

Gray Wolf

The Project is located within designated critical habitat for the Gray Wolf. Observations indicate the likelihood of a single wolf pack whose territory includes the Plant and Mine Sites. The overall footprint of the Mine Site would remove approximately two square miles (1,454 acres) of habitat, or 1 percent to a maximum of 10 percent of a single wolf pack territory. This reduction in available habitat is relatively small and is not expected to significantly affect the wolf population in the region, which is considered healthy by the MnDNR. After Closure, this area would again be available and suitable as wolf habitat, but this would not occur for over 40 years as described above for Lynx.

Vehicle collisions are a major cause of wolf mortality (Fuller 1989; Kohn et al. 2000; Mech 1977). The increased vehicular and rail traffic associated with the Project, including haul truck traffic within the Mine Site and truck and rail traffic between the Mine and Plant Sites (Table 4.4-2) could potentially result in vehicle collisions with wolves. Although there is the potential for incidental take from collisions, haul traffic at the Mine Site would likely have little direct impact on wolves because the area would be heavily affected by mining operations (e.g., high levels of noise, traffic, disturbance), which would discourage wolf use during the active mining phase. State and federal forest lands near the Mine or Plant Sites would continue to provide refuge for wolves, and it is likely wolves would favor these areas over those affected by mining for the duration of mine operations. Increased Project use of Dunka Road would increase the potential for vehicular collisions with wolves for the duration of mining operations.

Tribal cooperating agencies strongly suggest that the DEIS include a discussion and analysis of the expected road density that will result from the Project. Research has found that when road density exceeds 1 km / sq. km of land wolf habitat suitability declines.

The *Recovery Plan for the Eastern Timber Wolf* (USFWS 1992), which is the same species as the Gray Wolf, identifies five main factors critical to the long-term survival of this species. These critical factors are: 1) large tracts of wild land with low human densities and minimal accessibility by humans; 2) ecologically sound management; 3) availability of adequate wild prey; 4) adequate understanding of wolf ecology and management; and 5) maintenance of populations that are either free of, or resistant to, parasites and diseases new to wolves, or are large enough to successfully contend with their adverse effects. The Project would impact the availability of wild land (factor 1) and prey availability (factor 3) through a reduction in general habitat availability (approximately 1,454 acres) at the Mine Site, although adjacent Federal and state lands would continue to provide suitable habitat.

Therefore, the Project would potentially impact, but not significantly, the Gray Wolf because of the direct loss of suitable habitat and fragmentation of additional habitat, the increased potential for incidental take resulting from vehicular collisions, and indirect decline in prey species due to habitat loss. The Gray Wolf population in Minnesota (estimated at 2,922 gray wolves) is considered fully recovered by MnDNR as it has surpassed the federal delisting goal of 1,251 to 1,400 wolves.

Bald Eagle

In Minnesota, Bald Eagles typically nest in large trees within 500 feet of lakes or rivers (Guinn 2004). There are no large lakes or rivers located at the Plant or Mine Sites that would provide suitable nesting/foraging habitat. Activities that occur within one-quarter to two miles of nests[1] may have adverse effects on nesting eagles. Generally, the closer the activity the greater the effect. The nearest recorded Bald Eagle nest to the Mine or Plant Sites is approximately 2.4 miles from the Mine Site; consequently, there should be no adverse effect on existing nesting eagles due to activities at the Plant and Mine Sites.

Bald Eagle nesting territories in Minnesota generally have a 10-mile radius that varies with habitat quality (Guinn 2004). Bald Eagle nests near the Project area are on average 5.7 miles apart (3.8 to 9.4 mile range), which is less than the average territory radius and suggests that the area is saturated with Bald Eagle nesting territories and that no new eagles are likely to move into the area. As eagles become more numerous, any eagles seeking to establish new territories in the Project area would need to select lower quality habitat and/or move into closer proximity to human activity.

Therefore, the Project is not likely to adversely affect Bald Eagles because the Plant and Mine Sites are more than two miles from any known mesting sites and do not provide suitable habitat for nesting and foraging Bald Eagles.

Tribal cooperating agencies disagree with this conclusion; impacts to Bald Eagles could result from eagle feeding sites within or adjacent to the project area. Contaminants from the mine site, specifically mercury and heavy metals, could effect prey species thus having secondary impacts on eagle reproduction.

Wood Turtle

The only known population of Wood turtles in the Project area is located on the Partridge River downstream from the Mine Site. There is not suitable habitat for Wood turtles at the Mine or Plant Sites and no individuals are known to occur, although given the proximity of the Partridge River Wood turtles could potentially use the southern riparian fringe of the Mine Site. These fringe areas would not be permanently impacted by the Project; therefore, the Project should not have any direct effects on the Wood turtle.

The Project would not result in violations of surface water quality standards; therefore, there would be no significant Project-related changes to water quality in the Partridge River and no indirect effects on downstream habitat where Wood turtles are located (refer to Section 4.1 for a detailed discussion of Project effects on water quality). Changes in the Partridge River that may affect the Wood turtle include increased sedimentation and modifications in the flow regime. A small decrease in Partridge River flow during the active mining period is not likely to negatively affect the Wood turtle. The most likely effect of a decrease in water level would be to expose

[1] The US Fish and Wildlife Service eagle management guidelines suggest that human activity within this zone can be seen by eagles and, depending on the level of screening and habituation of individual eagles, may cause them to abandon a nest.

additional areas of riverbank for nesting. Over the long term, the exposed soil on the lower bank would be overtaken by vegetation from the upper bank.

Therefore, the Project is not likely to adversely affect Wood turtles because there would be no direct loss of individuals, populations, or suitable habitat and the Project would have no indirect effects on downstream habitat.

Tribal cooperating agencies have noted concerns in previous drafts of the EIS that the project may create attractive nesting sites where mining or heavy vehicle activity takes place. This could result in increased adult or nest mortality. The tribal cooperators do not see any new evidence or clear analysis to support the claim that the Project is not likely to adversely affect Wood turtles.

Heather Vole

The Heather Vole has not been observed during field surveys within 10 miles of the Plant or Mine Sites or found in small mammal surveys in the region (Christian 1999; Jannett 1998) and is at the southern edge of its range. Approximately 1,479 acres of potentially suitable habitat (upland alpine forests and grassland/brushlands) exists at the Mine Site, so the Heather Vole could be present, but, if so, likely in very small numbers. The Project would impact much of the Heather Vole's potential habitat at the Mine Site (approximately 53 percent), but is unlikely to jeopardize the presence of Heather Vole in Minnesota. Therefore, the Project is not likely to adversely affect Heather Voles.

Yellow Rail

The Yellow Rail was not found during surveys at the Mine Site and was not reported in NHIS database within 10 miles of the Project. Small, scattered areas of its preferred habitat, wet meadow/sedge meadow, are present at the Mine Site but the minimum nesting patch size used by rails (54 acres) (Goldade et al. 2002) exceeds the total amount of suitable habitat available (approximately 49 acres, refer to Section 4.2). Since the Yellow Rail was not detected in surveys and patches of its preferred habitat are smaller (or do not occur) than the reported minimum patch size for nesting, it is not expected to occur at the Plant or Mine Sites. Therefore, the Project is not likely to adversely affect the Yellow Rail.

Tiger Beetle

The lack of suitable habitat and any recorded observations in the Project area for the Tiger Beetle (*Cicindela denikei*) suggest that the species does not occur at the Plant or Mine Sites. Therefore, the Project should have no effect on the Tiger Beetle.

Species of Greatest Conservation Need

The Project would affect SGCN as a result of increased human activity, collisions with vehicular and rail traffic, and loss of habitat.

Increased Human Activity

Direct impacts due to increased human activity and consequent increases in trapping and hunting are unlikely because public access would be restricted. The USFS and PolyMet are currently working to complete a land exchange, which would convert Project lands to private ownership and therefore inaccessible for public use. This analysis assumes completion of the land exchange. The main access road (Dunka Road) is privately owned and would remain gated to prevent non-mining access during mining operations and following Mine Closure.

During operations, increased human activity may frighten some species and discourage their use of otherwise suitable habitat. In general, suitable habitat is available in the Project area and most mobile animal species would be displaced. Following migration to new areas, individuals displaced from the Plant and Mine Sites may increase competition for resources in their new habitat; however, this is unlikely unless the new habitat is already at or above its carrying capacity. Tribal cooperatoring agencies maintain that displaced wildlife tend to suffer higher mortality just by having to leave familiar territory. Less mobile species, such as herptiles, would likely incur relatively high mortality rates since they cannot emigrate from the area as quickly and would be more susceptible to changing habitat conditions. During the winter a combination of plowing and sand, gravel, or salts (magnesium chloride) applications would be used to maintain passable roadways. The potential exists for sand and salts to accumulate in the trenches adjacent to the roadways affected less motile species; however, these areas would not be considered high quality habitat and the impacts to wildlife are not considered significant.

Vehicular and Rail Traffic Impacts

Vehicular and train traffic, primarily between the Plant and Mine Sites, is expected to average approximately 3,989 miles per day with travels speeds averaging between 15 and 25 mph, with trains, fuel, and waste/supply trucks traveling somewhat slower (Table 4.4-2). There is additional vehicular traffic totaling approximately 3,930 miles per day within the Mine Site itself (Table 4.4-3).

Traffic impacts from collisions with wildlife depend to a large extent upon micro-site features, traffic volume, traffic speed, and the species involved (Forman et al. 2003). Micro-site features that increase the potential for road impacts are the presence of wildlife travel corridors across, and attractive habitat along, roads. The high density of wetlands at the Mine Site and the proposed retention of wetland “islands” among the haul roads may result in a relatively high rate of amphibian and reptile impacts. Shrub and trees near roadsides can increase road crossings by deer and bird use.

Wildlife mortality generally increases with increasing traffic volumes and speed. In general, highly mobile species and habitat generalists are expected to have higher road mortalities. There is little research on the visual and noise effects of traffic on certain animal groups (e.g., invertebrates, reptiles, amphibians). Small passerine birds appear affected by noise at distances up to several hundred meters from a road, while other wildlife groups (e.g., mammals) appear less sensitive (Kaseloo and Tyson 2004). The barrier effect of roads is greater for small mammals, amphibians, and reptiles than for birds and large mammals (Kaseloo and Tyson 2004). Edge effects in the small preserved forest island remnants between haul roads at the Mine Site would be greatest for species that require large blocks of continuous habitat (i.e., "area sensitive" or "core habitat" species). In general, the indirect vehicular and rail traffic effects of the Proposed Action are expected to be locally significant for amphibian and reptile SGSN species at the Mine Site and along the road and railroad, but not significant at the scale of the Nashwauk and Laurentian Uplands or the Partridge River watershed.

Wildlife Habitat Impacts

The direct effect on wildlife habitat (and by inference on SGCN species) was assessed by evaluating the acres of habitat types that would be lost under the Proposed Action. The area disturbed was derived from the U.S. Geological Service (USGS) Level 3 Gap Analysis Program (GAP) GIS data and the 2006 mine features layers from the MnDNR Division of Lands & Minerals (Table 4.4-4).

Table 4.4-4 Direct Effects of the Proposed Action on Key Habitat Types

Key Habitat Types	Directly Affected at Mine Site (Acres)	Directly Affected at Plant Site (Acres)
Mature Upland Forest, Continuous Upland/Lowland Forest[1]	613	151
Open Ground, Bare Soils	0	946
Brush/Grassland, Early Successional Forest	245	55
Open Water	1	539
Wetland[2]	597	63
Multiple Habitats	NA	NA
Total	**1,456**	**1,754**

Source: Derived from GAP Level 3 Land Cover Data

1 Contains significantly reduced cover types Jack pine forest (84 acres) and Mixed pine-hardwood forest (460 acres). Lowland forest may include small areas of wetlands not reflected in the total wetland impact of the project.

2 The Tailings Basin is not considered a jurisdictional wetland. However, this wetland provides low-quality habitat for open water and mud flat species. Wetland acreage provided here is based solely on land cover mapping and therefore varies from the wetland acreage delineated for regulatory purposes as described in Section 4.2.

<u>Mature Upland/Lowland Forest</u>

Most of the Plant Site is developed or disturbed with only approximately 16% (691 acres) consisting of forest habitat (Table 4.3-1). Approximately 151 acres of this forest habitat at the Plant Site would be disturbed, most of which are in small or isolated patches of aspen-birch forest that are in poor to fair condition (MnDNR 2009, NHIS) and that do not represent any significantly reduced cover types. Therefore, the Project would have little effect on SGCN in mature upland/lowland forest habitat at the Plant Site.

At the Mine Site, approximately 611 acres (23 percent) of the upland and lowland forest would be lost as a result of the Project, including about 84 acres of Jack pine forest (Table 4.3-7), which, as indicated above, is considered a "significantly reduced cover type." All of the SGCN species found in this mature forest habitat are birds (Table 4.4-1), which would be displaced, but likely not injured or killed, during mine construction and operation assuming construction does not occur during the breeding season when nest sites could be disturbed.

Reclamation of the Mine Site would include revegetating nearly all disturbed ground according to *Minnesota Rules*, part 6132.2700. At the Mine Site, red pine would be planted to reclaim approximately 792 acres of the Category 1, 2, and 3 stockpiles, although woody growth would be controlled on the tops and benches of the Category 3 stockpiles to prevent deep-rooted trees from penetrating the cap. Tribal cooperating agencies reiterate previous DEIS review statements that single species conifer plantations have little wildlife value.

Tree plantings would begin to resemble forest habitat types in approximately 20 years following Closure. Natural succession may increase the Jack pine composition within the red pine restoration area. Because most of revegetation areas are contiguous with remaining upland/lowland forest, the resulting size of the continuous upland/lowland forest patch at the Mine Site would be restored to near pre-mine levels, which would restore much of the SGCN species habitat. However, it should be noted that a red pine monoculture would not mimic the natural plant community at the Mine Site.

Natural succession would also alter the 147 acres of removed stockpile areas at the Mine Site that would be re-vegetated with grasses and other herbaceous materials. Initial colonization by lighter-seeded aspen, willows, and perhaps paper birch would begin at Year 20 following stockpile removal. Subsequent colonization and establishment by heavier-seeded tree species is likely to begin slowly and accelerate after Year 40 (20 years after Closure) when pole-sized aspen become established. At Year 60 (40 years after Closure), it is expected that the deciduous forest would contain a greater variety of tree species, possibly including Jack pine, paper birch, white spruce, and balsam fir. Natural succession would likely be slower in the Tailings Basin and in areas with compacted soils (such as reclaimed mining roads)—perhaps taking 50 to 100 or more years in some locations.

Reclamation and re-vegetation of the Mine Site would improve wildlife habitat relative to conditions during mine operations; however, the quality of habitat for SGCN species is likely to remain degraded for some decades after Closure relative to pre-mining operations due to conversion of high-quality habitat to lower-quality habitat.

Open Ground/Bare Soils

The likelihood of SGCN species using open ground/bare soils at the Mine or Plant Sites is small. These areas were created by past mining activity, are generally of low-quality, and are expected to decrease after Mine Closure as a result of reclamation. Therefore, Project effects on open ground/bare ground habitat should result in little adverse impact on wildlife.

Brush/Grassland

Brush/grassland (including early successional forest) at the Mine or Plant Sites consists of small vegetative patches that are generally not attractive to SGCN species (Figure 4.3-1). Young trees (less than four inches dbh) make up most of this habitat type (ENSR 2005). One SGCN species associated with this habitat type was observed by USFS personnel at the Mine Site (American

Woodcock) and Least Weasel may occur as well. Most of the other SGCN species (Table 4.4-1) are associated with large patches of grassland and savanna habitats, which are not present at the Mine Site. Approximately 245 of the 293 total acres of brush/grassland at the Mine Site would be directly impacted by the Project. Approximately 55 of the 263 acres of brush/grassland at the Plant Site would be directly affected by the Project. Overall, the Project would have minor adverse effects on grassland/brush SGCN species.

Mine reclamation would create approximately 212 acres of seeded grassland. In addition, PolyMet would remove or cover portions of the existing road, railroad, ditch, and dike systems and restore them as well as the Tailings Basin with grass/herbaceous seeding, resulting in approximately 2,803 acres of grassland/shrub and wetland habitat after Closure at the Plant Site. Reclamation of these areas, which currently constitute poor wildlife habitat, would ultimately enhance wildlife habitat in comparison to current conditions. Some SGCN species, including Eastern Meadowlark, Northern Harrier, and Common Nighthawk, would likely use the grasslands until they are replaced by early successional forest about 20 to 50 years after Closure, although these species are not common in the Iron Range. Early successional forests are likely to support two SGCN species: White-throated Sparrow and American Woodcock.

Open Water

Open water at the Project primarily occurs in the Tailings Basin. None of the targeted SGCN species were observed on open water during the survey (ENSR 2005); however, common waterfowl and water birds were observed at the Tailings Basin during migration, in particular Canada Geese and ducks. Much of this open water habitat at the Mine or Plant Sites would be impacted during mine operations. The open water of the Tailings Basin, however, is unlikely to provide valuable habitat because of the lack of emergent or submerged vegetation for feeding waterfowl, associated vegetated fringes, or upland nesting areas.

PolyMet would create approximately 278 acres of open water by eventually flooding the West Pit, which is estimated to fill approximately 45 years after mining ceases. Initially, water quality in the West Pit is predicted to exceed surface water standards for several parameters, but is expected to improve with time. The West Pit would be fenced as a deterrent to wildlife species and it should be noted that this habitat is not likely to provide high quality foraging habitat for waterfowl.

Tribal cooperating agencies note that pit water quality is expected to exceed surface water quality standards for hundreds or thousands of years. The DEIS should explain the basis for the statement that the West Pit would not provide high quality foraging habitat for waterfowl and discuss other potential uses of the Pit by waterfowl and other birds.

Wetlands

This section focuses on Project effects on wildlife species that use wetland habitats; additional discussion on wetland conditions and impacts is presented in Section 4.2. Of the wetland-related SGCN, the Marbled Godwit and Olive-sided Flycatcher were searched for, but not found during surveys (ENSR 2005); the Black Duck, American Bittern, and Swamp Sparrow are not likely to be present because they require non-forested wetlands and open water, which are relatively scarce on-site; the Red-Backed Salamander is primarily an upland species, but may be present along the edges of mixed hardwood swamps; the Bog Copper was not found during surveys and there are no records of any sightings within 12 miles of the Mine Site; and the Disa Alpine butterfly may inhabit the black spruce bogs of the Mine Site and is historically known to occur in the Laurentian and Nashwauk Uplands (MnDNR 2006, Tomorrow's Habitat for the Wild and Rare).

Based on the site-specific wetland delineation, the Project would impact approximately 1,168 acres of wetlands (850 acres of direct impacts and 318 acres of indirect impacts), primarily coniferous bog (661 acres of total impacts) and open bog (189 acres of total impacts). Tribal cooperating agencies strongly disagree with the conclusions presented in the wetlands section. The methodology used to predict the acres of wetlands indirectly impacted by the project pit dewatering are not adequate to assess indirect wetland impacts. In addition, approximately 320 acres of wetlands may be indirectly impacted north of the Tailings Basin, for a total impact of 1,488 acres. Although on-site wetland use by the SGCN species described above may be limited, these wetlands are generally considered to be of high quality and provide valuable habitat to a wide range of wildlife species.

Some 36,565 acres of wetland habitat exist in the Partridge River watershed surrounding the Mine Site. The wetland types affected at the Mine or Plant Sites, primarily black spruce and open bogs, are common in the Partridge River watershed. Consequently the loss of this habitat at the Mine Site is expected to displace wildlife into surrounding similar habitat, which would be sufficiently large to absorb the displaced wildlife.

Wetland mitigation is proposed both on-site and off-site. Approximately 175 acres of shallow and deep marsh wetland creation is proposed for on-site mitigation. This is significantly less than the wetland acreage lost and would not replace in-kind the wetland habitat impacted (primarily coniferous and open bogs). Off-site mitigation would consist of 1,123 acres of wetland creation consisting of various habitat types at two sites and an additional 202 acres of upland buffer at both sites (Section 4.2). The proposed off-site mitigation would result in the creation of substantially different habitat types in a different eco-region and in a different watershed (e.g., outside the St. Louis River watershed) than that of the impacted wetlands at the Mine or Plant Sites.

The SGCN species most likely to be present at, and affected by, the Project (e.g., Bog Copper, Disa Alpine) may use the off-site mitigation, although these sites provide less coniferous bog and more of other wetland habitat types (e.g., sedge meadow, marsh, shrub-carr, and hardwood and coniferous swamp) than occur at Mine or Plant Sites. SGCN species that utilize shallow and deep marsh and open water habitats created at the Mine Site in the East and West Pits would likely benefit from on-site mitigation. These may include American Bittern, Swamp Sparrow, and Black Duck, but their presence depends on the vegetation quality established after Closure.

Multiple Habitats

The species using multiple habitats and known to occur on or near the Mine Site (e.g., Gray Wolf, Canada Lynx, Least Flycatcher) are discussed above. Most multiple-habitat SGCN species use mature/continuous and early successional forest. Project effects are therefore largely limited to the mature/continuous forest above.

Regional Foresters Sensitive Species

The USFS manages 23 RFSS of wildlife in the Superior National Forest. Six of these species are ETSC species and are discussed above. Twelve of these species are also on the SGCN list and are discussed by habitat type above. The analysis of potential impacts to the remaining five RFSS of wildlife, which are not federally or state listed ETSC or SGCN species, are discussed below:

- The Great Grey Owl may be occasionally present at the Mine Site, since nest sites have been seen in the area. However, since this nest was unsuccessful, and subsequent owl calling surveys (ENSR 2005) found no owls, populations in the area are likely small and/or occasional. Owls are sensitive to disturbance, so populations would be unlikely to use the Mine Site during mine operations. Because populations are thought to be low, impacts to the Great Grey Owl populations are expected to be minimal.

- Systematic survey data for Three-toed woodpeckers are lacking, however, one bird was observed during field surveys (ENSR 2000) and by USFS personnel in 2007. Generally, the young condition of the forest habitat at the Mine Site is not suitable for Three-toed woodpeckers, and they are unlikely to be common. Woodpeckers are sensitive to disturbance and would not be expected to use the Mine Site during mining operations. Because populations are expected to be low, impacts to the Three-toed woodpecker populations are expected to be minimal.

- Survey data are lacking, but the Red-disked Alpine butterfly's acidic open bog habitat is present in the Mine Site. Since 189 acres of this habitat present at the Mine Site would be disturbed by the Project, impacts to this species may occur. This species, however, is not an ETSC or SGCN species and is globally secure; therefore, the Project is unlikely to jeopardize the presence of this species.

- Although the Jutta arctica has not been found at the Mine Site, this butterfly's preferred spruce bog habitat is present on the Mine Site. The Project would impact 661 acres of this spruce bog habitat. If this species is present at the Mine Site, it would incur impacts. This species, however, is not an ETSC or SGCN species and is globally secure; therefore, the Project is unlikely to jeopardize the presence of this species.

- The Quebec Emerald dragonfly inhabits poor fens, a wetland type not found at the Mine Site but having habitat similar to wet meadow/sedge meadow that is present. Approximately 45.8 of the existing 49 acres of wet meadow/sedge meadow at the Mine Site would be affected by mining activities. The presence of the Quebec Emerald in the region and the existence of similar habitat at the Mine Site suggest that this species may be impacted by the Project. This species, however, is not considered a SGCN and, therefore, the Project is unlikely to jeopardize the presence of this species.

4.4.3.2 No Action Alternative

The No Action Alternative would likely have a neutral to slightly positive effect on wildlife. The LTVSMC Plant Site reclamation would proceed as planned including revegetation of open ground and disturbed soil, removal of buildings, and revegetation of the Tailings Basin. The Mine Site, which is primarily young forest, would continue to mature, except where it is logged, which would benefit the majority of the Federal and state-listed ETSC and SGCN species and RFSS species found or likely to occur at the Mine or Plant Sites that prefer mature forest habitat.

4.4.3.3 Mine Site Alternative

The impacts of the Mine Site Alternative would be comparable to the Proposed Action, except that the long-term Category 4 waste rock and lean ore stockpiles would be eliminated, thereby reducing the total areal footprint of the stockpiles at Closure. This alternative would reduce the impacts primarily to Jack pine forest and mixed hardwood swamp habitat and retain these areas for resident wildlife species.

4.4.3.4 Tailings Basin Alternative

The impacts of the Tailings Basin alternative would comparable to the Proposed Action; however, would also involve the construction of an 8.4-mile water discharge pipeline from the Tailings Basin to the Partridge River downstream of Colby Lake. Construction of the pipeline would impact approximately 50.6 acres of wildlife habitat through clearing and routine maintenance associated with the expanded berm. While portions of the pipeline ROW are already maintained, clearing and maintenance would convert some upland forests to grassland/shrublands habitats and reduce habitat availability for forest-dwelling species. These impacts are not expected to be significant as they occur along existing disturbed areas and would not result in additional habitat fragmentation.

There are no ETSC species known to occur within the existing Tailings Basin and the Minnesota NHIS did not identify any ETSC species occurring within, or adjacent to, the proposed discharge pipeline corridor; therefore, it is unlikely that the Tailings Basin Alternative would impact ETSC species.

4.4.3.5 Other Mitigation Measures

As discussed above, there is the potential for wildlife mortality resulting from vehicle collisions, particularly to amphibians and reptiles at the Mine Site due to the pocket wetlands between the haul roads. The risk of vehicle collisions with wildlife could be reduced by controlling vehicular speeds, educating drivers using Dunka Road about potential collisions, and other similar prevention and avoidance techniques.

PolyMet proposes to reclaim disturbed areas as part of Mine Closure primarily with a combination of red pine and herbaceous planting that includes invasive, non-native species. Although rapid stabilization of these disturbed areas is a priority, there may be opportunities to enhance wildlife habitat using alternative revegetation measures. The recommended mitigation measures include planting a broader mix of native conifers and other native trees, shrubs, forbs, and grasses, which would result in a more diverse and better quality wildlife habitat at an earlier stage of forest succession. In addition to red pine, other appropriate species to plant could include Jack pine, white pine, red fescue, Canada goldenrod, and other native plants that have proven successful in mine land reclamation projects in the Laurentian Mixed Forest Province. Patches of forest with non-forested openings provide ideal habitat for white-tailed deer, a major wolf food in the Arrowhead Region. The Canada Lynx would benefit from a focus on conifer species that would provide winter habitat for snowshoe hare, the lynx's preferred food.

At Closure, the surface of haul roads and other infrastructure would be scarified and vegetatively stabilized; however, they would continue to potentially provide access to this area. Limiting off-road vehicles and foot traffic by no trespassing signage, and installing gates, rock barriers, or berms at likely entry points to the Mine Site would reduce human intrusion, enhance habitat restoration, and promote wildlife use.

The following potential mitigation measures may also indirectly benefit wildlife:

- Monitoring of Waste Rock Stockpiles and Tailing Basin – would help ensure that water quality would meet state standards and not adversely affect wildlife at the Mine Site; and

- Maximize the Elevation of the Category 1 and 2 Stockpile – maximizing the height of the Category 1 and 2 stockpile would reduce the footprint of this stockpile and thereby minimize direct impacts to wildlife habitat, although it is expected that the reduction in direct impacts would be small (e.g., a few acres) because the stockpile height is already at or close to its maximum height from a geotechnical engineering perspective.

4.4.4 Cumulative Impacts

Cumulative impacts affecting wildlife may include the loss or fragmentation of habitat and encroachments into critical wildlife travel corridors. These impacts were assessed by evaluating the effects of the Project with other past, present, and reasonably foreseeable future federal, state, tribal, and private actions.

4.4.4.1 Loss and Fragmentation of Wildlife Habitat

The study area for loss and fragmentation of habitat is the 10.8 million acre Arrowhead Region consisting of eight ecological subsections. The Project is located in the 810,000 acre Nashwauk Uplands (Plant Site) and the 567,000 acre Laurentian Uplands (Mine Site) subsections. The extent of habitat loss and fragmentation in the Arrowhead Region was analyzed semi-quantitatively using:

- Minnesota's Comprehensive Wildlife Conservation Strategy (MCWCS);

- Marschner's Original Pre-settlement Vegetation Map of Minnesota as interpreted and analyzed by researchers, the Minnesota Forest Resources Council, and at the subsection level in the MCWCS approach by the MnDNR;

- Scientific literature and reports (e.g., Minnesota Generic Environmental Impact Study (MnGEIS) on Timber Harvest, University of Minnesota researchers, Minnesota Forest Resources Council);

- Reports on mining, infrastructure, and forestry impacts (e.g., MnDNR Lands & Minerals Division mining impact and permit GIS data; Emmons and Olivier 2006; Barr Engineering 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species; Superior National Forest Management Plan Revision Final Environmental Impact Statement; state and county timber harvest data); and

- GIS land cover and ecological data (e.g., GAP Level 3 landcover data) and summaries of GIS land cover and ecological data in the MN GEIS on Timber Harvest, by the Minnesota Forest Resources Council as part of the MCWCS approach.

The MCWCS is a central component of MnDNR's strategy for managing wildlife populations in the state; use of the MCWCS is therefore appropriate as the basis for assessing cumulative effects on wildlife habitat loss and fragmentation for the Project.

4.4.4.2 Past and Current Habitat and Wildlife Trends

Two periods of changes in forest composition were evaluated – the 1890s to 1990s and 1977 to 1990, as indicative of past and relatively current trends in wildlife habitat, respectively.

Forest changes from the 1890s to the 1990s are indicative of past wildlife habitat trends. The MCWCS approach uses Marschner pre-settlement mapping as a baseline for describing changes taking place in sixteen vegetation types/ecosystems since the 1800s, using recent land cover data from the MnGAP Landcover data and reported by ecological subsection (MnDNR 2006, Tomorrow's Habitat for the Wild and Rare). The effects on wildlife were evaluated by noting the change in amount of each Marschner habitat type in terms of the effect on wildlife species which use that habitat type. Wildlife habitats that decreased in acreage from pre-settlement to current conditions present a higher risk of future SGCN population decreases and are in greater need of conservation in Minnesota.

The changes in habitat types in the Nashwauk and Laurentian Upland subsections from the 1890s to 1990s are presented in Table 4.4-6. These data indicate a significant decrease occurred from the 1890s to 1990s in red-white pine forest and mixed pine-hardwood forest in the Nashwauk Uplands, and in Jack pine woodland in the Laurentian Uplands. At the Mine Site, there is little red-white pine forest; about 1,003 acres of mixed pine-hardwood forest (but it is in the Laurentian rather than the Nashwauk uplands); and 183 acres of Jack pine forest (in the Laurentian Uplands). Although much of the Mine Site is classified as "Mature Upland Forest" by MnDNR definition (> five inch dbh), in fact most of this forest is still relatively young.

Table 4.4-6 Change in habitat types in the Nashwauk and Laurentian Upland Subsections from the 1890s to 1990s

Habitat Type	Nashwauk Uplands Subsection (Plant Site and Tailings Basin)		Laurentian Uplands Subsection (Mine Site)	
	% of Subsection Land Surface in 1890s	% of Subsection Land Surface in 1990s	% of Subsection Land Surface in 1890s	% of Subsection Land Surface in 1990s
Aspen Forest (Upland Deciduous Forest)	32.5	32.0	34.6	36.1
Lowland Conifer Forest/Shrubland	25.2	21.3	28.2	35.3
Jack Pine Woodland (Upland Shrub/Woodland)	10.5	19.4	19.4	4.7
Red-White Pine Forest (Upland Conifer Forest)	17.9	9.9	13.2	17.4
Mixed Pine-Hardwood Forest (Upland Deciduous Forest)	7.1	1.7	0.0[1]	0.3
Grassland	N/A[2]	5.2	N/A	0.5
Open Water[3]	6.3	6.1	N/A	4.3
Lowland Deciduous Forest	0.0	1.7	0.0	0.3
Wetland – Nonforest	0.6	0.9	0.0	0.1
Cropland	N/A	1.2	N/A	0.0
Developed	N/A	0.7	N/A	0.0

Source: MnDNR 2006, Tomorrow's Habitat for the Wild and Rare

Note: Not all columns total to 100 percent due to rounding and small variations in data availability as described below.

1 0.0 indicates less than 0.05 percent coverage

2 N/A indicates that insufficient data was available to determine percent coverage within the subsections, although these habitat types likely occurred at very low levels

3 Open water includes deep and shallow lake habitat. Insufficient data was available to determine the size of river habitats.

Other data for northeastern Minnesota (MFRC 1999) also show that conifer species (e.g., tamarack, white pine, Jack pine, red pine, spruce) and birch declined significantly in abundance, while other deciduous (e.g., aspen/cottonwood, sugar maple/maple, ash, balm-of-Gilead) and fir trees increased from the late 1890s to the 1990s. At the time of European settlement, forest patches were typically large and were dominated by a few species with white pine common in most forests (Friedman et al. 2005). In the majority of the region, forest communities have shifted from pine and tamarack as consistent co-dominants with other tree species, to aspen as a consistent co-dominant with other tree species (Jaakko Poyry Consulting 1994; Friedman et al. 2005). Further, research indicates that current mature forest represents only about 4.4% of the old growth acreage that existed in the 1800s (Jaakko Poyry Consulting 1994).

Tribal cooperating agencies consider the loss of mature forest a significant impact, and note that the activities on the mine site will prevent more forest acreage from reaching this mature community state, representing a nearly permanent loss of habitat.

Current trends in habitat and wildlife are indicated by 1977 to 1990 forest changes. Forest harvesting data circa 1990 indicate overharvesting of some cover types (e.g., aspen, Jack pine) in northeast Minnesota, although overall harvesting was less than the net growth of forests (MFRC 1999; Jaakko Poyry Consulting 1994). The USFS data (1977-1990) show significant increases in elm-ash-soft maple, tamarack, northern white-cedar, red-white pine, and maple-basswood forest. Spruce-balsam fir, black spruce, Jack pine, and aspen-birch forests declined significantly.

Some forest types (e.g., tamarack) that are currently increasing include species that decreased in abundance during the last century.

In general, land use in the Arrowhead Region over the past century has reduced the conifer component, size, age, and diversity of forests. The greatest impact has been to Jack pine, red-white pine, and mixed pine-hardwood forests. Reasons for the change include past timber harvesting, catastrophic wildfire, fire suppression, current timber harvesting practices.

Although there have been changes in forest composition, the Minnesota Forest Resources Council (1999 and 2003) concluded that the extent of current forest cover in northeastern Minnesota is approximately the same size as it was in the late 1800s. The Mesabi Iron Range is the largest developed area in northeast Minnesota, followed by Duluth and other smaller towns (MFRC 1999). Agricultural use is minimal. Developed land (including mined lands), cropland, and pasture land total 11 percent of the Nashwauk Uplands and 1 percent of the Laurentian Uplands. The balance is forest (54 percent and 79 percent, respectively), wetlands, and open water. The majority of forest land in northeast Minnesota is public (MFRC 1999), including reserved forests in the BWCAW, Voyageurs National Park, and state parks. Private forest ownership is shifting from farmers and industry to private individuals, especially near lakes.

Wildlife in northeast Minnesota is affected by habitat changes. Lane, Carr, and Perry (2003) concluded that past management practices produced a landscape pattern that contains less habitat for species needing large habitat patches such as ovenbirds, and poorer quality habitat for species requiring older and more diverse forest vegetation such as northern goshawks. The MFRC (1999) evaluated 1977 to 1998 MnDNR data and concluded that some wildlife populations (e.g., otter, fisher, marten) have increased over that period, while some were stable or within normal cyclical patterns (e.g., bobcat, ruffed grouse).

These studies generally suggest that Minnesota's forests are recovering from poor harvesting practices of a century ago and that wildlife is responding accordingly. The total amount of forest cover has returned to 1890 levels and the conifer component has recently increased, although not all conifer types have recovered (e.g., Jack pine). As a result, wildlife species that depend on forest cover with a conifer component were harmed by past forest changes but are favored by recent forest changes in the Arrowhead Region. Wildlife species that require mature to old forests or large forest patches were harmed by past forest changes, but may benefit from recent forest changes.

4.4.4.3 Future Wildlife Habitat Trends

An assessment of future cumulative impacts through 2014 from forestry, and for an unstated near-term period from mining and non-mining development, was completed for the 12.5 million acre Arrowhead Region (Emmons and Olivier 2006). This study estimated a loss of approximately 8,727 acres of wildlife habitat in the Arrowhead Region, representing approximately 0.1 percent of regional wildlife habitat. Forestry accounted for approximately 84 percent, mining 10 percent, and non-mining development 6 percent of these wildlife habitat losses (Emmons and Olivier 2006).

A subsequent study for the Keetac Expansion Project (Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species) expanded on the 2006 Emmons and Olivier Wildlife Corridor and Habitat analysis and quantified the habitat impacts from reasonably foreseeable mining and urban/development projects along the Iron Range. The 2009 Barr study differentiated between "High Impact" and "Moderate Impact" features as related to mining and other urban/development. High impacts result from features that create physically impenetrable barriers to wildlife including mining pits, in-pit activities, and hardscape such as operations plants and buildings. Moderate impacts result from areas that experience a change in topography, community structure, diversity, and function but would not be physically impenetrable for many species such as stockpiles, Tailings Basins, borrow areas, settling ponds, and haul roads. Moderate impact areas may naturalize and revegetate over time (Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species). The total loss of wildlife habitats due to these development projects are described in Table 4.4-7.

Table 4.4-7 Losses of Wildlife Habitat in the Iron Range Due to Reasonably Foreseeable Urban Development and Mining

			Future Losses due to Urban/Developed		**Future Losses due to Mining**		**Total Future Losses due to Urban/ Developed & Mining**	
Habitat Type	**Acres in the Iron Range**	**Percent of Iron Range**	**Acres (High/ Moderate)**	**Percent of Habitat Type[1] (High/ Moderate)**	**Acres (High/ Moderate)**	**Percent of Habitat Type[1] (High/ Moderate)**	**Acres (High/ Moderate)**	**Percent of Habitat Type (High/ Moderate)**
Open Wetland	6,731	0.7	0.0/228.3	0.0/3.4	7.8/166.8	0.0/2.5	7.8/395.1	0.0/5.9
Lowland Deciduous	17,651	1.7	0.0/564.6	0.0/0.1	73.8/ 485.9	0.0/2.8	73.8/ 1,050.5	0.0/6.0
Lowland Conifer/Shrubland	187,864	18.7	0.0/402.8	0.0/0.21	381.3/ 3,922.7	0.0/2.1	381.3/ 4,325.5	0.0/2.3
Upland Conifer	67,950	6.8	0.0/111.6	0.0/0.2	257.1/ 2,877.5	0.0/4.2	257.1/ 2,989.1	0.0/4.4
Upland Deciduous (Aspen/Birch)	277,692	27.7	1.2/867.8	0.0/0.3	2,259.2/ 10,923	0.01/3.9	2,260.4/ 11790.8	0.01/4.3
Upland Deciduous (Hardwoods)	28,680	2.9	0.0/34.7	0.0/0.1	769.8/ 1,099	0.3/3.8	769.8/ 1,133.7	0.03/4.0
Upland Shrub/Woodland	101,459	10.1	1.0/117.0	0.0/0.1	930.3/ 5,326.8	0.01/5.3	931.3/ 5,443.8	0.01/5.4
Water	56,604	5.6	0.0/15	0.0/0.0	102.1/ 1,771.2	0.0/3.1	102.1/ 1,786.2	0.0/3.2
Cropland	21,914	2.2	0.0/0.0	0.0/0.0	12.8/ 104.4	0.0/0.5	12.8/104.4	0.0/0.5
Grassland	64,931	6.5	0.0/26.3	0.0/0.0	337.2/ 1,531.7	0.01/2.4	337.2/ 1,558	0.01/2.4
Subtotal Vegetated Habitat	**831,476**	**82.9**	**2.2/ 2,368.1**	**0.0/0.3**	**5,131.4/ 28,209**	**0.01/3.4**	**5,133.6/ 30,577.1**	**0.01/3.7**
Urban/Developed	55.440	5.5	0.3/230.5	0.0/0.4	986/ 3,074.2	0.02/5.6	986.3/ 3,304.7	0.02/6.0
Mining-High[2]	37,157	3.7	N/A	N/A	N/A	N/A	N/A	N/A
Mining-Moderate[2]	78,626	7.8	N/A	N/A	N/A	N/A	N/A	N/A
Total	**1,002,699**	**100**	**2.5/ 2,598.6**	**0.0/0.3**	**6,117.4/ 31,283.2**	**0.6/3.1**	**6,119.9/ 33,881.8**	**0.6/3.4**

Source: Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species

1 For percent of habitat type, 0.0 includes occurrences less than 0.01 percent.

2 The area covered by existing mining features is provided to complete the data set; however, was not included in calculations for future habitat loss in the Barr 2009 study.

The future impact of forestry practices on wildlife habitat in the six Arrowhead counties (Cook, Lake, St. Louis, Itasca, Carlton, Aitkin) was estimated over the next 20 years for this DEIS using data from the Superior National Forest Revised Management Plan (USDA Forest Service 2004a and 2004b); the MnDNR (2006) timber sale database; St. Louis County timber harvest plans; and MnDNR estimates of private forest harvests (Miles 2007; Pro-West and Associates 2007). From these sources it is estimated that future timber harvest due to government and private actions may annually affect about 42,000 acres (0.9 percent) of the nearly 4.5 million acres of timberland in the 12.5 million acres constituting the Arrowhead counties.

Logging temporarily changes wildlife habitat by reducing the acreage of mature forest. Timber harvesting trends are shifting to more longer-rotation harvests that promote the regeneration of conifers. If this trend continues, the acreage of late-successional forest would increase, especially in spruce-fir and mixed conifer-deciduous stands (Mehta et al. 2003).

Cumulative impacts from historic, current, and reasonably foreseeable future mining activities in the Mesabi Iron Range are estimated to be 153,184 acres. Existing mine features (already disturbed wildlife habitat) cover 115,783 acres. These features include ore mines that were in operation before permitting requirements were established by the State, as well as past and currently permitted taconite mines. Future losses of existing vegetative cover types due to reasonably foreseeable future mining projects (Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species) on both public and private lands in the Mesabi Iron Range total approximately 37,401 acres (Table 4.4-7). This estimate is inconsistent with the Emmons and Olivier 2006 data because the Barr Engineering data includes additional reasonably foreseeable projects developed since the EOR study was published in 2006. The primary habitat impacts would be to upland conifer, shrub/woodlands, and croplands habitats with grasslands, open wetlands, existing urban/developed land, upland deciduous and conifer-deciduous habitats, and lowland forests/shrublands affected to a lesser extent. The grasslands are unlikely to be native prairie, but rather non-native hay meadows, pastures, and reclaimed mine sites.

4.4.4.4 Conclusions

Assuming a harvest level of approximately 42,000 acres annually in northeast Minnesota, the wildlife habitat affected by forestry over 20 years (the life of the NorthMet Project) would be about 840,000 acres. This level of harvest and the trend towards longer-rotation harvests and larger harvest units would slowly increase the conifer component and the age of forests in northeast Minnesota. Forest diversity and forest patch size may increase depending on ownership. These trends would benefit wildlife that depend on mature forest, forests with conifers, and large forest patches. As noted above, habitat for this type of wildlife had been reduced by forestry practices since 1890. The proposed mining projects would affect an additional 32,000 acres over approximately the same period.

In total, approximately 877,000 of forest land could be impacted over the projected 20 year term of the Project by forestry (96 percent) and mining (4 percent). It should be noted that forestry impacts are short-term land conversions and the affected areas still provide habitat that can support nearly continuous wildlife use, although for different species, while it recovers through natural forest succession. Mining impacts, on the other hand, represent a total habitat loss (i.e., wildlife use is essentially eliminated in the affected area for the duration of mine operations) that has a longer duration and slower recovery (e.g., lack of nutrients and organic material in soils slow forest succession). It is assumed that all existing and future mining projects would be required to revegetate disturbed areas as part of Closure. Over time, the extent of area affected by mining should decrease as revegetation and forest succession occur.

In terms of effects on wildlife, forestry and mining would primarily impact species requiring large habitat patches. Current trends in forestry practices favoring longer rotation harvest would incrementally benefit species that require older and more diverse (e.g., larger conifer component) forest, but even with this trend, relatively little forest would reach "maturity." Mining contributes to habitat loss in some cover types that have declined historically (e.g., upland conifer, upland conifer-deciduous), but these habitat types are gradually increasing with current harvesting levels and practices. Mining may have some positive effects on wildlife by offsetting the loss of non-forested habitats (e.g., abandoned farms converting to forest) with the creation of grasslands as part of Mine Closure. This benefit, however, is only temporary as these areas will eventually become forested as a result of natural succession.

4.4.5 Wildlife Travel Corridors

4.4.5.1 Approach

The minerals present in the Mesabi Iron Range have and will likely continue to include mining operations. The potential for relatively continuous mining operations and/or habitat loss along this range could pose a barrier for wildlife movement. Wildlife populations move less frequently between habitat patches when passage is blocked by mining operations, roads, and urban development. This may lead to increased population and genetic isolation and decreased meta-population dynamics, which in turn can lead to decreases in overall population stability and persistence. Two studies have examined the potential cumulative effects of mining operations on wildlife movement along the Iron Range: Emmons and Olivier (2006) and Barr Engineering (Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species). The conclusions in this analysis are based on Emmons and Olivier (2006) and supplemented with additional findings from Barr Engineering (Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species).

Emmons and Olivier (2006) completed a wildlife corridor analysis for moose, deer, bear, and other large mammals in a 15-mile-wide zone along the approximately 115-mile-long Mesabi Iron Range. The study identified 13 major wildlife travel corridors connecting large roadless blocks along the Iron Range and the loss of any were considered significant. These corridors ranged from less than 0.1 to over 3.2 miles wide, with a total combined length of 20.2 miles. Barr Engineering (Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species) also analyzed wildlife corridors along the Mesabi Iron Range identifying 5 additional corridors (for a total of 18) along the same extent and differentiating between mine features that precluded wildlife movement (high impact features) and mine features that were still passable and would potentially revegetate over time (moderate impact features) (Figure 4.4-1).

Emmons and Olivier may have underestimated the number of corridors by treating all historic mining features as impediments to travel, and not accounting for closed mines, revegetation, and natural succession. Historic mining impacts may range from relatively small, gently-sloped spoil piles and ore mine pits less than 50 feet deep (no to slight impediment), to large, steep-sided taconite pits that may be up to several hundred feet deep (significant impediment). The EOR analysis, therefore, represents a conservative estimate of the number and size of remaining wildlife travel corridors in the Iron Range.

Impacts to the wildlife travel corridors were classified as: 1) direct loss of habitat inside the corridor; 2) fragmentation of habitat inside the corridor; 3) isolation of a corridor by the creation of a barrier inside or near its termini; and 4) direct loss or fragmentation of large habitat blocks outside the corridor. These large habitat blocks are the presumed destinations of animals using the corridors; if they disappear, it is assumed that there would be fewer large mammals in the vicinity that would use the corridors.

This analysis included the following projects that could potentially represent barriers to wildlife travel. The corridors are identified as described in Emmons and Olivier (2006):

- Minnesota Steel DRI, Steel Plant and Connected Actions (Corridors 2, 3, 4);
- US Steel Keewatin Taconite Mine and Plant (Corridor 4);
- Mittal Minorca East Reserve/Inspat Inland (Corridor 8);
- NorthMet Mine, Tailings Basin, and Railroad Spur (Corridors 11, 12);
- Peter Mitchell Mine Pits Expansion (Corridors 12, 13);
- Mesabi Nuggett Phase I and II (Corridor 10);
- Mesaba Energy Power Generation Station (Corridors 2, 10); and
- Cliffs Erie Railroad Pellet Transfer Facility (Corridor 10).

4.4.5.2 Wildlife Corridor Impacts by the NorthMet Project

Of the 13 wildlife corridors identified by Emmons and Olivier (2006), Corridors 11 and 12 are in the vicinity of the Mine or Plant Sites. These corridors are identified as Corridors 16 and 17 by Barr Engineering (Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species).

Corridor 11 (16) is located southeast of the existing Plant Site (Figure 4.4-1). The existing LTVSMC Tailings Basin provides poor habitat, is not likely to be heavily used by wildlife, and currently obstructs animal movement. Because current use is already limited, increased activity at the Tailings Basin would have minimal impact on wildlife movement through the corridor. The proposed vegetative restoration of the Tailings Basin and adjacent processing plant at Mine Closure may increase the value of corridor by improving habitat to the northwest. The mining features surrounding this corridor are considered to be moderate impact features that would not be complete barriers to wildlife movement (Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species). No high impact features would be constructed such that wildlife movement through the corridor would be prevented.

Corridor 12 (17) is located approximately 0.5 mile northwest of the Mine Site. Operations at the Mine Site would indirectly impact the corridor by reducing the size of, and acting as a source of noise and activity near, the large habitat block southeast of the corridor. These activities would limit access to the corridor in the vicinity of the Mine Site; however, the corridor would continue to be accessible from the south and southwest. Vegetative restoration of the stockpiles and disturbed areas, as proposed during Closure, would mitigate some of the effect of habitat loss in this large habitat block in the long term. Not all the Mine Site would be available for habitat restoration due to fencing around the mine pits and the open water in the West Pit.

Rail and vehicular traffic between the Mine and the Plant Sites would increase as a result of the Project. This transportation corridor is outside of Corridors 11 (16) and 12 (17); however, it runs parallel to the corridors and would potentially impact wildlife use, although the impact would be minimal.

In summary, the Project would have negligible effect on Corridor 11 (16), and would eventually enhance this corridor after the completion of Tailings Basin restoration. Although the Project would not physically encroach into Corridor 12 (17), mining operations could generate sufficient activity and noise to discourage wildlife use of this corridor during mine operations. Long term effects Post-Closure and restoration are not expected to be significant. Tribal cooperating agencies' position is that Corridor 11 is currently a poor and obstructed corridor pending the long term success of a proposed revegetation corridor, and #12 will likely be degraded as a corridor by the Project; these impacts should be considered significant.

4.4.5.3 Wildlife Corridor Impacts by Other Projects

The other reasonably foreseeable projects are anticipated to affect eight of the 13 wildlife travel corridors (Table 4.4-9) identified by Emmons and Olivier (2006). These effects may include blocking or encroachment into the mapped wildlife corridors, affecting adjacent habitat that may make the corridor less valuable, and increasing traffic along new or existing roads through the corridor. These impacts range from the possible complete loss of Corridors 3, 5 and 13 (Barr Engineering Corridors 3, 6, and 18) depending upon final extent of mining activities; to minor fragmentation within Corridor 2 (Barr Engineering Corridors 2); and habitat loss near Corridors 4, 6, and 12 (Barr Engineering Corridors 4, 8, and 17). Barr Engineering (Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species) also identified two additional corridors (Corridors 5 and 9) that would be lost, while Corridor 15 would incur minimal impacts. These impacts should be considered significant.

Table 4.4-9 Cumulative Impacts to Wildlife Travel Corridors in the Mesabi Iron Range

Wildlife Travel Corridor[1]	Original EOR Identified Impacts to Corridors		Additional Identified Impacts to Corridors		
	Type of Impact	**Project**	**Type of Impact**	**Project**	**Impact**
1 (1)	Minimal Isolation	Urban Development	None		
2 (2)	Isolation	Highway Traffic	Fragmentation and Isolation	MN Steel Connected Action	Nashwauk-Blackberry Gas Pipeline (underground with grass cover) passes through this forested corridor from north to south; rail spur traffic crosses NE of corridor
3 (3)	Direct Loss	Mining/ Urban Development	Direct Loss	MN Steel mine pits and stockpiles	East half and least fragmented part of corridor largely removed
4 (4)	Isolation	Mining / Highway Traffic	Direct Loss	MN Steel Tailings Basin/ Keewatin	Habitat loss to NE and SE of corridor
NA (5)	NA	NA	Direct Loss	Hibbtac Project	Loss of low quality corridor
5 (6)	Fragmenta-tion	Highway Traffic/ Urban Development	Direct Loss	US Steel/ Hibbing Taconite Co.	Mining operations nearly block northern extent and west third of corridor
NA (7)	NA	NA	None		
6 (8)	Isolation	Highway Traffic	Direct Loss	US Steel Minntac	Mine and Tailings Basin may have small effect on habitat to NE of corridor
NA (9)	NA	NA	Direct Loss	Minntac expansion	Mine pit expansion will eliminate eastern end of corridor
7 (10)	Minimal Impact	Urban Development	None		
8 (11)	Isolation	Mining	Direct Loss	Mittal Steel East Reserve	East Reserve pit prevents access between north and south blocks of the corridor.
NA (12)	NA	NA	None		
9 (13)	Minimal Impact	Urban Development	None		
10 (14)	Minimal Impact	Mining/ Urban Development	Minimal Impact	Cliffs-Erie RR Pellet Transfer Facility/ Erie Mining	RR transfer facility overlaps with prior impacts, no additional habitat or corridor loss. Likely increase in traffic/noise.
NA (15)	NA	NA	Minimal Impact	Mesabi Nugget	Expansion of west mine pit will reduce corridor width, but not eliminate use
11 (16)	Minimal Impact	Urban Development	None		
12 (17)	No Impact		Direct Loss and Fragmentation	NorthMet mine area/ Northshore mine	Mine area reduces habitat to south of corridor (<1000 acres). Permitted actions may directly fragment corridor or nearly block northern end part of corridor
13 (18)	No Impact		Direct Loss	Northshore Peter Mitchell	Possible expansion eastward may block or fragment Corridor 13

Sources: Emmons and Olivier 2006; Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species.

[1] The primary corridor numbers are based on Emmons and Olivier (2006). For comparison purposes, the numbers in parenthesis represent the corresponding corridor numbers in the Barr Engineering (2009) study. NA indicates that this corridor was not identified in the Emmons and Olivier (2006).

4.4.5.4 Travel Corridor Mitigation

No wildlife travel corridor mitigation measures are specifically proposed for the Project. Reclamation work, especially establishment of diverse forest cover, would partially restore the large habitat blocks northwest and southeast of Corridors 11 (16) and 12 (17). In addition, removal of the rail spurs, buildings, and roads, and re-vegetation of disturbed areas during closure would improve wildlife habitat near the corridors. Lastly, closure of operations would reduce human activity and noise levels near the corridors, thereby improving the attractiveness of the area to wildlife.

The tribal cooperating agencies' position is that per Emmons & Oliver (2006), any new impacts to the existing wildlife migration corridors is by definition significant, and should require mitigation. For the entire time period (decades) of mine development and operation, Corridor 12 would experience a significant direct loss or fragmentation of wildife habitat, and impact the ability of many wildlife species to migrate throughout their ranges. Also, until the Section 106 consultation process between the USACOE and the tribes is complete, it is not possible to determine the potential impacts to treaty-protected wildlife.

4.5 FISH AND MACROINVERTEBRATES

4.5.1 Existing Conditions

The Project area encompasses several waterbodies that provide a variety of habitats for fish and aquatic macroinvertebrates. This section evaluates impacts to fish and aquatic macroinvertebrates in the Embarrass River, including Trimble Creek, which drains north from the LTVSMC Tailings Basin, and the Partridge River, including Colby Lake and Whitewater Reservoir.

4.5.1.1 Special Status Fish and Macroinvertebrates

As with wildlife resources, assessment of fish and macroinvertebrates included consideration of the MCWCS (MnDNR 2006, Tomorrow's Habitat for the Wild and Rare). The MCWCS identifies SGCN by ecoregion subsections based on a statewide approach. Two unionid mussel species (creek heelsplitter, *Lasmigona compressa*; and black sandshell, *Ligumia recta*) and three species of fish (lake sturgeon, *Acipenser fulvescens*; northern brook lamprey, *Ichthyomyzon fossor*; and shortjaw cisco, *Coregonus zenithicus*) are classified as SGCN in the affected subsection. These species also are listed by the state as species of special concern and the USFS as RFSS. A discussion of each of the SGCN fish species and unionid mussel species is provided below.

Lake sturgeon

The lake sturgeon is a large, ancient fish that is broadly distributed throughout the Mississippi River, Great Lakes, and Hudson Bay drainages (Scott and Crossman 1973a; Wilson and McKinley 2005). Lake sturgeon typically inhabit large lakes and rivers and are usually found in waters that are 15 to 30 feet deep (Wilson and McKinley 2005). Spawning takes place in swift-flowing water 2-15 feet in depth, often at the base of a low waterfall that blocks further migration upstream (Scott and Crossman 1973a). The species has been classified as threatened in both Canada and the United States by a special committee of the American Fisheries Society (Williams et al. 1989) and is a species of special concern in Minnesota.

Historically, lake sturgeon migrated approximately 14 miles upriver from Lake Superior in the St. Louis River (Auer 1996). Spawning occurred between the falls near Fond du Lac, which formed a natural barrier to upstream migration, and Bear Island located a few miles downstream (Goodyear et al. 1982; Kaups 1984; Schram et al. 1999). Native Americans speared sturgeon below the rapids and captured them in seines farther downstream (Kaups 1984). The lake sturgeon was extirpated from the St. Louis River during the early 1900s (Schram et al. 1999).

The St. Louis River currently is one of 17 tributaries to Lake Superior identified by the Great Lakes Fishery Commission (GLFC) as a priority stream where lake sturgeon rehabilitation should be focused, and the St. Louis is one of only six rivers identified by the GLFC as a priority for lake sturgeon stocking (Auer 2003). A stocking program was initiated in 1983 to reintroduce lake sturgeon to the St. Louis River; however, stocking was reduced in 1995 and discontinued in 2000 (MnDNR undated, Fisheries Management Plan). The stocking has resulted in an increase in lake sturgeon abundance in the St. Louis River estuary near Duluth (Schram et al. 1999). Recruitment has not yet been observed (Auer 2003); although MnDNR staff recently observed mature sturgeon on the historical spawning grounds at Fond du Lac. The Fond du Lac

Reservation has stocked lake sturgeon into the St. Louis River above the Fond du Lac dam near the confluence with the Cloquet River. There are anecdotal accounts of recaptures by local anglers, and in July 2009 an angler took a picture of an individual caught near the city of Cloquet; however, no lake sturgeon have been recaptured by Fond du Lac Resource Management personnel. Upstream migration of lake sturgeon from the stocking location would be blocked by the dam at Forbes, approximately 14 miles downstream of the Embarrass River confluence with the St. Louis River.

There are no known occurrences of lake sturgeon and no likely habitat for lake sturgeon in the Project area.

The tribal cooperating agencies' position is that lake sturgeon were once prevalent in many tributaries to the Great Lakes, and that prior to the extensive dam construction on the lower St. Louis River, the upper St. Louis River was likely part of the historical range of the species. Tribal conservation officers have verified angler success in catching lake sturgeon upstream of the Minnesota Power hydropower dams in the past few years. The Fond du Lac Resource Management Division based its attempted restocking program on historical accounts of lake sturgeon abundance during the early logging period in Minnesota's history.

Northern brook lamprey

The northern brook lamprey is a small, nonparasitic, jawless fish. This species' typical habitat is creeks and small rivers, apparently avoiding small brooks and large rivers (Scott and Crossman 1973b). There are no known occurrences of this species in or near the Project area. Cochran and Pettinelli (1987) identified northern brook lamprey at a site south of Cloquet, Minnesota, approximately 75 miles south of the Project area. Since 1986 it has been collected from six other sites in the Lake Superior drainage (Hatch et al. 2003). Suitable habitat for northern brook lamprey is likely to exist in the Project area; however, the nearest known occurrence of this species is far removed from the Project area.

The tribal cooperating agencies' position is that no conclusions about the presence of northern brook lamprey can be made in this analysis without specific surveys in the Project Area. Tribal fisheries biologists have definitively identified this species in the Dark River, just a few miles to the west of the St. Louis River.

Shortjaw cisco

Formerly found in deep water of several of the Great Lakes (Scott and Crossman 1973c), the shortjaw cisco has been extirpated from Lakes Erie, Huron, and Michigan and is in decline in Lake Superior (COSEWIC 2003). The species is also found in Gunflint and Saganaga Lakes (MnDNR 2006, Tomorrow's Habitat for the Wild and Rare), which are two of the deepest natural lakes in Minnesota. Invasive species, habitat degradation and competition or predation may be factors that are limiting recovery (Pratt and Mandrak 2007). There are no known occurrences or likely habitat for shortjaw cisco in the Project area.

Mussel Species

Unionid mussels (Unionidae) constitute one of the most imperiled major taxa in the United States (Master et al. 2000), and the CWCS identifies 26 unionid species within the state that are species of special concern. Two of these species, creek heelsplitter (*Lasmigona compressa*) and black sandshell (*Ligumia recta*), are known to exist in the St. Louis River basin (Table 4.5-1). Heath (2004) sampled mussels at two sites each in the Partridge River and Embarrass River watersheds (Figure 4.5-1 and Table 4.5-2). One mussel species was collected in the Partridge River basin, the giant floater (*Pyganodon grandis*), and two species were collected in the Embarrass River basin including the giant floater and the fat mucket (*Lampsilis siliquoidea*) (Table 4.5-1). These two species collected in the Partridge River and/or Embarrass River are widely distributed feeding generalists, tolerant of silt-dominated substrate, and often found in lakes, ponds or slow-moving water pools of small to medium-sized creeks and rivers (Cummins and Mayer 1992; Heath 2004).

Table 4.5-1 Mussel Species Identified in the Lake Superior Basin, St. Louis River Basin, Partridge River, and Embarrass River

		Location			
		Sietman (2003)		Heath (2004)	
Scientific Name	**Common Name**	**Lake Superior Basin**	**St. Louis River Basin**	**Partridge River**	**Embarrass River**
Elliptio complanata	eastern elliptio	X	X		
Anodontoides ferussacianus	cylindrical papershell	X	X		
Lasmigona complanata	white heelsplitter	X	X		
L. compressa[1]	creek heelsplitter	X	X		
Pyganodon grandis	giant floater	X	X	X	X
Strophitus undulatus	creeper	X	X		
Utterbackia imbecillis	paper pondshell	X			
Lampsilis cardium	plain pocketbook	X	X		
L. siliquoidea	fat mucket	X	X		X
Ligumia recta[1]	black sandshell	X	X		

Source: Adapted from Heath (2004)
[1] Minnesota Species of Special Concern

Table 4.5-2 Location and Physical Characteristics of Mussel Sample Sites

Name	Site	River Mile	Mean Depth (cm)	Substrate Composition
Partridge River	M1	20.5	80	95% silt 5% boulder
Partridge River	M2	16.7	60	40% silt 30% boulder 15% coarse sand 15% fine sand
Trimble Creek	M3	N/A	20	50% gravel 50% coarse sand
Embarrass River	M4	N/A	60	20% boulder 20% rubble 20% coarse sand 20% fine sand 20% clay

Source: Modified from Heath (2004)

Some of the unionid species known to exist in the St. Louis River basin were not collected by Heath (2004). These species include creeper (*Strophitus undulatus*); plain pocketbook (*Lampsilis cardium*); white heelsplitter (*Lasmigona complanata*); and the black sandshell

(*Ligumia recta*) (Table 4.5-1). These uncollected species are typically found in larger streams (Cummins and Mayer 1992) and may exist farther downstream in the drainage system. However, the SGCN-designated black sandshell is restricted to riffles or raceways in gravel or firm sand (Cummins and Mayer 1992). As a result, it is unlikely that the black sandshell occurs in the Project Area, given its absence from the sample sites and the lack of its typical habitat.

Other species known to exist in the St. Louis River drainage but also not collected by Heath (2004) at stations M-1 or M-2 included cylindrical papershell (*Anodontoides ferussacianus*) and creek heelsplitter (*Lasmigona compressa*). These species are typically found in small streams and may exist in the upper Partridge River drainage at sites other than those sampled (Heath 2004). The SGCN-designated creek heelsplitter is found in sand and fine gravel substrates (Cummins and Mayer 1992). Sand and gravel substrate exists in the Embarrass River watershed sites sampled. Sand was the dominant bed material at the two Trimble Creek cross sections characterized in RS26 (Barr 2005) as well as at the biological sample site in that stream (B-6, Table 4.5-4; M-3, Table 4.5-2) and sand constituted 40 percent of the substrate at the mussel sample site in the Embarrass River (M-4; Table 4.5-2). Sand and gravel were absent or a minor substrate type at the sites sampled in the Partridge River watershed (Table 4.5-4 and Table 4.5-2). Thus, the creek heelsplitter was not collected at any of the sample sites containing potentially suitable habitat, and it is unlikely that this species exists in the Project area

The tribal cooperating agencies' position is that there was not an adequate sampling effort to determine the presence of the creek heelsplitter in the Project Area, particularly for a species that is already known to be limited in numbers or distribution. While the detection probability is low for each site, tribal fisheries biologists have sampled this species in the headwaters region of the St. Louis River, approximately a mile downstream of Seven Beavers Lake (B. Borkholder, pers. comm.) in 2008.

4.5.1.2 Partridge River and Embarrass River

Breneman (2005) conducted a biological survey at two sites in the Partridge River near the Mine Site, at a third site on the South Branch Partridge River, and at three sites in the Embarrass River watershed (Figure 4.5-2). The downstream site on the Partridge River (B3) is approximately 16.7 miles upstream of Colby Lake, and the upstream site (B2) is approximately 20.4 miles upstream of Colby Lake. A third site on the South Branch Partridge River (B1), identified by Breneman (2005) to be a suitable reference site for the Partridge River sites, is approximately 4.3 miles upstream of the South Branch Partridge River confluence with the Partridge River. The sites in the Embarrass River watershed comprised two wetland sites and one stream site (on Trimble Creek, B6). Tables 4.5-3 through 4.5-5 provide information on physical habitat and water quality characteristics coincident with the biological samples. The two wetland sites (B5 and B7) are excluded from Tables 4.5-3 and 4.5-4, which list stream characteristics. No rare, threatened, or endangered species were collected by Breneman (2005) in the fish and benthic macroinvertebrate survey.

Table 4.5-3 Major channel characteristics at biological survey stream sites in the Partridge River and Embarrass River watersheds, August - September 2004

	Location		Channel Characteristics				
Name	Site	River Mile[1]	Catchment (mi^2)	Width (cm)	Depth (cm)	Velocity (cm/s)	Discharge (m^3/s)
South Branch Partridge R.	B1	4.3	N/A	753	26.74	6.90	0.10

Partridge R. (upstream)	B2	20.4	15.2	954	20.67	15.13	0.19
Partridge R. (downstream)	B3	16.7	23.0	724	72.23	7.03	0.26
Trimble Cr.	B6	1.5	7.4	190	58.70	10.47	0.13

Source: Adapted from Breneman (2005)

1 River mile indicated for the South Branch Partridge River site (B1) is measured from the confluence with the mainstem Partridge River. River mile indicated for sites B2 and B3 is measured from the mouth of Partridge River at Colby Lake. River mile indicated for Trimble Creek is measured from the confluence with the Embarrass River.

Table 4.5-4 Physical features of biological survey stream sites in Project Area streams

Name	Site	Dominant Feature	Coverage (% area)	Secondary Feature[1]	Sampled Reach Length (m)	Silt Depth (cm)	Canopy Cover (%)	QHEI[2] Score
South Branch Partridge River	B1	Boulder	81.74	EAV	130	0.31	3.90	70
		Gravel	3.98	Islands				
		Silt	10.62					
		Woody debris	3.65					
Partridge River (upstream)	B2	Boulder	84.12	EAV	135	1.36	45.50	79
		Pebbles	3.67	Islands				
		Silt	12.21	SAV				
Partridge River (downstream)	B3	EAV	3.45	Cut bank	120	5.83	4.33	65
		Silt	96.55	SAV				
Trimble Creek	B6	Sand Silt	43.16 56.84	Cut bank SAV	105	5.83	8.23	65

Source: Adapted from Breneman (2005).
1 EAV=emergent aquatic vegetation, SAV=submersed aquatic vegetation.
2 QHEI (qualitative habitat evaluation index (Rankin 1989)) is designed to provide an integrated evaluation of physical habitat characteristics important to fish communities and ranges from 0 (low) to 100 (high).

Table 4.5-5 Water quality characteristics at biological survey sites sampled August - September, 2004

		Water Quality Characteristic				
Name	**Site**	**Temp (°C)**	**Conductivity (µmho)**	**Dissolved Oxygen (% saturation)**	**pH**	**Oxidation-Reduction Potential (mV)**
South Branch Partridge R.	B1	15.50	55	62.8	6.19	492.60
Partridge R. (upstream)	B2	15.84	112	61.9	6.86	481.20
Partridge R. (downstream)	B3	14.88	98	65.1	6.25	390.20
Embarrass R. wetland (upstream)	B5	14.30	857	57.5	7.43	436.10
Trimble Cr.	B6	15.36	506	66.6	7.58	302.80
Embarrass R. wetland (downstream)	B7	14.32	760	51.2	7.51	278.10

Source: Adapted from Breneman (2005).

Breneman (2005) collected macroinvertebrates at six sites in the Partridge River and Embarrass River watersheds. The results of his collections are summarized in Table 4.5-6. The assemblages observed in the survey are typical of those sampled elsewhere in the northeast region of Minnesota (Breneman 2005). The low percentage of Ephemeroptera, Plecoptera, and Tricoptera composition at the Trimble Creek site (B6) is likely a consequence of the dominance of silt substrate and may be of anthropogenic origin given the location downstream of the LTVSMC Tailings Basin.

Table 4.5-6 Composition of Macroinvertebrate Assemblages Six Sites in the Project Area

Name	Site	No. of Samples	Total Taxa	Mean Abundance	% Ephemeroptera, Plecoptera, or Tricoptera	% Chironomidae	% Detritivores	% Omnivores	% Herbivores	% Carnivores
South Branch Partridge R.	B1	7	90	626.57	6.24	57.80	46.10	21.46	7.42	20.24
Partridge R. (upstream)	B2	6	89	1260.67	14.56	65.25	60.19	17.51	10.69	8.45
Partridge R. (downstream)	B3	4	82	1278.09	15.78	52.15	45.56	18.31	7.36	23.93
Embarrass R. wetland (upstream)	B5	3	54	2529.48	16.94	46.78	57.08	7.92	17.71	14.27
Trimble Cr.	B6	4	64	653.54	0.47	26.96	72.12	10.30	4.73	7.74
Embarrass R. wetland (downstream)	B7	3	37	1549.19	1.98	64.64	57.80	10.75	4.00	24.56

Source: Data and functional group assignments from Breneman (2005)

Table 4.5-7 lists the fish species collected at the six sites in the Partridge River and Embarrass River watersheds. No recreationally important fish species were collected at the two sites on the Partridge River or at the sites in the Embarrass River watershed. Northern pike was collected at the reference site on the South Branch Partridge River.

The species composition and species richness (total number of species) of the fish assemblages present at the two sites on the Partridge River (B2 and B3) and in Trimble Creek (B6) are consistent with general expectations for stream of this size and chemical-physical habitat characteristics in this region and are similar to the site on the South Branch Partridge River (B1). Fish species richness is not expected to be high in habitats of the type found in the Partridge River and Trimble Creek. MPCA intends to develop an Index of Biotic Integrity (IBI) for the ecological region encompassing the St. Louis River and its tributaries, including the Partridge and Embarrass Rivers. The IBI will establish expectations for various metrics including species richness, accounting for regional variation and catchment size, and it can be used to evaluate the biological condition of a given site. In an IBI, the scores are assigned to individual metrics based on expectations for sites with minimal human influence, and the scores for individual metrics are summed to produce an overall assessment of the biological condition of the site (Karr 1981; Karr et al. 1986).

Table 4.5-7 Fish species collected at six sites in the Project Area

		Site					
Scientific Name	**Common Name**	**B1**	**B2**	**B3**	**B5**	**B6**	**B7**
Catostomus commersonii	white sucker	X	X	X		X	X
Rhinichthys cataractae	longnose dace	X	X	X			
Luxilus cornutus	common shiner	X	X				X
Etheostoma nigrum	Johnny darter	X	X				
Hybognathus hankinsoni	brassy minnow	X	X				
Lota lota	burbot	X				X	
Esox lucius	northern pike	X					
Phoxinus eos	northern redbelly dace		X		X	X	X
Culaea inconstans	brook stickleback		X		X	X	X
Rhinichthys atratulus	blacknose dace		X				
Semotilus margarita	pearl dace		X				
Noturus gyrinus	tadpole madtom			X			
Umbra limi	central mudminnow			X	X	X	X
Phoxinus neogaeus	finescale dace				X		X
Pimephales promelas	fathead minnow				X		X
Semotilus atromaculatus	creek chub					X	X

Source: Breneman 2005

The MPCA has not yet developed an IBI applicable to the Partridge River and Trimble Creek; however, an IBI has been developed for several ecologically-defined regions in the state, including the Upper Mississippi River Basin (Niemela and Feist 2002) and the St. Croix River Basin (Niemela and Feist 2000). Assuming that collection protocols are comparable and the four stream sites sampled by Breneman (2005) are relatively unaffected by human activities, the results presented in Table 4.5-7 support the general expectation of relatively low species richness compared to surrounding ecological regions that contain habitat supporting a richer fish fauna (Table 4.5-8). For example, nine species were collected at the upstream site on the Partridge River (B2, catchment 15 square miles). This degree of species richness is less than what would be expected in a stream in a similar sized catchment in the Upper Mississippi River Basin (≥14 species) or St. Croix River Basin (≥10 species). The observed departure from expectations for other ecological regions is even greater at the downstream site, B3 (catchment area of 23 square miles), where fewer (only four) species were collected and a greater number would be expected (Upper Mississippi River Basin expectation: ≥14 species, St. Croix River Basin expectation: ≥15 species). This departure from richness expectations for the Mississippi and St. Croix River Basins is probably a manifestation of the species-poor nature of habitats encompassed by the Partridge River watershed rather than an indication of existing anthropic impacts. The Qualitative Habitat Evaluation Index (QHEI) (Rankin 1989) is designed to provide an integrated evaluation of physical habitat characteristics important to fish communities and ranges from 0 (low) to 100 (high). The moderate QHEI scores at the sampled sites (Table 4.5-4) are consistent with the observation that physical habitat is one of the factors that limits species richness at these sites.

The tribal cooperating agencies' position is that the conclusions regarding potential anthropogenic impacts are in some cases inconsistent, and in other cases simply not defensible. The writers conclude that macroinvertebrate species richness (low EPT taxa) at one site may be of anthropogenic origin given its location downstream of the LTVSMC tailings basin, but dismiss that possibility with regards to the fish community. We would agree that most of these sampling sites represent headwaters habitat conditions (particularly B3), which alone can account for less-than-expected species richness. But there is no evidence to support a conclusion that low species richness in either the macroinvertebrate or fish communities is solely a manifestation of poor habitat, and not also potentially a result of previous mining impacts in the watershed. The QHEI scores are of little use in this analysis, as this index is notoriously poor in its power to distinguish the quality of habitat in headwaters streams; hard substrate is a key variable leading to a high QHEI score. In the technical report (Breneman 2005), the author expressed a disclaimer on the data interpretation from site B3, because of its habitat characteristics. It is critical to recognize that the six sampling sites in this survey represent 3-4 distinct habitat conditions, which is useful as background data but makes any comparisons problematic.

Table 4.5-8 Index of biotic integrity (IBI) scoring criteria for fish species richness in the Upper Mississippi River Basin and the St. Croix River Basin

	Species Richness (Number of Species)		
	Upper Mississippi River[1]	St. Croix River[2]	St. Croix River[2]
IBI Score	5-35 mi^2 catchment	<20 mi^2 catchment	20-54 mi^2 catchment
10 (high)	≥14	≥10	≥15
7	11-13	8-9	12-14
5	8-10	6-7	9-11
2	5-7	4-5	6-8
0 (low)	0-4	0-3	0-5

[1] Niemela and Feist (2002)
[2] Niemela and Feist (2000)

4.5.1.3 Colby Lake and Whitewater Reservoir

Colby Lake and Whitewater Reservoir are the two lentic (standing) waterbodies potentially affected by water discharges and withdrawals associated with the Project. Partridge River flows through Colby Lake. Whitewater Reservoir is hydraulically connected to Colby Lake by a diversion works, and water moves between the two waterbodies either by controlled gravity-fed flow or by pumps depending on the relative water levels in the two waterbodies (refer to Section 4.1 for details).

Colby Lake is a mesotrophic (moderately productive) lake with a surface area of 539 acres and a littoral (water depth up to 15 feet) area of 377 acres. Maximum depth is 30.0 feet. The dominant littoral substrates are boulders (diameter >10 inches), rubble (diameter 3 to 10 inches), and gravel (size unspecified) (MnDNR 2007, Lake Information Report: Colby). Aquatic plants are moderately abundant, dominated by water lilies (Nympheadeae), pondweed (*Potamogeton* sp.), and water shield (*Brasenia schreberi*). Average Secchi depth is 2.0 feet and submersed plants grow to a maximum depth of 6.0 feet. The non-native curly-leaf pondweed (*Potamogeton crispus*) is found in the west end of the lake. At the time of the fisheries survey conducted in July 2005 (MnDNR 2007, Lake Information Report: Colby), surface water temperature was 81^{o}F, and the bottom temperature was 55^{o}F. Oxic water (dissolved oxygen concentration >2 ppm) supporting fish extended to a depth of 22 feet where the temperature was 57^{o}F. A heated water plume (≥100^{o}F at the surface) extended from the Laskin Energy Center power plant discharge. Fish species collected in the lake are listed in Table 4.5-9. MnDNR investigations through July 2005 indicate that fish abundances have been generally low. While explicit expectations (i.e., numeric biological criteria or fisheries management criteria) for the composition of the fish assemblage have not been established by MPCA or MnDNR for Colby Lake, the fish assemblage appears to be similar to what might be expected based on other lakes in the region with similar physical and water quality conditions.

The tribal cooperating agencies' position is that if there is data to support this statement, it should be cited in the EIS.

Whitewater Reservoir is a mesotrophic water body that encompasses a total surface area of 1,210 acres and a littoral area of 564 acres. Maximum depth is 73.0 feet. The dominant littoral substrate is gravel, rubble, and sand. Aquatic plants are moderately abundant along the shore and in shallow bays. The dominate taxa are cattails (*Typha* sp.), sedges (*Cyperaceae*), northern milfoil (*Myriophyllum sibericum*), and pondweed. Average Secchi depth is 12.0 feet and submersed plants grow to a maximum water depth of 8.0 feet. At the time of the MnDNR fisheries survey in mid-August 2002, the surface water temperature was 72^{o}F, and the bottom water temperature was 48^{o}F. Oxic water extended to a depth of 25 feet where the water temperature was 66^{o}F. Walleye were introduced to the reservoir following impoundment in 1955, and stocking continued through 1984. Fish species collected in the reservoir by the MnDNR surveys are listed in Table 4.5-9. Total catch of fish in gillnets in 2007 was well above average among the 41 lakes in northeast Minnesota that share similar ecological characteristics, and was above average for this lake (MnDNR 2007, Lake Information Report: Whitewater). As is the case for Colby Lake, explicit expectations (i.e., numeric biological criteria or fisheries management criteria) have not been established by MPCA or MnDNR for the composition of the fish assemblage in Whitewater Reservoir; however, composition appears to be similar to what might be expected for Whitewater Reservoir based upon physical and water quality conditions.

The tribal cooperating agencies' position is that if there is data to support this statement, it should be cited in the EIS.

Both Colby Lake and Whitewater Reservoir are listed by MPCA as impaired with respect to aquatic consumption because of fish consumption advisories for mercury. This is typical of many lakes in the region. The lake is not listed as impaired with respect to any other aquatic life criteria (MPCA 2006, Minnesota's Impaired Waters); however, Colby Lake is listed as impaired with respect to aquatic recreation based on nutrient/eutrophication biological indicators (MPCA 2008, Minnesota's Impaired Waters).

Table 4.5-9 Fish Species Collected in Colby Lake and Whitewater Reservoir by MnDNR Fisheries Surveys [1]

Scientific Name	Common Name	Colby Lake[2]	Whitewater Reservoir[3]
Ameiurus melas	black bullhead		X
Pomoxis nigromaculatus	black crappie	X	X
Lepomis macrochirus	bluegill	X	X
Ictalurus punctatus	channel catfish	X	
Micropterus salmoides	largemouth bass	X	X
Esox lucius	northern pike	X	X
Lepomis gibbosus	pumpkinseed	X	X
Ambloplites rupestris	rock bass	X	X

Moxostoma macrolepidotum	shorthead redhorse	X	X
Sander vitreus	walleye	X	X
Catostomus commersonii	white sucker	X	X
Ameiurus natalis	yellow bullhead	X	
Perca flavescens	yellow perch	X	X

[1] Collection methods included gillnets, trapnets, and shoreline seining.
[2] Surveys conducted in 1968, 1985, and 2005.
[3] Ten surveys conducted post-impoundment, 1967-2002.

Little information exists on the macroinvertebrate assemblages of Colby Lake and Whitewater Reservoir. Sampling conducted in many lakes in the region (including Colby and Whitewater) as part of the Minnesota State Planning Agency Regional Copper-Nickel Study (MSPA et al. 1981) found that nearly all of the taxa collected in the littoral zone of lakes were also collected in the streams of the region. The littoral zone of the lakes had a more diverse macroinvertebrate fauna than did the profundal (deep water) zone. Gastropods (snails) were collected from the littoral zone of Colby Lake and pelecypods (clams) were collected from the profundal zone (Johnson and Lieberman 1981). The most frequently collected and most abundant taxa collected from the profundal zone of Colby Lake were the phantom midge (*Chaoborus* sp.), a mayfly species (*Hexagenia limbata*), and two midge taxa (*Procladius* sp. and *Chironomus* sp.), similar to other lakes of the region and characteristic of good water quality (Johnson and Lieberman 1981).

The tribal cooperating agencies' position is that the benthic invertebrate data described above does not support a conclusion of good water quality. In the first place, the data is nearly 30 years old, and secondly, the presence of *Chaoborus* and the two other midge taxa is not indicative of good water quality; these species are not on the sensitive end of the pollution tolerance index.

4.5.2 Impact Criteria

The following criteria were considered in evaluating impacts to fish and aquatic species:

- Project construction, operation, or post-closure results in non-attainment of narrative or numeric water quality criteria for the protection of aquatic life in affected water bodies;
- Project construction, operation, or post-closure exacerbates conditions in water bodies that are designated non-attaining with respect to narrative or numeric water quality criteria for the protection of aquatic life;
- Project construction, operation, or post-closure alters stream conditions resulting in a macroinvertebrate assemblage that is degraded compared to that found at appropriate reference sites;
- Project construction, operation, or post-closure results in degradation of the structure or function of the fish assemblage in affected stream segments compared to appropriate reference sites;
- Project construction, operation, or post-closure adversely affects one or more aquatic SGCN or their habitat; and
- Project construction, operation, or post-closure adversely affects one or more aquatic RFSS species or their habitats.

4.5.3 Environmental Consequences

4.5.3.1 Proposed Action

Potential impacts to fish and macroinvertebrates can be a result of alteration of water quality or alteration of the physical habitat supporting the aquatic biota. Water quality can potentially be altered through deposition of materials released to the atmosphere, surface runoff of contaminated water, or discharge of contaminated groundwater to the surface water body. Alteration of physical habitat may be a direct result of changes in the hydrological regime that reduce the quantity of habitat through changes in stream flow, or may be an indirect effect of changes in the flow regime that alter the physical structure of the stream channel. Each of these types and pathways of impact is discussed below.

Physical Habitat Effects

Hydrologic changes often ~~is~~ are one of the major sources of impacts to fish and macroinvertebrates. Predicted hydrologic changes to the Embarrass River are so small (net increase of 6 percent flow during operations/net decrease of 1 percent during Closure); consequently, hydrologic impacts on aquatic life in the Embarrass River watershed are expected to be insignificant. The following discussion addresses potential hydrologic impacts in the Partridge River. While many aspects of the hydrologic regime can be important to the maintenance of fish and macroinvertebrate assemblages (Richter et al. 1996; Poff et al. 1997; Richter et al. 2003), reduction in baseflow (the portion of streamflow from groundwater) is particularly relevant because it represents a loss of habitat. Table 4.1-52 indicates that baseflow is generally reduced in the Partridge River through the period of mining operations, with the impact subsequently diminishing somewhat once mining operations cease and the West Pit begins to fill with water. The model predictions for three locations on the Partridge River indicate impact on baseflow is greatest at the most upstream location and that impact is progressively smaller with relative position downstream. Peak impacts on baseflow occur in Year 20 and range from 22 percent reduction at SW002 (on the north branch of the Partridge River, northeast of the Mine Site) to 15 percent at SW004 (on the north branch of the Partridge River, immediately upstream of the confluence with the south branch). Following Closure and refilling of the West Pit, predicted reductions in baseflow relative to baseline conditions range from 20 percent at SW002 to 13 percent at SW004. The 1-day, 3-day, 7-day, 30-day, and 90-day annual minimum flows at SW002 are also predicted to decline approximately 20 percent, which may be of sufficient magnitude to appreciably alter the structure and function of biotic assemblages in the Partridge River in the vicinity of SW002 and to a lesser degree in the vicinity of Stations SW003 and SW004 further downstream. Below the confluence with South Branch Partridge River (Stations SW004a, SAW005, and USGS gage), reductions in minimum flows and baseflow are only a few percent and biologically insignificant. Predicted percentage changes (reductions) in maximum flows are greatest at SW004, ranging from -10.1 percent for 90-day maximum to -9.7 percent for 1-day maximum. Average duration of the high flow pulses (measured in days) is predicted to decrease by 16 percent; the total high pulse duration (measured in days per year) is predicted to decrease by 4 percent. Sediment accumulation may result from these predicted reductions in high end flows; however, it would be limited to the Partridge River above Colby Lake and is not expected to be of sufficient magnitude to have a significant effect on physical habitat for aquatic biota

The tribal cooperating agencies' position is that there is insufficient flow data and hydrologic modeling to support the conclusion that reductions in high end flows above Colby Lake would not have a significant effect on physical habitat for aquatic biota. Comments submitted on previous drafts of the EIS have expressed tribal technical staff concerns that any alteration of flow at the magnitude predicted will definitely result in a decrease of stream power, with a subsequent decrease in the size of particle able to be transported. Thus, increased sedimentation is likely to result.

Generally, flows in the Partridge River would be reduced during and following mining operations. Following filling of the West Pit, however, average monthly flow increases at the more downstream locations (SW004a, SW005, and USGS Gage) during the summer and early fall. The resulting flow, however, is less than the monthly average flows during spring. Furthermore, predicted maximum flows decrease during and following mining activity, and the frequency of high flow events is not predicted to increase. Consequently, hydrologic alteration is not expected to degrade physical habitat by destabilizing and resizing the stream channel.

While seasonal minimum flows occur during January when biological activity is at a minimum, a secondary seasonal minimum occurs during late summer when biological activity is high. Low flow during late summer when water temperatures are relatively high can stress aquatic communities, particularly fishes, under natural conditions. Reduced flows at these times would be expected to exacerbate this stress, while increased flows would be expected to reduce it. Late summer monthly flows would be reduced by 5 to 8 percent during mining depending on location along the Partridge River, but after West Pit filling these flows are predicted to increase as much as 16 percent at SW004a immediately below the confluence with the south branch of the Partridge River. Thus, over the longer term, hydrologic alteration may reduce this seasonal stress to the aquatic biota.

Tribal cooperating agencies have expressed their disagreement with this conclusion in previous drafts of the EIS. The aquatic biota present in these streams have adapted over millennia to normal seasonal fluctuations in streamflow, and there is no evidence presented to support the conclusion that over the longer term, hydrologic alteration from this Project may be beneficial to the biota. Clearly, over the shorter term, the significant hydrologic alterations predicted *would* be expected to adversely affect the biota.

Potential impacts to Colby Lake and Whitewater Reservoir, if they occur, would result from changes in the hydrologic characteristics of inflows to Colby Lake from the Partridge River, or from water withdrawals made from Colby Lake to provide make-up water for the NorthMet processing plant. Since water levels in Colby Lake are and will continue to be maintained by drawing water from Whitewater Reservoir, the principal effect of Project-related water withdrawals from Colby Lake would be on water levels in Whitewater Reservoir. Given the expected average demand of 3,500 gpm, average water level in Whitewater Reservoir is predicted to be 0.39 feet (4.7 inches) lower than under baseline conditions. Under the higher 5,000 gpm withdrawal scenario, average water level in Whitewater Reservoir is 1.00 feet lower than the base case. Annual water level fluctuations in Whitewater Reservoir are predicted to be 4.22 feet under the 3,500 gpm withdrawal scenario and 6.84 feet under the 5,000 gpm scenario. This is comparable to historical water level fluctuations (although somewhat higher than more recent fluctuations after LTVSMC stopped mining) and is not expected to have an adverse impact on fish or macroinvertebrate assemblages in Whitewater Reservoir. Fisheries assessments from 1988 through 2007, however, show somewhat higher and more stable numbers of fish, particularly for walleye and northern pike, compared to the earlier period. This may be a related to the reduction in water level fluctuations. In addition, increased water level fluctuations in Whitewater Reservoir have the potential to promote mercury methylation (addressed in Section 4.5.4, below).

Water Quality Effects

The Project is not predicted to result in any exceedences of surface water chronic standards in the Partridge River, Colby Lake, or the Embarrass River, even under extreme low flow conditions (see Section 4.1). These standards, specifically the Class 2 standards, were developed to be protective of aquatic life and to promote the "propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats" (*Minnesota Rules*, part 7050.0222). The chronic standards are the most restrictive stardards and reflect "the highest water concentration of a toxicant to which organisms can be exposed indefinitely without causing chronic toxicity (*Minnesota Rules*, part 7050.0218, subpart 3, item I).

Colby Lake and several lakes downstream on the Embarrass River are listed as impaired with respect to fish consumption because of mercury contamination of fish tissue (MPCA 2008, Minnesota's Impaired Waters). Discussion of mercury-related impacts is presented in Section 4.1.2.3.

Water quality modeling indicates that the Embarrass River would meet Minnesota water quality standards for all modeled constituents except aluminum downstream of groundwater discharges affected by the Plant Site (Section 4.1.3). Baseline aluminum concentrations observed at sampling location PM-13 in 2004, 2006, and 2007 averaged 0.1916 mg/L, which exceeds the applicable water quality criterion for protection of aquatic life (0.125 mg/L) by 53 percent. Seepage from the Tailings Basin is predicted to increase the aluminum concentration at PM-13 an additional 29 percent over existing conditions. Thus, aquatic life may already be impaired in the Embarrass River due to aluminum, and aluminum in Tailings Basin leakage may exacerbate impairment if it exists. Despite the existing and predicted concentrations of aluminum in the Embarrass River near the Tailings Basin, impacts to aquatic life are uncertain because of the complex environmental chemistry of this element. Temperature, pH, and dissolved organic carbon interact to affect aluminum toxicity (Witters et al. 1990; Gundersen et al. 1994). Aluminum toxicity usually is associated with acidic waters (e.g. Baker and Schofield 1982); however, toxicity also is associated with slightly alkaline (pH > 7.0) conditions (Gundersen et al. 1994), and mixing zones, where pH and aluminum speciation rapidly change, can be particularly toxic to fish (Rosseland et al. 1992; Poléo et al. 1994; Witters et al. 1996). Aluminum exerts its toxic effect on fish by impairing gill function (Baker and Schofield 1982; CCME 2003). Other impacts to aquatic life are not expected as a result of groundwater discharge originating from the Tailing Basin.

Tribal cooperating agencies' position is that existing contamination seeping from the LTVSMC Tailings Basin must be adequately addressed through PolyMet's assumption of remedial liabilities under the VIC program, and that mitigation measures should be included and discussed in the draft EIS to ensure that no new exceedences of the aluminum aquatic life use criterion will occur.

4.5.3.2 No Action Alternative

Under the No Action alternative, fish and other aquatic life would be exposed to the water quality, hydrologic, and physical habitat conditions that currently exist as a result of past mining activities. There would be no change in impacts from the baseline conditions.

4.5.3.3 Mine Site Alternative

This alternative is not expected to reduce impacts on aquatic life as compared to the Proposed Action. Impacts to aquatic life due to water quality changes in the Partridge River or Colby Lake are not expected under either this alternative or the Proposed Action. This alternative would not change the impacts to the hydrology of the Partridge River, Colby Lake, or Whitewater Reservoir that are associated with the Proposed Action.

4.5.3.4 Tailings Basin Alternative

This alternative would substantially reduce the amount of sulfate in seepage water that would discharge to the wetlands north of the Tailings Basin and into the chain of lakes along the Embarrass River, which are "high risk" situations for potential methyl mercury formation. As a result, this alternative is expected to reduce the risk of methyl mercury forming and therefore would reduce potential impacts on aquatic life as compared to the Proposed Action. Although discharge of pumped seepage would increase sulfate loadings to the lower Partridge River, this alternative is expected to meet all surface water quality standards and therefore would not significantly change the effect on aquatic life in the Partridge River compared to the Proposed Action.

4.5.3.5 Potential Mitigation Measures

Section 4.1.3.5 describes several potential other mitigation measures for impacts from the Project. Some of these measures have the potential to affect fish and macroinvertebrates and are discussed below.

- Construction of a fully lined tailings basin on top of the former tailings basins 1E and 1W would reduce the potential for leachate from the tailings to migrate off site via groundwater and exacerbate the aluminum and sulfate levels in the Embarrass River (and thereby reduce the potential for contributing to methylmercury production in the Embarrass River watershed). The Proposed Action is not expected to have hydrological impacts to the Embarrass River, so this mitigation would not provide hydrologic benefits.

4.5.4 Mercury and Bioaccumulation in Fish

4.5.4.1 Purpose

Bioaccumulation of mercury in fish is a complex issue that encompasses multiple media, pollutants, pathways, and mechanisms. Current scientific understanding of the factors and mechanisms affecting mercury bioaccumulation is limited. Much of the current knowledge is tentative and subject to change in light of ongoing and future research. The purpose of this section is to provide a simple, but comprehensive, synthesis of readily available information to support a general characterization of the potential for the Project to contribute to or exacerbate elevated mercury concentrations in fish in the Project area. Both cumulative effects due to atmospheric deposition and project-specific effects associated with methylmercury are examined.

4.5.4.2 Background

Mercury contamination of fish is a widespread problem in Minnesota and elsewhere. Many of the waterbodies in the Project area are among those listed as impaired by mercury, including the Partridge and St. Louis Rivers; Wynne, Sabin, Embarrass, and Esquagama Lakes (through which the Embarrass River flows); Colby Lake and Whitewater Reservoir (MPCA 2006, Minnesota's Impaired Waters). These water bodies have fish consumption advisories because the mercury concentrations in fish tissue pose a hazard to human health (MDH 2007, Fish Consumption). Mercury contamination of fish also poses a toxicity risk to fish-eating wildlife (Wolfe et al. 1998; Wiener et al. 2003).

The MPCA has developed a statewide plan to reduce mercury concentrations in fish over time and eventually allow de-listing of water bodies that are currently impaired with respect to fish consumption because of mercury-related fish consumption advisories. Minnesota’s Total Maximum Daily Load (TMDL) for mercury (MPCA 2007, Fish Consumption) serves as the state’s blueprint for reducing mercury concentrations in fish and eliminating this cause of waterbody impairment. Because the TMDL is a statewide plan, and because atmospheric deposition of mercury generally is the ultimate source of the contamination, the TMDL focuses on releases of mercury to the atmosphere. Atmospheric emissions enter a global pool of airborne mercury that is characterized by long-range transport (up to thousands of miles) and residence times of up to a year (Porcella et al. 1996; USEPA 1997). Mercury originating outside of northeast Minnesota, and even outside of Minnesota, dominates atmospheric deposition in the Project area. Approximately 10 percent of the mercury deposition in northern Minnesota is emitted from Minnesota-based sources (Jackson et al. 2000). The remaining 90 percent is evenly divided among other North American sources, global sources, and natural background emissions (Engstrom and Swain 1997; MPCA 2005, Mercury Reduction; MPCA 2007).

The waterbodies listed above, as well as most other waterbodies in the St. Louis River basin were excluded from the statewide mercury TMDL because mercury levels in the fish were above the level considered achievable by the TMDL. These waterbodies may be subject to one or more separate TMDLs to be developed in the future.

A report prepared in support of the NorthMet Project and Minnesota Steel Project (RS69, Barr 2006) examined the contribution of several projects and actions to mercury deposition in northeast Minnesota, including the NorthMet Project. That analysis concluded that collectively the facilities included in the analysis have the potential to increase statewide mercury emissions by 6 percent and deposition of mercury by 0.6 percent. The analysis assumes that deposition within Minnesota happens to be equal to emissions from within the state, and that 10 percent of the increased emissions would be deposited within the state, assumptions that may not be valid. Based on that analysis, atmospheric emissions associated with the Project would not be likely to have a significant effect on mercury bioaccumulation in fish (see Section 4.6).

The tribal cooperating agencies’ position is that the analysis of predicted mercury deposition from several proposed mining projects and its conclusion that mercury emissions associated with this Project would not be likely to have a significant effect on mercury bioaccumulation in fish is not convincing. For these waterbodies, any additional mercury deposition is not acceptable, because fish tissue concentrations are already so high that even the reductions proposed in the statewide mercury TMDL would not reduce fish tissue mercury sufficiently to remove them from the impaired waters list. Any increase in mercury emissions is also inconsistent with the goals of the Lake Superior LaMP (Lakewide Management Plan), which calls for zero discharge of nine bioaccumulative contaminants of concern, including mercury. Increased mercury emissions in Minnesota will also translate into increased mercury deposition across the Lake Superior basin, and Minnesota's mining district is likely the largest contributing source of mercury within the basin.

In addition to atmospheric deposition, local factors related to Project construction and operation have the potential to promote mercury bioaccumulation, either through mobilization of mercury stored in rock, soil, peat, and vegetation on site, or through enhanced methylation of mercury (described below). Factors other than atmospheric deposition of mercury are potentially more important with respect to the potential for the Project to contribute to mercury bioaccumulation in fish. The additional factors considered here are:

- Mobilization of sulfate resulting from the Project;
- Hydrologic changes and water level fluctuations;
- Land cover changes, including forest clearing; and
- Peatland disruption, including stockpiling of overburden and decomposition of organic matter from wetlands.

The role that each of these factors plays in methylmercury production is discussed in Section 4.1.

Virtually all dispersal of mercury in the environment (especially atmospheric dispersal) occurs in inorganic form (Fitzgerald and Clarkson 1991). Virtually all of the mercury accumulated in edible fish tissue (>95 percent), however, is accumulated as organic monomethylmercury (CH_3Hg) (Bloom 1992). Thus, methylation is a key step in bioaccumulation of mercury. Methylmercury is a product of inorganic mercury reduction by sulfate-reducing bacteria, a process that is stimulated by elevated sulfate concentrations (Gilmour et al. 1992; Krabbenhoft et al. 1998).

The analyses described here do not support precise estimates of Project effects on mercury bioaccumulation. Furthermore, effects are not estimated in ways that allow them to be quantitatively aggregated. This situation arises, in part, from the current state of the science related to mercury cycling in ecosystems. Despite these limitations, some broad interpretations can be made from the results. First, local changes to the terrestrial and aquatic environment resulting from the Project have greater potential to enhance bioaccumulation of mercury than does the increase in atmospheric deposition of mercury from the projects included in the cumulative impact analysis. Second, loss of wetlands may marginally reduce methylmercury yield of the Partridge River watershed over the long term; however, the projected magnitude of this effect is relatively small and would appear, if at all, only after transient effects of the project have diminished. Third, factors tending to increase methylmercury production and delivery to surface waters would dominate during mine operation and perhaps for some time following Mine Closure. Sulfate mobilization, water level fluctuation, and mobilization and methylation of mercury sequestered in peat all tend to increase the potential for mercury bioaccumulation in fish. Finally, the effects of sulfate and mercury mobilization and their effects on mercury methylation are cumulative although not necessarily strictly additive. Individually and collectively these factors may significantly increase the potential for bioaccumulation in fish by increasing the production and bioavailability of methylmercury.

Increased sulfate can be expected to no more than double mean methylmercury bioavailability upstream of the USGS gage above Colby Lake, in the Embarrass River, and in the St. Louis River basin upstream of the Embarrass River confluence.

The tribal cooperating agencies' position is that doubling methylmercury bioavailability in these watersheds is unacceptable, as access to fish that can be safely consumed is an essential component of treaty resource harvest rights. Consultation with tribes on cultural resource impacts is ongoing, and the potential impacts to tribal members of a significant increase in mercury in fish harvested in on-Reservation and ceded territories waters has not been adequately addressed.

Over the long term wetlands loss associated with land cover changes could reduce methylmercury yield of the watershed by less than 10 percent; however, over the near term land cover disturbance is expected to increase mercury yield by an unquantified amount. The effect of peat excavation and stockpiling is highly uncertain. Mobilization and methylation of mercury sequestered in the peat on the Mine Site could result in large increases in methylmercury bioavailability in the Partridge River drainage depending on the rate at which the mercury in the peat is mobilized and methylated. This effect would also be influenced by the manner in which stockpiled peat and associated runoff and leachate are managed.

The tribal cooperating agencies' position is that any increase of methylmercury bioavailability in the Partridge River watershed constitutes a significant adverse impact to a critical trust resource. The State of Minnesota's mercury TMDL process will not adequately address the fish consumption impairment in these waterbodies, and any new discharges that would result in further degradation to waters with an existing water quality impairment would not be legally permittable under the Clean Water Act (see Friends of Pinto Creek v. EPA (9th Cir.), known as the Carlota Decision).

4.6 AIR QUALITY

4.6.1 Existing Conditions

4.6.1.1 Regional Climate and Meteorology

The climate classification for the Project area and Minnesota in general, is defined as continental. The region is subject to continental polar air masses throughout most of the year and during the cold season is subject to more frequent Arctic air masses. During the summer months, the southern portion of the State gives way to warm air entering northward from the Gulf of Mexico. As Pacific Ocean air masses move across the western United States, relatively mild and dry weather can be observed throughout the year, depending upon the strength of the air mass.

Based upon surface data taken at Hibbing Monitoring Station, predominant winds are from the north-northwest through west-northwest, accounting for approximately 25 percent (Figure 4.6-1). Winds from the south-southeast through southeast show a secondary predominance, occurring approximately 15 percent of the time. Average monthly temperatures range from 4^{o}F in the coldest month (January in the northwest) to 85^{o}F in the hottest month (July in the southwest). Mean annual temperatures range from 36^{o}F in the extreme north to 49^{o}F in the southeast along the Mississippi River. Extreme temperatures can vary from 114^{o}F in the summer to -60^{o}F in the winter (MnDNR 2009, Crossroads of Climate Change). During the three coldest months (December through February), maximum daily temperatures are below 32^{o}F for 24 days per month. Temperatures in the summer months rarely reach maximum temperatures above 90^{o}F (only 5 to 6 days per year).

The majority of precipitation (approximately two-thirds) occurs between May and September, with annual precipitation ranging from 35 inches in the southeast and gradually decreasing to 19 inches in the extreme northwest. Northeastern Minnesota generally receives approximately 70 inches of snow per year in the northeast highlands and decreases to 40 inches per year near the south and eastern borders. Snow cover in Minnesota averages of 110 days per year with one inch or more on the ground, although there is a marked difference between the northern (where the Project is located) and southern portions of the state, ranging from 140 days per year to 85 days per year of snow cover, respectively.

4.6.1.2 Local and Regional Air Quality

The USEPA has established National Ambient Air Quality Standards (NAAQS) for seven criteria air pollutants including, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), and lead (Pb). Primary standards are established to protect the public health; secondary standards are set to protect public welfare, including protection from damage to animals, crops, vegetation, visibility, and buildings.

In addition, the MPCA has also promulgated ambient air standards for the State of Minnesota, known as the Minnesota Ambient Air Quality Standards (MAAQS). In addition to the criteria pollutants, the MAAQS contain standards for total suspended particulates (TSP) and hydrogen sulfide (H_2S).

The NAAQS and MAAQS are summarized in Table 4.6-1.

Table 4.6-1 Summary of NAAQS and MAAQS

Pollutant	Averaging Period	Standard Value	Standard Value	Standard Type[1]	Notes
Carbon Monoxide	1-Hour	35 ppm	40 mg/m^3	Primary	Not to be exceeded more than once per year
	1-Hour[2]	30ppm	35 mg/m^3	Primary	
	8-Hour	9 ppm	10 mg/m^3	Primary and Secondary	
Nitrogen Dioxide	Annual Arithmetic Mean	0.05 ppm	100 $\mu g/m^3$	Primary and Secondary	Not to be exceeded.
Ozone	8-Hour	0.075 ppm	147 $\mu g/m^3$	Primary and Secondary	Daily maximum 8-hour average
Lead	Quarterly		0.15 $\mu g/m^3$	Primary and Secondary	Rolling 3-month Average
Total Suspended Particulate (TSP)[2]	Annual Geometric Mean		75 $\mu g/m^3$ 60 $\mu g/m^3$	Primary Secondary	Not to be exceeded.
	24-Hour		260 $\mu g/m^3$ 150 ug/m3	Primary Secondary	Not to be exceeded more than once per year
PM_{10}	Annual Arithmetic Mean[2]		50 $\mu g/m^3$	Primary and Secondary	Not to be exceeded.
	24-Hour		150 $\mu g/m^3$	Primary and Secondary	Not to be exceeded more than once per year on average over 3 years
$PM_{2.5}$	Annual Arithmetic Mean		15 $\mu g/m^3$	Primary and Secondary	Not to exceed the 3-year average of the weighted annual mean concentrations
	24-Hour		35 $\mu g/m^3$	Primary and Secondary	Not to exceed the 3-year average of the 98th percentile of 24-hour concentrations
Sulfur Dioxide	Annual Arithmetic Mean	0.03 ppm 0.02 ppm	80 ug/m3 60 ug/m3	Primary Secondary[2]	Not to be exceeded.
	24-Hour	0.14 ppm	365 $\mu g/m^3$	Primary and Secondary	Not to be exceeded more than once per year
	3-Hour	0.5 ppm	1300 $\mu g/m^3$	Primary and Secondary	
	3-Hour[2]	0.35 ppm	915 $\mu g/m^3$	Secondary	
	1-Hour[2]	0.5 ppm	1300 $\mu g/m^3$	Primary	
Hydrogen Sulfide[2]	½-Hour	0.05 ppm	70 $\mu g/m^3$	Primary	Not to be exceeded over 2 times per year
	½-Hour	0.03 ppm	42 $\mu g/m^3$	Primary	Not to be exceeded over 2 times in any 5 consecutive days

Source: MPCA, 2008.

1 Primary standards set limits to protect human health; Secondary standards set limits to protect public welfare.

2 Minnesota State Ambient Air Quality Standard only

Ambient air quality is measured at various locations throughout the State. Ambient monitoring data from the closest monitoring stations to the Project are provided in Table 4.6-2. As seen from the table, all reported air quality data are below the NAAQS and MAAQS.

Table 4.6-2 Monitored Background Concentrations (2004 – 2006)

Pollutant	Averaging Period	Monitored Background Concentration	Standard Value	Standard Type	Monitoring Station
Carbon Monoxide	8-Hour	1.6 ppm	9 ppm	Primary	314 West Superior Street, Duluth
	1-Hour	3.3 ppm	35 ppm 30 ppm(1)	Primary Primary and Secondary	314 West Superior Street, Duluth
Nitrogen Dioxide	Annual	0.004 ppm	0.05 ppm	Primary and Secondary	Carlton County
Ozone	8-Hour	0.066 ppm	0.08 ppm	Primary and Secondary	Voyageurs national Park
Lead	Quarterly	0.01 µg/m^3	1.5 µg/m^3	Primary and Secondary	Virginia City Hall
Total Suspended Particulate (TSP)[1]	Annual	16 µg/m^3	75 µg/m^3 60 µg/m^3	Primary Secondary	Virginia City Hall
	24-Hour	32 µg/m^3	260 µg/m^3 150 µg/m^3	Primary Secondary	Virginia City Hall
PM_{10}[2]	Annual	15 µg/m^3	50 µg/m^3	Primary and Secondary	Virginia City Hall
	24-Hour	32 µg/m^3	150 µg/m^3	Primary and Secondary	Virginia City Hall
$PM_{2.5}$	Annual	6.1 µg/m^3	15 µg/m^3	Primary and Secondary	Virginia City Hall
	24-Hour	19 µg/m^3	35 µg/m^3	Primary and Secondary	Virginia City Hall
Sulfur Dioxide	Annual	0.001 ppm	0.03 ppm 0.02 ppm[1]	Primary Secondary	Rosemount, MN
	24-Hour	0.005 ppm	0.14 ppm	Primary and Secondary	Rosemount, MN
	3-Hour	0.010 ppm	0.5 ppm 0.35 ppm	Primary and Secondary[3] Secondary[4]	Rosemount, MN
	1-Hour	0.019 ppm	0.5 ppm[1]	Primary	Rosemount, MN

Source: MPCA, 2008
Minnesota State Ambient Air Quality Standard only.

1 The EPA revoked the annual PM_{10} standard (effective December 17, 2006). However, it is still reflected in the State of Minnesota's regulations.

2 Secondary standard for Air Quality Control Regions 128, 131, and 133.

3 For Air Quality Control Regions 127, 129, 130, and 132.

4.6.1.3 Federal Regulations

Attainment Status

An area that does not meet NAAQS are considered to be a "nonattainment area" for that pollutant and are required to provide state implementation plans (SIPs) to control existing and future emissions in order to bring the area into compliance with the NAAQS. "Attainment areas" are those areas that either have collected ambient air quality data to demonstrate that it is in compliance or do not have data to show they are in non-compliance with the NAAQS, known as "unclassified areas".

Prevention of Significant Deterioration Increments

The Project area is in attainment for all criteria air quality pollutants and is considered to be a Class II attainment area. For attainment areas, the USEPA has promulgated Prevention of Significant Deterioration (PSD) Increments for three pollutants, NO_2, SO_2, and PM_{10}, for both Class I and Class II regions. Because emissions from the Project are below "major source" thresholds for the PSD program and this Project is not subject to PSD requirements, increment requirements do not apply. For the purposes of this DEIS, Project impacts have been compared to the PSD Class I (generally pristine areas) and Class II (remaining areas) increments. The increments are designed to allow for ambient concentrations within an area to increase by the maximum allowable amount above baseline concentrations. Class I PSD Increments are designed to keep pristine areas clean and have more restrictive allowable increment thresholds. These areas include national parks, wilderness regions, monuments, and other areas as specified in 40 FR 51.166(e). Class II PSD increments are designed to allow further growth within the rest of the country. Table 4.6-3 provides a summary of the Class I and Class II PSD Increments.

Table 4.6-3 Summary of Allowable PSD Class I and Class II Increments

Pollutant, Averaging Period	Allowable Increment (ug/m^3)	
	Class I Region	**Class II Region**
SO_2, 3-hour	25	512
SO_2, 24-hour	5	91
SO_2, Annual	2	20
NO_2, Annual	2.5	25
PM_{10}, 24-hour	8	30
PM_{10}, Annual	4	17

Air Quality Related Values

In addition to PSD Increments, major projects that are located within 300 kilometers (186 miles) of a Class I area may be required by the Federal Land Manager (FLM) to evaluate impacts on air quality related values (AQRVs), including flora/fauna visibility, water quality, soils, and odor. The Project is located within 300 km of four Class I regions, including BWCAW and Rainbow Lakes Wilderness (RLW), administered by the USFS, and Voyageurs National Park (VNP) and Isle Royale National Park (IRNP), under the administration of the National Park Service (NPS). Although the Project is not considered a major source, an evaluation of the AQRVs was conducted for comparison in this DEIS. Table 4.6-4 provides the distances to each region from the Project.

Table 4.6-4 Project Setting to Class I Regions

Class I Region	Nearest Distance from Project (km/mi)
BWCAW	34/21
VNP	82/51
RLW	142/88
IRNP	218/135

New Source Performance Standards

The Federal New Source Performance Standards (NSPS) are technology-based standards that are applicable to new or modified stationary sources of regulated emissions. The NSPS program has defined emission limitations for approximately 70 source categories that are designated by size as well as type of process. A comprehensive list of the applicable regulations for this facility will be included as part of the air quality permit. The following is a partial list of standards that may apply to the Project, which may increase or decrease depending on the final assessment of the permit application assessment by the MPCA:

- Subpart A – General Provisions, which provides for general notification, record keeping, and monitoring requirements.
- Subpart LL – Standards of Performance for Metallic Minerals Processing Plants, which covers particulate and opacity emission limits for any new, modified, or reconstructed sources.
- Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants, which limits particulate emissions and opacity from new, modified, or reconstructed sources processing nonmetallic mineral (e.g. limestone or construction rock).
- Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines, which limits NO_x, PM, CO, fuel oil sulfur content, and opacity for new, modified and reconstructed stationary compression ignition internal combustion engines.
- Subpart Dc – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units which, depending on fuel type, can regulate PM, and/or SO_2 emissions from new, modified, or reconstructed boilers.

Air Conformity Determination

A conformity determination must be conducted by the lead federal agency if a federal action would generate emissions exceeding the conformity threshold levels (de minimis) of the pollutant(s) for which an air basin is designated as a nonattainment area or a maintenance area. Since the Project area is classified as in attainment for all criteria pollutants, a General Conformity Determination is not required.

4.6.1.4 State of Minnesota Regulations

Nonferrous Mineland Reclamation Rule 6132.800 is administered by the MnDNR and requires the control of dust from areas disturbed by mining operations.

The MPCA has promulgated rules concerning the control and permitting of sources throughout Minnesota. The following regulations will be evaluated for the Project.

Prevention of Significant Deterioration Review

Minnesota Rules, part 7007.3000 incorporates by reference the federal PSD requirements that provides for a pre-construction review and permit process for the construction and operation of a new or modified major stationary source in attainment areas. The program includes:

- BACT Demonstration;
- Ambient Air Quality Analysis to assess Project impacts with NAAQS, MAAQS, and PSD Increments;
- An assessment of AQRV of the direct and indirect effects of the Project on general growth, soil, vegetation, and visibility for Class I regions within 300 km;
- An ambient monitoring program if no representative data are available; and
- Public comment.

The Project is designed to limit synthetic minor emissions below major source thresholds. Thus for permitting purposes, the Project would not be considered a major source for PSD (BACT demonstration, PSD Increment assessment and AQRV assessment would not be required via *Minnesota Rules*, part 7007.3000). However, a comprehensive analysis of NAAQS, MAAQS, PSD Class I and II Increments, and air quality related values was performed as part of the evaluation of impacts in the DEIS.

As noted above, a BACT demonstration would not be required for this Project if it is not permitted as a major source. However, as required by the Final SDD, an evaluation of pollution control technology was conducted for the Plant and Mine Sites (RS58A, Barr 2008; RS58B, Barr 2008).

Minnesota Standards of Performance

A comprehensive list of Minnesota Standards of Performance would be identified in the air quality permit. The following provides a partial list of Minnesota Standards of Performance that may be applicable to the Project. It should be noted that this list may increase or decrease, depending upon the final assessment of the permit application by the MPCA.

- Control of Fugitive Particulate Matter (*Minnesota Rules*, part 7011.0150), which applies to bulk material handling operation, roads, and other fugitive sources. The rule prohibits the release of "avoidable amounts" of PM and facilities are required to take reasonable precautions to prevent the discharge of visible fugitive emissions beyond the property line.
- Standards of Performance of Stationary Internal Combustion Engines (*Minnesota Rules*, part 7011.2300). This applies to the emergency fire water pumps and the emergency generators, which limits SO_2 emissions to 0.5 lb/MMBTU heat input.
- Standards of Performance for Post-1969 Industrial Process Equipment (*Minnesota Rules*, part 7011.0715). This would apply to all new ore handling equipment and other new sources that would generate PM emissions for which a standard of performance has not been promulgated in a specific rule. Due to the remote location of the Project (i.e., any source that is not in the

Minneapolis-Saint Paul Air Quality Control Region and the city of Duluth and which is located not less than one-quarter mile from any residence or public roadway) the required control equipment efficiency standard would be 85 percent.

- Standards of Performance for Existing Indirect Heating Equipment (*Minnesota Rules*, part 7011.0510). The rule limits the PM emissions between 0.4 and 0.6 lb/mmBTU, limits SO_2 emissions between 1.6 and 4.0 lb/mmBTU, and limits opacity to 20 percent. This may apply to existing indirect heaters if used in the mining and processing operations.
- Standards of Performance for New Indirect Heating Equipment (*Minnesota Rules*, part 7011.0515). The rule limits emissions of PM to between 0.1 and 0.4 lb/mmBTU, SO_2 emissions between 0.8 and 4.0 lb/mmBTU, NO_x emissions between 0.2 to 0.7 lb/mmBTU, and opacity to 20 percent. This may apply to new indirect heaters that may be used in the mine processing operations.
- Standards of Performance for Fossil-Fuel-Burning Direct Heating Equipment (*Minnesota Rules*, part 7011.0610). The rule limits PM emissions based upon process throughput and limits opacity to 20 percent. This may apply to process heaters that may be used in the mine processing operations.
- Standards of Performance for Pre-1969 Industrial Process Equipment (*Minnesota Rules*, part 7011.0710). The rule limits mass PM emissions based upon process weight and limits opacity to 20 percent. Alternatively, due to the remote location of the Project, compliance can be demonstrated with a pollution control equipment efficiency of 85 percent. This may apply to existing ore handling equipment that may be used in the mine processing operations.
- Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (*Minnesota Rules*, part 7011.3520). The rule incorporates federal Standards of Performance for Stationary Compression Ignition Internal Combustion Engines under the 40 CFR, Part 60, Subpart IIII . This may apply to fire water pumps and emergency generators that may be used in the mine processing operations.
- Stationary Reciprocating Internal Combustion Engines (*Minnesota Rules*, part 7011.8150). The rule incorporates federal National Emission Standards for Hazardous Air Pollutants (NESHAP) under the 40 CFR, Part 63, Subpart ZZZZ. This may apply to fire water pumps and emergency generators that may be used in the mine processing operations.

4.6.2 Impact Criteria

Various state and federal air quality standards and emissions standards have been established to minimize degradation of air quality. The impact criteria used for the evaluation of potential impacts on air quality from the Project or an alternative is whether it would cause any of the following conditions:

- Exceedence of NAAQS and MAAQS;

In addition to legally applicable statutory or regulatory requirements, the following criteria also were considered in evaluating impacts from this Project:

- Adversely affect human health as determined by an Air Emissions Risk Analysis (AERA);

- Result in consumption of PSD increments as defined by the Clean Air Act (CAA), Title I, PSD rule;
- Adversely affect visibility in Class I areas; or
- Adversely affect other AQRV in Class I areas.

4.6.3 Environmental Consequences

To determine whether the Project would result in any of the above listed conditions, an evaluation of the emissions associated with the Project was performed through air dispersion modeling. The results of air dispersion modeling were reviewed against the stated conditions. Detailed air dispersion modeling was conducted to evaluate compliance with NAAQS and MAAQS, to conduct PSD increment analysis, and to review potential impacts to Class I and Class II areas. Although the Project is not considered a major source for PSD considerations, the modeling analysis for the purpose of the DEIS was conducted pursuant to the PSD regulations. The methods used for modeling are summarized below. Also summarized below are the results of the modeling and potential impact of the Project used to represent an upper bound for assessing potential impacts.

The potential effects of air pollutants emissions are discussed in this section based on activities and operations at the Plant and Mine Sites. The majority of potential criteria and non-criteria pollutant emissions are expected from the autoclaves, limestone material handling and the mine haul roads. Fugitive emissions of PM_{10} would result from the handling of limestone and other materials and wind erosion at the tailings basin. Air quality modeling addressed emissions from all of the sources (inclusive of mobile sources). PolyMet is proposing to accept emission limits below the major source threshold (stationary sources less than 250 tpy for criteria pollutants) to be classified as a synthetic minor PSD source and therefore would not be subject to PSD requirements including modeling attainment with PSD increments for permitting purposes. As demonstrated in Table 4.6-5, the Project does not have projected actual emissions above major PSD threshold on an annual basis. Even so, modeling analyses were performed to assess its impact for the purposes of the DEIS.

Impacts due to these emissions for the Plant and Mine Sites are examined in more detail later in this section. This section describes the potential impacts that may occur on local and regional air quality from implementing the Project. Potential visibility impacts that could occur from increases in regional haze and localized visibility are also discussed.

It is the position of the Tribal cooperating agencies that an overlooked environmental impact from fugitive emissions is the reactivity of the waste rock dust. Tribal cooperators believe that while the dust might not necessarily create sulfuric acid it is reactive enough that additional sulfates might form in wetlands and lead to an increase of methylation of mercury. Further analysis should be done and the results included in the DEIS.

4.6.3.1 Proposed Action

Criteria Pollutants

From an air quality perspective, emissions from the Project would be expected to occur from the mining operations at the Mine Site and ore/concentrate processing at the Plant Site. Although the emission generating activities at these two sites are separated geographically, they are joined by the rail line that would be used to transport ore from the Mine Site to the Plant Site. As such, the Project is considered as a single project for permitting purposes, and thus, the total emissions from both sites are summed for the purposes of this analysis.

At the Mine Site, emissions were estimated for material handling sources associated with excavation, portable crushing and screening operations, blast hole drilling, unpaved roads, and vehicle exhaust.

Material handling includes the loading of overburden, waste rock, lean ore, and ore into trucks with shovels or loaders. After it is hauled, the ore would be dumped into the Rail Transfer Hopper and the overburden, waste rock, and lean ore would be unloaded at the appropriate stockpile or pit. The crushing and screening operations would be used to separate the larger rocks from soil and gravel in the overburden to produce rock suitable for construction purposes. Haul trucks would be traveling over unpaved roads from the excavation site to the rail loading and stockpiling areas. Fugitive emissions would be generated as part of these operations.

At the Plant Site, point source emissions are predicted to occur from the crushing plant, flotation operation autoclaves and other hydrometallurgical processes, process consumables handling sources, and combustion sources. In addition, fugitive emissions are expected to occur from raw materials handling, Plant Site roads, Tailings Basin, and Dunka Road sources. Water or dust suppression would be used on all unpaved roads, resulting in a 60 percent reduction in emissions.

Detail information of the emission calculations for the Mine Site and Plant Site sources are provided as separate documents (RS57A, Barr 2008; RS57B, Barr 2008; RS57C, Barr 2008; RS57D, Barr 2008; RS57E, Barr 2008). Table 4.6-5 summarizes the projected actual emissions for the Mine Site, Plant Site, and Total Emissions from stationary sources for comparison with PSD Major Source Thresholds. It should be noted that in accordance with PSD permitting requirements the fugitive sources are not included in the determination of a major source unless it belongs to a listed source category.

Table 4.6-5 Annual Criteria Air Pollutant Emissions

Pollutant	Plant Site Projected Actual Emissions	Mine Site Projected Actual Emissions	Total Projected Actual Emissions	PSD Major Source Thresholds
NO_x	40	8	48	250
SO_2	18	0.7	18	250
PM_{10}	175	3	178	250
$PM_{2.5}$	149	1	150	250
VOC	101	0.7	102	250
Pb	0.1	0.0	0.1	250
CO	101	3	103	250

However, to assess modeling impacts, mobile and fugitive emissions from the operations were evaluated. Emissions from mobile and fugitive source from the Project are provided in Table 4.6-6.

Table 4.6-6 Annual Modeled Mobile and Fugitive Air Pollutant Emissions

Pollutant	Plant Site Projected Actual Emissions	Mine Site Projected Actual Emissions	Total Projected Actual Emissions
NO_x	0	316	316

SO_2	0	10	10
PM_{10}	122	685	807
$PM_{2.5}$	36	91	127

$PM_{2.5}$ has been determined to be a criteria pollutant by the USEPA, however, due to the complexity in developing and assessing $PM_{2.5}$ emissions from a regulatory standpoint and challenges in the federal courts, the USEPA has been delayed in developing regulations regarding assessment of $PM_{2.5}$ for regulatory compliance. In 2008, the USEPA issued guidance to the states for inclusion in their state plans. Recently (July, 2008), the USEPA issued guidance to the states on addressing $PM_{2.5}$ in regulatory permitting that allows states to defer consideration of condensable fraction of $PM_{2.5}$ until accurate methodology has been developed and validated. However, the MPCA requires that $PM_{2.5}$ condensables be counted as emissions.

Due to these recent changes, PolyMet has recently developed analyses to address the $PM_{2.5}$ emissions and impacts. Although these analyses have not been completely reviewed and validated at the time of the DEIS submission, a preliminary assessment is addressed in this DEIS. Upon final validation, the complete analyses will be included in the Final EIS.

Toxic Emissions

Small amounts of toxic emissions known as Hazardous Air Pollutants (HAP) are expected to occur throughout the Project. Table 4.6-7 provides the estimate of HAP emissions for the Project. These emission levels reflect potential emissions taking into account the proposed pollution control equipment for the Project (i.e., controlled potential to emit). As seen from the table, total emissions of a single HAP is below 10 tpy and the combined HAP emissions are below 25 tpy, indicating that the HAP emissions would not exceed USEPA PSD major source thresholds for HAP. Although toxic emissions from mobile sources were not included in the table to address emission thresholds, these emissions were used in assessing the impacts on health described later in this section.

Table 4.6-7 Annual HAP Emissions

Pollutant	Plant Site Potential To Emit (tpy)	Mine Site Potential To Emit (tpy)	Total Potential To Emit (tpy)	PSD Major Source Threshold (tpy)
Single HAP[1]	5	1	6	10
Combined HAPs	12	5	17	25

[1] Nickel is worst-case HAP for the Plant Site, manganese is worst-case for the Mine Site. Worst-case for Project totals is nickel. Values in Table 4.6-6 reflect nickel emissions.

Predictive Modeling Approach

The AERMOD (Version 07026) air quality model was used with the Building Profile Input Program (BPIP, version 04274) at the Plant Site and no building downwash parameters at the Mine Site to model Project operations with the exception that downwash was used for locomotive exhaust. The MPCA prefers the AERMOD modeling system and USEPA has included AERMOD as an approved guideline model. Deposition was accounted for in the modeling using AERMOD’s half-life option (Barr 2008, Dispersion Modeling Protocol). The model was set to RURAL dispersion because the terrain/land use within 3 kilometers (1.9 miles) of the site is almost completely rural. Meteorological data (2001-2005) from the Hibbing station and concurrent International Falls mixing heights data, suitable for input to AERMOD were used for the NorthMet Project modeling.

The air quality modeling addressed the individual point sources, as well as all sources of fugitive particulate matter. The modeling was conducted to determine the extent of impacts from criteria pollutant emissions on ambient air quality and to identify the significant impact area (SIA) for each pollutant. Modeling was conducted for PM_{10}, NO_2, and SO_2 and their respective applicable averaging time at both the Plant and Mine Sites (Barr 2008, Class II Air Dispersion Modeling – Mine Site; Barr 2008, Class II Air Dispersion Modeling – Plant Site). Ozone emissions were not modeled or analyzed for NAAQS due to the regional nature of ozone formation involving complex interaction of multi-pollutants. It should be noted that O_3 is not emitted directly from any mining or ore-processing source. Emissions of Pb were not modeled because the Project would not result in appreciable lead emissions. Carbon monoxide emissions were not modeled due to the MPCA determined likelihood that there would not be any concern about the outcome of the modeling.

The SIA was determined for pollutants, which are shown to have a significant impact in ambient air at any point and more refined modeling was carried out to evaluate compliance with PSD increments and NAAQS. All point and fugitive sources associated with the Plant and Mine Sites were included in the source input for PSD increment modeling, with the exception of the Plant Site paved roads and the Tailings Basin which were in operation at the baseline date. Additionally, data on the following nearby major increment-consuming (or - expanding) sources, which were determined and provided by the MPCA, were also included as source input:

- Peter Mitchell Mine;
- Mesabi Nugget Phase 1 Project;
- Cliffs Erie Pellet Yard;
- Syl Laskin Energy Center; and
- LTV Steel Mining Company (LTVSMC)

Model inputs for Mesabi Nugget and Syl Laskin Energy Center were taken from previous modeling completed at the site for the Mesabi Nugget Project. The Peter Mitchell Mine inputs were taken from its Title V permit. Model inputs for the Cliffs Erie Pellet Yard were taken from the air permit application for the pellet yard upgrade. For comparison to the NAAQS, a background concentration was added to the modeled concentration. PM_{10} background concentrations represent the 2004-2006 average concentrations for the high-second-high 24-hour concentration and annual average concentration from Virginia, Minnesota air quality monitoring site. SO_2 and NO_x background concentrations are from 2004-2006 data at the Rosemont and Carlton County, Minnesota monitoring stations, respectively.

<u>Class I Area-Related Modeling Approach</u>

An air quality modeling analysis was conducted to estimate impacts of the Project on air quality in Class I areas. The Class I AQRV analyses addressed PSD Class I Increments for SO_2, PM_{10}, NO_2, sulfur and nitrogen deposition, and visibility impairment (regional haze). The dispersion modeling analysis used standard EPA long-range transport modeling methodologies, and followed guidance as presented in EPA's Guideline on Air Quality Models, the IWAQM Phase 2 report, and the FLAG Phase I report (Barr 2008, Class I Air Dispersion Modeling Report). The analyses also incorporated suggestions and guidance received from the U.S. Forest Service and the National Park Service. The CALPUFF air quality model was used for all Class I area analyses.

Input options and data utilized in the models generally corresponded to default or recommended values along with representative, Project-specific source input parameters (Bar 2008, Class I Air Dispersion Modeling). The CALPUFF modeling analysis used MM5 meteorological data for the available years 2002, 2003, and 2004, as outlined in the Final SDD. Additional surface, upper air, and precipitation data were used in CALMET to refine the meteorological fields. Hourly surface data from 74 stations and precipitation data from 99 stations were used along with upper air data from five stations.

The Class I AQRV analysis addressed impacts to the BWCAW, IRNP, RLW, and VNP

Subsequent to submittal of the Class I Modeling Report (Barr 2008) and addendum, PolyMet re-evaluated the vehicle fleet based on visibility impacts and the availability of specific vehicles and technology. The modeling was generally completed with the same procedures as the earlier modeling, with the exception that modeling with a one kilometer meteorological data grid was not performed in the BWCAW for the updated vehicle fleet. The previous modeling had shown essentially equivalent or better results with the one kilometer grid, so modeling with the four kilometer grid was considered sufficient.

NAAQS and PSD Increment Impact Analysis

State and federal air quality rules prohibit emissions from a new Process Plant that cause or contribute to a conflict with MAAQS or NAAQS. In addition, impacts from these emissions were compared to established PSD increments. To demonstrate compliance with these requirements, an air dispersion modeling analysis for the Project was conducted (Barr 2008; Class I Air Dispersion Modeling; Barr 2008, Class II Air Dispersion Modeling).

It should be noted that the modeling analysis to date was conducted prior to the latest revision to the PD and does not reflect the current Proposed Action for the Tailings Basin described in Section 3. However, these changes only affect emissions (and impacts) of PM_{10} and $PM_{2.5}$, an increase of 91 tons/year and 11 tons/year, respectively. These represent an overall 19 percent increase in PM_{10} emissions and 5 percent increase in $PM_{2.5}$ emissions. Based upon only the increase in emissions, impacts from PM emissions are not expected to change the conclusions identified in this section since the impacts, compared to the standards, were low compared to the increase in potential emissions, except for two scenarios. The exceptions include the 24-hour PM_{10} Class II Increment values and the $PM_{2.5}$ NAAQS impacts for the Plant Site assessment, which were originally modeled at 97 percent of the standard. Based upon location of the increased emissions and the maximum impact locations identified in the original modeling, it is likely that the contribution from the increased emissions will have a significant contribution to the overall total. However, the modeling will be completely evaluated in the Final EIS.

The Plant Site emissions were modeled with all sources operating at full capacity in a single modeling run. This conservatively over estimates the impact as not all sources will be capable of operating simultaneously. PM_{10} is the primary pollutant emitted from the Plant Site. Emissions of SO_2 and NO_X would be in small quantities because the process is conducted at relatively low temperatures and would not include any continuous operating fuel combustion sources. The Mine Site emission rates are based on a daily average throughput of 32,000 tons of ore.

The primary emission generating activities at the Plant and Mine Sites are located 8 miles apart other and connected by a private railway that was originally constructed to transport iron ore pellets from Erie Mining Company's process plant to their ore dock. The railway is proposed to be used for the transportation of ores from the Mine Site to the Plant Site. Due to the distance between the Plant and Mine Sites emission sources, it is more practical and reasonable to perform individual air dispersion modeling for receptors at each site. For the Mine Site grid, both Mine and Plant Site emissions were modeled explicitly. However, for the Plant Site grid, the emissions from the Mine Site were not included as impacts from these sources were below the Significant Impact Level (SIL) for these receptor locations from previous modeling, as agreed upon with MPCA. The results are discussed below.

The SIL in Table 4.6-8 shows modeled impacts at the Plant and Mine Site receptors. The Maximum Area modeled impacts are maximums from either the Plant Site or the Mine Site analyses, since each analysis includes all Project emissions, as defined above. The USEPA has developed SILs as a way to screen out, from further PSD analysis, pollutants that are not expected to cause any significant contribution to existing air quality levels. The emissions included are at 100 percent capacity for each averaging period.

Table 4.6-8 Highest Project Impacts and PSD Class II SILs

Pollutant	Averaging Time	Plant Site Area Modeled Impacts (ug/m^3)	Mine Site Area Modeled Impacts (ug/m^3)	Maximum Area Modeled Impacts (ug/m^3)	SIL (ug/m^3)
SO_2	3-hour	147	2.1	147	25
	24-hour	37	0.61	37	5
	Annual	5	0.04	5	2
PM_{10}	24-hour	56	29	56	5
	Annual	11	4.9	11	1
$PM_{2.5}$	24-hour	14	13	15	5
	Annual	5	3	5	1
NO_2	Annual	9	1.9	9	1

Class II PSD Increment Analysis

Increment analyses were completed for SO_2, PM_{10}, and NO_X for both the Plant and Mine Sites. The modeling included all Project increment consuming sources at maximum emission rates plus all nearby increment consuming (and expanding) emissions sources, including, Cliffs Erie Pellet Yard, LTVSMC, and Mesabi Nugget. The results of the increment analyses are shown in Table 4.6-9, along with a comparison to the allowable Class II PSD increments.

Mine Site Receptors Analysis

The PM_{10} modeling was conducted for two operating scenarios corresponding to the different Category 1 and 2 waste rock disposal operations that would occur over the 20 year life of the mine. The worst case years for stockpile disposal of Category 1 and 2 waste rock (Year 8) and in pit disposal (Year 16) were chosen to represent the worst case for the entire mine life. NO_X and

SO_2 are primarily emitted by mobile sources. Due to the low modeled concentrations and constant emission rates for NO_X and SO_2, only one scenario (Year 8) was modeled for these two criteria pollutants (i.e. worst case emissions for the mobile sources were modeled with the Year 8 mine configuration). The modeling results for the Mine Site receptors, including sources from the haul road, material handling, mine pits, and diesel locomotives indicate that the highest modeled 24-hour highest 2nd high (H2H) PM_{10} concentration was 27 ug/m^3 for the Year 8 operating scenario and 29 ug/m^3 for the year 16 operating scenario. The H2H corresponds to not exceeding a standard more than once per year, as defined by the applicable standard. Modeling was also performed for NO_X at the Mine Site receptors for PSD Increment analyses. Based on the dispersion modeling results, the PSD Increment concentration for NO_X is 1.9 ug/m^3. SO_2 impacts from the Project at the Mine Site were below the SILs, so no additional modeling including nearby sources was performed.

Plant Site Receptors Analysis

The operation at the Plant Site, including fugitive sources, building vents, limestone material handling, and vehicular traffic on paved roads would result in a maximum increment concentration for PM_{10} of 29 ug/m^3 on a cumulative impacts boundary receptor grid, based on the 24-hour H2H modeling. Modeled impacts for SO_2 and NO_X at the Plant Site receptors are well below the PSD Class II increments thresholds.

The data in Table 4.6-9 summarize the PSD Increment modeling results and demonstrate that the Project, in conjunction with all other neighboring PSD sources, would comply with all state and federal increment requirements. The maximum concentrations for the Plant Site receptor grid and the Mine Site receptor grid are presented separately. Since the two receptor grids represent two separate areas of concern, the maximum concentrations are not additive. The Tribal cooperating agencies' position is that the current modeling analysis does not reflect the current proposed action for the tailings basin (an increase of 91 tpy and a 19% increase) and that this analysis must be redone using the current proposed action for the tailings basin. The Tribal cooperating agencies also note that an increment analysis is still needed for $PM_{2.5}$.

Table 4.6-9 Results of Class II PSD Increment Analysis

Pollutant	Averaging Time	Plant Site Grid Modeled Impacts (ug/m^3)	Mine Site Grid Modeled Impacts (ug/m^3)	PSD Increment Limits (ug/m^3)
SO_2	3-hour	147	N/A	512
	24-hour	37	N/A	91
	Annual	5	N/A	20
PM_{10}	24-hour	29	29	30
	Annual	0	4.9	17
NO_X	Annual	9	1.9	25

Notes:
SO_2 concentrations were not modeled due to negligible incremental impact.
Modeled PM_{10} concentrations are based on operating scenarios at Year 8 and Year 16.
Plant Site modeled emissions include expansion credit and are evaluated at Plant Site boundary.
Mine Site modeled emissions include Plant Site, Mesabi Nugget, Cliffs Erie Pellet Yard, and LTVSMC.

Class II NAAQS and MAAQS Evaluation

The NAAQS modeling predicted the maximum impact of the Plant and Mine Sites and other regional sources. The highest total impacts modeled, plus background concentrations, are compared to applicable MAAQS and NAAQS. Maximum emission rates were modeled for all Project sources and key criteria pollutants (NO_X, SO_2, and PM_{10}).

Mine Site

The analysis included potential emissions from nearby sources in the NAAQS analysis, including Mesabi Nugget, Cliffs Erie Pellet Yard, Peter Mitchell Mines, and the Plant Site. The other sources to the west of the Mine Site (Mesabi Nugget, Cliffs Erie Pellet Yard, and the Plant Site) were modeled collectively in a separate modeling run to determine their maximum modeled impact on the Mine Site receptor grid (Barr 2008, Class II Air Dispersion Modeling, January; Barr 2008, Class II Dispersion Modeling, September). The Tribal cooperating agencies' position is that the Keetac Expansion Project should also be included for impacts as it will increase production by 2/3 and correspondingly its emissions will also increase and influence the NAAQS evaluation. The Tribal cooperating agencies also note that it is within 45 miles of the PolyMet project and in the general vicinity of the prevailing winds.

The PM_{10} NAAQS modeling results conservatively added the maximum modeled emissions from the Mine Site plus the maximum modeled impact from the other nearby sources plus ambient background concentrations for comparison to the NAAQS. Cumulative modeling and further analyses for SO_2 were not performed because the SO_2 concentration at the Mine Site was shown to be well below the SILs. It should be noted that the SILs have been established by the USEPA such that concentrations below these levels are not anticipated to contribute to a change in the overall impact when combined with other nearby source impacts. NO_X concentrations were just above the SIL of 1 ug/m^3 and are modeled with contributions from nearby emission sources.

Plant Site

The NAAQS modeling on the Plant Site ambient boundary grid included all PolyMet plant sources evaluated in the PSD increment modeling plus the Tailings Basin emissions, unpaved road emissions, and paved road emissions associated with the limestone traffic. The maximum 24-hour PM_{10} modeled impact of 88 ug/m^3 occurred along the Plant Site southern boundary (Figure 4.6-3). All predicted concentrations are below allowable levels and the results demonstrate compliance with all MAAQS and NAAQS.

Table 4.6-10 below summarizes results of the NAAQS model analysis for Plant and Mine Sites. Using the same procedure as described for the PSD Increments, the maximum from either the Plant Site receptors or the Mine Site receptors was added to the ambient background to assess total impact, since each area modeling analysis included all of Project and nearby sources. The H2H PM_{10} concentration for the five-year modeling period was used for comparison to the NAAQS PM_{10} 24-hour standard. Ambient air background concentrations were added to modeled concentrations to determine compliance with NAAQS and MAAQS. PM_{10} background concentrations represent the 2004-2006 average concentrations from the H2H 24-hour concentration and annual average concentration from the air quality monitoring site data in Virginia, Minnesota. The Tribal cooperating agencies' position is that the total impact of $PM_{2.5}$ and its relativity to the NAAQS standard might be closer than what is indicated due to several factors. Namely, $PM_{2.5}$ emissions from the tailings basin which have not been modeled, and that the location of the air quality monitoring site is upwind of the proposed project, Mesabi Nugget Project and Peter Mitchell mine so that the ambient background levels might be higher than indicated.

Table 4.6-10 Results of Class II NAAQS Modeling

Pollutant	Averaging Time	Maximum Modeled – Plant Site (ug/m^3)	Maximum Modeled – Mine Site (ug/m^3)	Background (ug/m^3)	Total (ug/m^3)	NAAQS and MAAQS (ug/m^3)
SO_2	1-hour	272	N/A	90	362	1300
	3-hour	147	N/A	25	172	915
	24-hour	37	N/A	11	48	365
	Annual	5	N/A	3	8	60
PM_{10}	24-hour	56	52	32	88	150
	Annual	11	7	15	26	50[1]
$PM_{2.5}$[2]	24-hour	14	13	20	34	35
	Annual	5	3	6	11	15
NO_X	Annual	9	2	12	21	100

[1] The annual NAAQS for PM_{10} was rescinded on October 17, 2006.
[2] The results reflect preliminary analyses, full evaluation of the analyses will be provided in the FEIS.

Class I PSD Increment Modeling Results

Maximum modeled pollutant concentrations within the BWCAW, VNP, IRNP, and RLW regions were calculated for each of three years and are provided in Table 4.6-11. As seen from the table all of the concentrations, except for the 24-hour PM_{10} concentrations at BWCAW, are below their respective Class I SIL threshold, indicating that for these pollutants and averaging times, no significant impacts are predicted. The exceedence of the PM_{10} 24-hour Class I SIL at BWCAW does not indicate there is a significant impact, rather, a cumulative analysis must be considered. The Tribal cooperating agencies also note that a Class 1 Increment Analysis is still needed for $PM_{2.5}$ and that it should be included for the DEIS. The cumulative analysis for this pollutant and averaging period is reflected in Section 4.6.4.3.

Table 4.6-11 Summary of PSD Class I Increment Analysis

Pollutant	Averaging Period	Year Evaluated 2002	2003	2004	Max (ug/m^3)	Class I Inc (ug/m^3)	Class I SIL (ug/m^3)
Boundary Waters Canoe Area Wilderness							
SO_2	3-Hour	0.444	0.532	0.511	0.532	25	1
	24-Hour	0.118	0.123	0.121	0.123	5	0.2
	Annual	0.007	0.009	0.007	0.009	2	0.1
NO_2	Annual	0.045	0.054	0.045	0.054	2.5	0.1
PM_{10}	24-Hour	0.458	0.480	0.519	0.519	8	0.3
	Annual	0.034	0.040	0.031	0.040	4	0.2
Voyageurs National Park							
SO_2	3-Hour	0.056	0.063	0.072	0.072	25	1
	24-Hour	0.019	0.018	0.028	0.028	5	0.2
	Annual	0.001	0.001	0.001	0.001	2	0.1
NO_2	Annual	0.005	0.006	0.005	0.006	2.5	0.1
PM_{10}	24-Hour	0.114	0.127	0.217	0.217	8	0.3
	Annual	0.007	0.007	0.007	0.007	4	0.2
Isle Royale National Park							
SO_2	3-Hour	0.006	0.006	0.007	0.007	25	1
	24-Hour	0.002	0.002	0.002	0.002	5	0.2
	Annual	0.000	0.000	0.000	0.000	2	0.1
NO_2	Annual	0.001	0.001	0.001	0.001	2.5	0.1
PM_{10}	24-Hour	0.033	0.046	0.030	0.046	8	0.3
	Annual	0.002	0.002	0.002	0.002	4	0.2
Rainbow Lakes Wilderness							
SO_2	3-Hour	0.015	0.015	0.011	0.015	25	1
	24-Hour	0.007	0.005	0.006	0.007	5	0.2
	Annual	0.000	0.000	0.000	0.000	2	0.1
NO_2	Annual	0.001	0.001	0.001	0.001	2.5	0.1
PM_{10}	24-Hour	0.063	0.046	0.050	0.063	8	0.3
	Annual	0.003	0.003	0.003	0.003	4	0.2

Class I Areas-Air Quality Related Values Impact Analysis

An air quality modeling analysis was conducted to estimate impact of the Project on air quality in Class I areas. The analysis addressed visibility impacts to the BWCAW, VNP, and IRNP. The Class I AQRV analyses also included sulfur and nitrogen deposition and SO_2 impacts on soils, water, and vegetation. The results are discussed below.

Class I Visibility/Regional Haze Analysis

A visibility/regional haze impact analysis was carried out for BWCAW, IRNP, and VNP. The recommended methodology for assessing visibility impacts according to the Federal Land Managers' (FLM) Air Quality Related Values Work Group (FLAG) guidance involves the use of CALPOST to process the data on concentrations of pollutants from the CALPUFF modeling of 24-hour emissions. In CALPOST, a daily value of light extinction is defined by the concentrations of each pollutant that can affect visibility, taking into account the efficiency of each particulate type in scattering light, and the relative humidity which influences the size of sulfates and nitrates. The FLM has established threshold changes in light extinction (Δb_{ext}) as a percentage of natural background that are believed to represent potential adverse impacts on visibility. These thresholds are 5 percent (a potentially detectable change) and 10 percent (a level that may represent an unacceptable degradation).

Table 4.6-12 presents results of the initial CALPUFF visibility analysis following the current FLAG methodology. The data in Table 4.6-11 indicate that calculated visibility impacts greater than 5 or 10 percent could occur at some point within the BWCAW on a small number of days each year. The Tribal cooperating agencies also note that a Class 1 Area Visibility impact is still needed for $PM_{2.5}$ and that it should be included for the DEIS. As a result, a culpability study was conducted, as recommended by the FLM for BWCAW, to assess the significant contributing sources to the visibility impacts greater than 5 percent visibility degradation and potential emission reductions to reduce these impacts.

Table 4.6-12 Class I Area Visibility Results for Project (Method 2 Analysis)

Class I Area and Meteorological Data Year	Days with ≥5% Visibility Impact	Days with ≥10% Visibility Impact	Maximum Δb_{ext} (%)
BWCAW 2002/2003/2004	23/11/8	1/0/0	14.68/9.22/8.95
VNP 2002/2003/2004	0/0/0	0/0/0	3.78/3.90/4.50
IRNP 2002/2003/2004	0/0/0	0/0/0	1.22/1.12/1.05

The data in Table 4.6-12 indicate that calculated visibility impacts greater than 5 or 10 percent could occur at some point within the BWCAW on a small number of days each year.

At the time of the DEIS, no culpability study has been conducted for the impacts presented in Table 4.6-12. However, a culpability study was conducted for previous modeling analysis. Based upon the original modeling reported in February 2008 (Barr 2008, Class I Areas Air Dispersion Modeling), approximately 34 percent of the worst-case day impacts were associated with the space heaters at the Plant Site, primarily due to NO_x emissions. The Tribal cooperating agencies position is that NOx emissions from the locomotives are predicted to account for 26 percent of the worst cause day impacts as well. Potential mitigation measures to reduce these emissions are discussed in Section 4.6.3.4.

In addition to the control measures described in Section 4.6.3.4, and since these data suggest a potential for detectable visibility degradation due to Project emissions, a cumulative analysis was carried out to better quantify and evaluate the possibility of overall visibility impacts (see Section 4.6.4).

Effects on Soils, Waters, and Vegetation

<u>Deposition of Nitrogen and Sulfur</u>

Potential impacts to soils, waters, and vegetation in Class I areas due to deposition of sulfur and nitrogen were evaluated based upon model-predicted annual deposition for the Project emissions from the Plant and Mine Sites. Criteria for assessment of deposition impacts are different for USFS areas (BWCAW and RLW) and National Park Service (NPS) areas (IRNP and VNP). The NPS has established a Deposition Analysis Threshold (DAT) of 0.01 kilograms per hectare per year for both sulfur and nitrogen deposition for Class I areas in the eastern United States. The DAT is a level below which incremental adverse impacts are not anticipated. The USFS have established "Green Line Values" for assessing impacts of deposition at BWCAW and RLW, which account for soil conditions and water chemistry in development of safe levels. The Green Line values represent the total pollutant loading below which there are no adverse impacts (Barr 2008, Comparison of Emission Levels). As such, for BWCAW and RLW, background deposition levels are added to Project impacts to assess against Green Line Values. It should be noted that current background deposition for RLW (5.88 kg/ha-yr) is at the Green Line Value range for nitrogen (5-8 kg/ha-yr). All other background deposition values for BWCAW and RLW are below their respective Green Line Values (see Table 4.6-13).

The CALPUFF results for each of the Class I areas were processed with CALPOST to calculate total annual deposition of sulfur and nitrogen at each receptor as a result of the Project emissions. Model results for annual impacts (maximum annual average emissions) were assumed in the modeling**.** Total sulfur deposition is calculated from the wet (rain, snow, fog) and dry (particle, gas) deposition of SO_2 and sulfate; total nitrogen is represented by the sum of nitrogen from wet and dry fluxes of nitric acid, nitrate, ammonium sulfate and ammonium nitrate, and the dry flux of NO_x.

Terrestrial impacts of nitrogen and sulfur deposition for the BWCAW and RLW are shown in Table 4.6-13. As stated earlier, Green Line Values (Wilderness Areas) are compared to the Project deposition plus background and the DAT values (National Parks) are compared to the Project impacts only. As seen from the table, the maximum predicted total sulfur and nitrogen deposition are all below Green Line Value ranges for BWCAW. In addition, the maximum predicted total sulfur deposition is also below the Green Line Value for RLW. However, the maximum predicted total nitrogen deposition at RLW (5.9 kg/ha-yr) is at the Green Line Value range of 5-8 kg/ha-yr. The nitrogen deposition contribution from the Project emissions is approximately one-hundredth of one percent of the total nitrogen deposition impact (0.001 kg/ha-yr).

Table 4.6-13 also summarizes the aquatic impacts from sulfur and nitrogen deposition for BWCAW and RLW. Green Line Values for aquatic impacts are based upon total sulfur deposition as well as total sulfur deposition plus 20 percent nitrogen deposition (sulfur + 20% nitrogen). Maximum predicted total S deposition and total sulfur + 20% nitrogen deposition impacts were below the Green Line Value ranges for BWCAW. As with the terrestrial impacts for RLW, the maximum predicted total S deposition and total sulfur + 20% nitrogen deposition impacts are at the Green Line Value, with nearly all of the impacts are associated with the current background level.

Table 4.6-13 Maximum Annual Deposition of Sulfur and Nitrogen from the Project in Class I Wilderness Areas (kilogram per hectare per year)

Class I Area	Project Deposition	Background Level	Total Deposition (Project + Background)	Aquatic Green Line Value	Terrestrial Green Line Value
BWCAW					
Sulfur	0.005	2.9	2.9	7.5-8.0[1]	5-7[1]
Nitrogen	0.015	4.8	4.8	-	5-8[1]
Sulfur + 20% Nitrogen	0.008	3.8	3.8	9-10[1]	-
RLW					
Sulfur	0.000	3.9	3.9	3.5-4.5[1]	5-7[1]
Nitrogen	0.001	5.9	5.9	-	5-8[1]
Sulfur + 20% Nitrogen	0.000	4.2	4.2	4.5-5.5[1]	-

[1] USFS Green Line Value (include total deposition – increment and background)

Incremental nitrogen and sulfur deposition impacts from the Project emissions are summarized in Table 4.6-14 for the two national parks, IRNP and VNP. The maximum annual predicted incremental nitrogen and sulfur deposition impacts have levels below each NPS DAT level for both IRNP and VNP. Highest impacts are predicted in the VNP with values approximately one-tenth of the incremental DAT levels.

Table 4.6-14 Maximum Annual Deposition of Sulfur and Nitrogen from the Project in Class I National Park Areas (kilogram per hectare per year)

Class I Area	Project Deposition	Auratic DAT	Terrestrial DAT
IRNP			
Sulfur	0.000	0.01[1]	0.01[1]
Nitrogen	0.000	0.01[1]	0.01[1]
VNP			
Sulfur	0.001	0.01[1]	0.01[2]
Nitrogen	0.002	0.01[1]	0.01[1]

[1] NPS DAT (includes increment deposition only)

SO_2 Impacts on Resources

Potential SO_2 impacts on flora and fauna in Class I areas were evaluated on the basis of the model-predicted concentrations from Project emissions. The USFS has set screening criteria for potential air pollution impacts on vegetation for SO_2. As stated earlier, Green Line screening values "were set at levels at which it was reasonably certain that no significant change would be observed in ecosystems that contain large numbers of sensitive components."

Though the USFS screening levels were established specifically for Class I areas administered by the Forest Service (i.e., BWCAW and RLW) it is reasonable to apply the same criteria to VNP and IRNP, which is administered by the NPS but does not have a published standard similar to the USFS. Table 4.6-15 compares CALPUFF Projections of Project impacts and existing background concentrations to the Green Line screening levels for each Class I area. The summation of Project and background contributions is well below the Green Line levels. It can therefore be concluded that there would be no threat to sensitive vegetation in Class I areas from direct SO_2 emissions produced by the Project.

There are no established screening criteria for NO_2 and PM_{10}. However, as shown in Class I Increment Modeling Results (Barr 2008), Class I area concentrations of NO_2 and PM_{10} from the Project would be below significance levels and therefore can be expected to have negligible impacts.

Table 4.6-15 Comparison of Projected Class I SO_2 Concentrations to Green Line Screening Criteria for Vegetation Impacts

Class I Area	Background (ug/m^3)	Max. NorthMet (ug/m^3)	Total (ug/m^3)	Green Line Value (ug/m^3)
	Annual	Annual	Annual	Annual
BWCAW	1.2	0.009	1.2	5
IRNP	2.0	0.000	2.0	5
RLW	1.6	0.000	1.6	5

VNP	0.7	0.001	0.7	5

Potential Estimated Human Health Risk from the Plant and Mine Sites

Plant Site AERA

An AERA was conducted for the Plant Site and results were reported in the scoping EAW (May 2005). The 2005 AERA included specific chemicals for potential evaluation (CFPE) as defined in MPCA's AERA Guidance (MPCA 2004). Project changes since May 2005 resulted in the AERA being completely revised for the DEIS. As identified in the March 2007 AERA, seventy-four CFPEs were identified in the evaluation for the Plant Site, of which 39 having reference toxicity values available were considered in the quantitative assessment (RS38A, Barr 2007). Table 4.6-16 summarizes the emissions used for the most recent assessment, but also identifies the minor changes in pollutants evaluated in the May 2005 AERA as compared to the March 2007 AERA (RS38A, Barr 2007).

It should be noted that this analysis was based upon a total particulate emission rate of 481 tpy. The Tribal cooperating agencies' position is that this analysis does not use the full particulate emission rate from the plant site, which would be 622 tpy using Table 4.6-6 with fugitive and mobile sources. Also unaccounted for are the additional 102 tpy from the tailings basin. Based upon the revision of the Project, as described in Section 3, the toxic compounds are based upon a total particulate emission rate of 183 tpy. Although the current Project utilizes LTVSMC tailings to develop a portion of the current Tailings Basin, sampling data from the LTVSMC tailings show that the toxic compounds are lower than the modeled tailings material, except for manganese, beryllium, cadmium, and antimony, even though cadmium and antimony were below sampled detection limits. However, these four compounds were not drivers in the original risk assessment.

A conservative assessment was conducted to assess the upper-limit change in health effects from the change in soil concentrations for these for pollutants. Assuming that the carcinogenic risk and hazard indices from these four pollutants were solely from the original tailings material, the ratio of the LTVSMC tailings soil concentrations to the original tailings material concentration for these four pollutants were multiplied by the total carcinogenic risk (and hazard index) for each pollutant to estimate the maximum change. The results indicated that the overall risk increased from 3.2 E -6 to 3.9 E -6 for the off-site worker receptor and from 5.3 E -6 to 6.9 E -6 for the farmer receptor, all well below 1.0 E -5 cancer risk threshold. Similarly, the overall chronic hazard index increased from 0.45 to 0.56 (off-site worker) and 0.19 to 0.24 (farmer). All chronic hazard indices are below the 1.0 significant threshold.

Estimations of risk were conducted for both the maximum exposed individual (MEI) and the reasonable maximum exposed off-site worker (RME-OSW). The MEI represents a worst-case screening assessment that is designed to represent the upper-limit bounds of potential incremental risk and assumes a continuous outdoor exposure of 24 hours per day, 365 days per year, for a period of 70 years. This screening procedure is conservative by nature and is intended as a regulatory tool to define whether more detailed analysis is warranted rather than estimating actual risk levels. The RME-OSW is designed to assess hypothetical risks to offsite workers and is based upon an outdoor exposure level of 8 hours per day, 250 days per year for a period of 25 years (USEPA 1993).

Table 4.6-16 Chemicals for Evaluation of the Incremental Human Health Risk Assessment

Chemical		March 2007 AERA	Emissions 2007 (lb/hr)	Emissions 2007 (tpy)
1,3-Butadiene	106-99-0	X	2.08E-05	9.11E-05
7,12-Dimethylbenzo(a)anthracene	57-97-6	X	1.35E-06	5.92E-06
Acetaldehyde	75-07-0	X	1.01E-03	3.62E-03
Acrolein	107-02-8	X	1.10E-04	2.31E-04
Antimony	7440-36-0	X	4.53E-04	2.04E-03
Arsenic	7440-38-2	X	8.54E-04	8.07E-02
Barium	7440-39-3	X	2.20E-02	2.97E-01
Benz(a)anthracene	56-55-3	X	7.74E-06	9.70E-06
Benzene	71-43-2	X	7.34E-03	7.40E-03
Benzo(a)pyrene	50-32-8	X	1.19E-06	1.13E-06
Benzo(b)fluoranthene	205-99-2	X	8.77E-06	3.04E-06
Benzo(k)fluoranthene	205-82-3	X	1.08E-06	1.24E-06
Beryllium	7440-41-7	X	4.88E-05	3.75E-04
Boron	7440-42-8	X	1.60E-02	1.27E-01
Cadmiun	7440-43-9	X	5.05E-03	2.22E-02
Carbon Disulfide	75-15-0	X	8.57E-01	3.75E+00
Chromium (III)	7440-47-3	[a]		
Chromium (VI)	18540-29-9	X	5.67E-05	2.48E-04
Chrysene	218-01-9	X	1.23E-05	5.26E-06
Copper	7440-50-8	X	1.86E+00	8.66E+00
Cumene	98-82-8	[a]		
Dibenzo(a,h)anthracene	53-70-3	X	1.75E-06	2.14E-06
Dichlorobenzene	25321-22-6	X	2.03E-04	8.87E-04
Formaldehyde	50-00-0	X	1.45E-02	6.11E-02
Hexane	110-54-3	X	3.04E-01	1.33E+00
Hydrogen Chloride	7647-01-0	X	1.00E+01	2.44E+00
Hydrogen Fluoride	7664-39-3	X	1.34E-03	5.85E-03
Hyrdrogen Sulfide	7783064	X	1.45E-02	6.11E-02
Indeno (1,2,3-cd)pyrene	193-39-5	X	9.33E-01	4.09E+00
Isopropyl Alcohol	67-63-0	[a]		
Lead	7439-92-1	X	2.67E-02	4.83E-01
Manganese	7439-96-5	X	9.16E-02	1.74E+00
Mercury	7439-97-6	X	9.41E-04	4.17E-03
Naphthalene	91-20-3	X	6.48E-03	1.07E-02
Nickel	7440-02-0	X	1.18E+00	5.67E+00
Oxides of Nitrogen	NA	X	5.47E+01	1.37E+02
Propylene	115-07-1	X	2.75E-03	1.20E-02
POM	NA	X	1.90E-03	1.64E-03
Selenium	7782-49-2	X	5.30-04	3.42E-03
Sulfuric Acid	7664-93-9	X	2.73E+00	1.15E+01
Toluene	108-88-3	X	3.18E-03	4.96E-03
Xylene (mixed isomers)	1330-20-7	X	1.79E-03	1.70E-03
Number of CFE			39	39
CFE Emissions			**72.78**	**177.84**

[a] Project revisions/refinements since the May 2005 AERA was prepared that now eliminate these pollutants from the list of chemicals potentially emitted from the plant processes or plant area processes.

Air dispersion modeling was conducted to assess the potential for exposure of the chemicals for evaluation (CFE), using the AERMOD model with 5 years of hourly meteorological data from the Hibbing weather station. Direct and indirect risk estimates were made for inhalation and bioaccumulative toxic pollutant ingestion, respectively, using the MPCA Risk Assessment Screening Spreadsheet (RASS). The RASS estimates potential incremental cancer and noncarcinogenic human health risks for both acute and long-term effects.

Acute risks were estimated for the ambient air at and beyond the Project boundary. Because of the historical and present mining and industrial land use around the Plant Site, the reasonable future land use for residential and farming was considered in assessing chronic risks for areas (i.e., receptors).outside of the former LTVSMC air boundary. The former LTVSMC ambient air boundary encompasses most of the industrial land use in the Hoyt Lakes area and no farmers or residents are expected to be present within this area for the foreseeable future.

The results of the Plant site assessment demonstrate that the chronic cancer and noncarcinogenic impacts were below significance thresholds and the acute noncarcinogenic health effects were also below the significance level, when adjusted for locational differences of the risk-driver maximum modeled air concentrations (RS70, Barr 2008); that is, when the hazard quotients are calculated for all pollutants at each receptor and meteorological condition modeled.

The MEI cancer risk was estimated to be 5 E -6 for farmers and 4 E -6 for a hypothetical nearby residence, which is below the Minnesota Department of Health (MDH) guidance value of 1 E -5. Similarly, the maximum RME-OSW cancer risk was predicted at 3 E -6, also below the MDH cancer risk significance level. The major risk drivers for these estimated cancer endpoints were nickel, arsenic, and cadmium compounds. The Tribal cooperating agencies position is that there are conflicting statements due to risk effects. From the 2nd paragraph of this section, "*Although the current Project utilizes LTVSMC tailings to develop a portion of the current Tailings Basin, sampling data from the LTVSMC tailings show that the toxic compounds are lower than the modeled tailings material, except for manganese, beryllium, cadmium, and antimony, even though cadmium and antimony were below sampled detection limits.* ***However, these four compounds were not drivers in the original risk assessment****.*" If cadmium is higher than what was modeled and is a major risk driver this MEI analysis could be inconclusive as it does not take into effect the latest data.

The non-cancer chronic MEI hazard index (HI) for the farmers and residences were each calculated to be 0.19, primarily from the nickel emissions. Due to the variation (i.e., each compound has a unique concentration where health effects are expected for a target organ) in estimating the health effects for noncarcinogenic effects, the hazard index is the sum of the individual ratios of the maximum concentration divided by the chemicals' reference exposure level (REL); the MDH has defined the significance value for chronic HI as 1.0. Thus, the MEIs for both farmer and residences are approximately 20 percent of the chronic significance threshold. The chronic HI for the RME-OSW was predicted to be 0.45, which is still half of the chronic significance criteria.

The results of the acute non-cancer MEI HI was predicted at the Plant Site operating boundary with a value of 1.1, as compared to the MDH's acute HI guidance threshold of 1.0. This screening value assumes the summation of the acute HIs for all pollutants regardless of their toxic endpoint (specific target organ) and the specific locations of maximum modeled air concentrations of the compounds. The risk drivers for the maximum acute MEI was NO_2 from the natural gas combustion, nickel from the Hydrometallurgical Plant, and arsenic emissions associated with fugitive dust from the Tailings Basin. When adjusting HIs for various locations (i.e., all pollutant concentrations at the same time and space), the maximum acute MEI HI was reduced to 0.9, just below the acute significance threshold.

Mine Site AERA

As with the Plant Site, an AERA was conducted for the Mine Site emissions (RS38B, Barr 2008). Emissions from the Mine Site AERA included specific chemicals for potential evaluation (CFPE) as defined in MPCA's AERA Guidance (MPCA 2007). Fifty-two CFPEs were identified in the evaluation for the Mine Site, of which 32 having reference toxicity values available were considered in the quantitative assessment (RS38B, Barr 2008). Table 4.6-17 summarizes the emissions used for this assessment.

Table 4.6-17 Chemicals for Evaluation of the Incremental Human Health Risk Assessment

Chemical[1]		**Total Mine Site Emissions (Year 8) (lb/hr)**	**Total Mine Site Emissions (Year 8) (tons/yr)**	**Total Mine Site Emissions (Year 16) (lb/hr)**	**Total Mine Site Emissions (Year 16) (tons/yr)**
1,3-Butadiene	106-99-0	0.0026	0.0113	0.0026	0.0113
Acetaldehyde	75-07-0	0.0156	0.0681	0.0156	0.0681
Acrolein	107-02-08	0.0023	0.0102	0.0023	0.0102
Antimony compounds	7440-36-0	0.004	0.0102	0.004	0.0101
Arsenic compounds	7440-38-2	0.006	0.0167	0.006	0.0164
Barium compounds	7440-39-3	0.0726	0.1862	0.0719	0.1805
Benzene	71-43-2	0.0479	0.2071	0.0479	0.2071
Benz(a)anthracene	56-55-3	6.40E-05	2.78E-04	6.40E-05	2.78E-04
Benzo(a)pyrene	50-32-8	1.63E-05	7.07E-05	1.63E-05	7.07E-05
Benzo(b)fluoranthene	205-99-2	5.85E-05	2.53E-04	5.85E-05	2.53E-04
Benzo(k)fluoranthene	205-82-3	1.52E-05	6.60E-05	1.52E-05	6.60E-05
Beryllium compounds	7440-41-7	0.0009	0.0023	0.0009	0.0023
Boron compounds	7440-42-8	0.0857	0.2041	0.0876	0.2092
Cadmium compounds	7440-43-9	0.003	0.0078	0.003	0.008
Chrysene	218-01-9	8.45E-05	0.0004	8.45E-05	0.0004
Copper compounds	7440-50-8	0.368	1.0932	0.384	1.1527
Dibenzo(a,h)anthracene	53-70-3	2.18E-05	9.53E-05	2.18E-05	9.43E-05
Formaldehyde	50-00-0	0.0349	0.1522	0.0349	0.1522
Indeno(1,2,3-cd)pyrene	193-39-5	2.56E-05	0.0001	2.56E-05	1.11E-04
Lead compounds	7439-92-1	0.0776	0.1859	0.0794	0.1908
Manganese compounds	7439-96-5	1.2153	3.1822	1.2386	3.2406
Mercury compounds	7439-97-6	7.35E-05	3.18E-04	7.34E-05	3.18E-04
Naphthalene	91-20-3	0.0092	0.0397	0.0092	0.0397
Nickel compounds	7440-02-0	0.2522	0.6862	0.2522	0.6775
Oxides of Nitrogen (NO_x) as NO_2	NA	30.3425	611.2	30.3425	611.2
Propylene	115-07-1	0.1584	0.6841	0.1584	0.6841
Selenium compounds	7782-49-2	0.0096	0.0273	0.0096	0.027
Sulfuric Acid Mist (mixture with SO_3)	7664-93-9	0.0075	0.0325	0.0075	0.0325
PCDD/PCDF (TEQ basis)[2]	NA	5.46E-09	2.36E-08	5.46E-09	2.36E-08
Toluene	108-88-3	0.0172	0.0743	0.0172	0.0743
Vanadium (as vanadium oxide)	7440-62-2	0.0459	0.1194	0.0458	0.117
Xylene (mixed isomers)	1330-20-7	0.0118	0.0512	0.0118	0.0512
Number of CFE	32				
CFE Emissions		32.8	618.2	32.8	618.3

[1] Worst case Mine Site Emissions were identified to occur in Year 8 and in Year 16. Quantitavtive risks were estimated for both the Year 8 and the Year 16 emission scenario. Additional details on the emission estimates are provided in EIS Report RSS7B (October 2007) and reformatted spreadsheet (December 2007).

[2] PCDD/PCDF (TEQ, I-TEQ basis) is the same as 2,3,7,8-TCDD equivalents presented in Table 2-1

Estimations of risk were conducted for the MEI for both residential and farmer. As stated earlier, the MEI represents a worst-case screening assessment that is designed to represent the upper-limit bounds of potential incremental risk and assumes a continuous outdoor exposure of 24 hours per day, 365 days per year, for a period of 70 years.

Similar air dispersion modeling was conducted to assess the potential for exposure of the CFE, using the AERMOD model with 5 years of hourly meteorological data from the Hibbing weather station. The assessment was conducted for the Years 8 and 16 of operation. Direct and indirect risk estimates were made for inhalation and bioaccumulative toxic pollutant ingestion, respectively, using the RASS.

Acute risks were estimated for the ambient air at and beyond the Mine Site property boundary. Because of the historical and present mining and industrial land use around the Mine Site, the reasonable future land use for residential and farming was considered in assessing chronic risks for areas (i.e., receptors).outside of the former LTVSMC air boundary. The former LTVSMC ambient air boundary encompasses most of the industrial land use in the Hoyt Lakes area and no farmers or residents are expected to be present within this area for the foreseeable future.

The results of the Mine Site assessment demonstrate that the chronic cancer and noncarcinogenic impacts from direct exposure (inhalation) using the Mine Site property boundary were below significance thresholds and the acute noncarcinogenic health effects were also below the significance level (RS38B, Barr 2008). The maximum MEI cancer risk occurred from the assessment of Year 16 emissions with a maximum value of 4 E -6, which is below the MDH guideline value of 1 E -5. The maximum sub-chronic and acute non-cancer MEI were calculated to be 0.003 and 0.2 respectively, which are both well below the MDH guidance of 1.0.

The MEI multi-pathway (direct + indirect) cancer risk estimated was estimated to be 3 E -5 for farmers using the LTVSMC boundary. This is above significance the MDH guidance of 1 E -5. The major risk drivers were due to indirect exposure (i.e. ingestion from home grown crops) of dioxins, indeno(1,2,3-d,e)pyrene, and dibenzo(a,h)anthrezene. It should be noted that maximum risk is located at the LTVSMC boundary. The nearest small farms are located approximately 6.5 miles from the Mine Site. Due to the climate, terrain, predominance of forest vegetation and low fertility of the soil in the vicinity of the Mine Site suggest that it is unlikely that future farming would be developed in the area of the maximum MEI. The Tribal cooperating agencies' position is that regardless of the likelihood of farming being present at the boundary of the installation, the farm that is 6.5 miles away still might be within an area of exceedence of the MDH standard even though it is not at the maximum risk receptor point and must be evaluated to all direct and indirect toxic health risks associated with this project. It is also the position of the Tribal cooperating agencies that all risks outside the project boundaries need to be below MDH guidelines at the time that an air permit is issued to this facility. Thus, the inhalation MEI due to direct exposure (inhalation only) would be representative at the MEI location at the LTVSMC boundary.

The MEI multi-pathway cancer risk for a hypothetical nearby residence was 7 E -7, which is below the MDH guidance value of 1 E -5. The major risk drivers for these estimated cancer endpoints were nickel compounds.

Greenhouse Gases

The issue of climate change and anthropogenic greenhouse gas emissions is a complex and evolving topic from both a scientific and regulatory standpoint. Global atmospheric temperature largely shapes our earth's climate based upon the changes of the intensity of the solar radiation from the sun. The climate is primarily regulated by the presence of greenhouse gases and particulates that trap heat inside the earth's atmosphere or shade it from the sun, resulting in solar intensity. Natural conditions and anthropogenic emissions can also affect the solar intensity (Barr 2009, NorthMet Project Greenhouse Gas and Climate Change Evaluation Report).

Greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Over geologic history, changes in climate have been strongly linked to changes in greenhouse gas levels in the earth's atmosphere, where higher temperatures generally occur during periods of higher atmospheric CO_2 levels and lower temperatures generally corresponding to lower atmospheric CO_2 levels. The impacts of climate change are described below and are based upon the most current data sources available at the time of this writing (July 2009).

According to the Intergovernmental Panel on Climate Change (IPCC), evidence has lead the majority of scientists to conclude with 99% certainty that human activities, particularly the burning of fossil fuels, have resulted in increases in the concentrations of greenhouse gases in the earth's atmosphere since preindustrial times. Similarly, scientists can conclude that because the major greenhouse gases emitted by humans are known to have atmospheric residence times on the order of tens to hundreds of years, atmospheric greenhouse gas levels will continue to rise over the next few decades. The body of evidence has lead scientists to conclude with 99% certainty that higher levels of atmospheric greenhouse gas tend to warm the planet. Globally, an "unequivocal" warming of 1.0 to 1.7°F occurred over the last 100 years (MnDNR 2009, Crossroads of Climate Change). The past 100 years have seen global average temperature increases of about 1.5^{o}F. The global average temperature has increased by about 1.2 to 1.4^{o}F since 1890, with the ten warmest years of the past century occurring between 1997 and 2008 (NASA 2008). Warming is observed over the world's oceans and in both the Northern and the Southern hemispheres.

The IPCC's most recent report (IPCC 2007) Projects that, under a business-as-usual scenario, globally averaged surface temperature will increase by 2.5 to 10.4°F between 1990 and 2100. A 2.5°F increase in temperature would be a relatively mild outcome, but a 10.4°F increase in temperature would be severe.

The observed increases in global average surface temperature may also be seen in the records of average annual temperatures at the regional and state level. Over the past century, temperatures in the United States have risen at an average rate of 0.11°F per decade, with the past 25 years showing temperature increases of approximately 0.56^{o}F per decade (NOAA 2007). The annual average temperature of Minnesota has increased approximately 1^{o}F in the last century, from 43.9°F (1888-1917 average) to 44.9°F (1963-1992 average) (MPCA 2009, Global Climate Change and Its Impacts on Minnesota). The winter season has brought even more dramatic increases of up to five degrees in parts of northern Minnesota (MPCA 2009, Global Climate Change). Much of the warming observed in Minnesota has occurred over the last few decades. The observed rate and total increase in temperatures appear more extreme when the more recent years on record are averaged. For example, the observed trend in warming is more than 5°C when average statewide temperatures from only 1980 to the present are considered (MnDNR 2009, Crossroads of Climate Change).

Minnesota is situated in a unique location that makes it particularly vulnerable to the potential effects of climate change. Climate changes in temperature can modify other meteorological conditions, such as precipitation patterns and shifts in seasons, which could affect forest ecosystems, water resources, other unique ecosystems, agriculture, and human health over the next century. Future emission scenarios, using global climate models (GCMs) Project a rise from 10-20 percent increase over the next century in the Great Lakes Region (UCSUSA 2009). This may also affect the seasonal variability with the winter and spring seasons having increases of 15 percent and the summer season decreasing by as much as 50 percent.

Although it is less certain, water resources could be affected by the climate change patterns. Due to increased temperature, evaporation will likely increase which could reduce levels in lakes, rivers and stream levels up to 12 inches (MnDNR 2009, Crossroads of Climate Change). Increased precipitation could also affect flooding conditions. In addition, severe weather patterns could be affected, resulting in maximum 25 and 100-year precipitation events and flood patterns.

Warmer temperatures may shorten winter seasons, resulting in decreased ice cover on the lakes and streams, as well as early ice breakup in the spring. In addition, water temperatures are likely to rise, which could cause concerns with aquatic ecosystems, and lead to increase algal blooms.

If increased evapotranspiration is not returned to the state, Minnesota's climate will become drier, which could replace the forests with prairie ecosystems (MPCA 2009, Global Climate Change and Its Impacts on Minnesota). Minnesota's forested areas could decrease by 50 to 70 percent (MPCA 2003, Climate Change Action Plan). On the other hand, if increased precipitation occurs, resulting in a wetter climate, the current conifers would be replaced with hardwood trees due to adaption. Pine, birch, and maple forests will be replaced with oak, elm, and ash.

Minnesota's wetland and bog ecosystems may also face changes due to increase precipitation. Variation in wet periods, dry periods, and severe storm frequency could lead to changes in wetland type and distribution includes wetland losses in some area and wetland gains in other areas.

Changes in Minnesota's climate could have serious implications for agriculture in the state. Increasing temperatures and the resulting increased rates of evaporation decrease soil moisture and ultimately increase the demand for irrigation. This could exacerbate the strain already placed on water supplies by warming, and lead to further deterioration of water quality (MPCA 2009, Global Climate Change and Its Impacts on Minnesota).

Human health-related concerns could be exacerbated by changes in Minnesota's climate, including heat-related illnesses and premature deaths. A Minneapolis study indicates the possibility of a 3^{o}F summer warming could coincide with a tripling of heat-related deaths in Minnesota (MPCA 2009, Global Climate Change and Its Impacts on Minnesota).

In a recent study (Tagaris 2009), predicted changes due to climate change on $PM_{2.5}$ and ozone ambient levels indicated that in the Minnesota region, $PM_{2.5}$ concentrations would increase significantly, while regional ozone concentrations may decrease. The study also showed that the overall premature mortality rates from the impacts would increase due to the overwhelming increases in $PM_{2.5}$.

Warming trends also increase the likelihood of insect-borne illnesses, by creating more potential habitats for insects such as mosquitoes. Malaria, dengue fever, and yellow fever are all transported by mosquitoes, whose territory climate change could effectively expand northward into Minnesota.

In view of the potential impacts due to climate change and the overall global interest, the USEPA has recently proposed a rule that requires mandatory reporting of greenhouse gas emissions from large sources in the United States. In general, USEPA proposes that suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of greenhouse gas emissions submit annual reports to USEPA. The gases covered by the proposed rule are CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and other fluorinated gases including nitrogen trifluoride (NF_3) and hydrofluorinated ethers (HFE). The proposed rule would require the first annual GHG emission report to be submitted on March 31, 2011, for 2010 emissions.

In response to the 2007 supreme court ruling 549 U.S. 497 (2007), Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the CAA were signed by the EPA administrator on April 17, 2009 and was open for public comment for a 60 day period following publication in the Federal Register. The proposal makes two findings regarding greenhouse gases under section 202(a) of the CAA. The Administrator is proposing to find that the current and projected concentrations of the mix of six key greenhouse gases in the atmosphere threaten the public health and welfare of current and future generations. The Administrator is further proposing to find that the combined emissions of CO_2, CH_4, N_2O, and HFCs from new motor vehicles and motor vehicle engines contribute to the atmospheric concentrations of these key greenhouse gases and hence to the threat of climate change.

In addition, the U.S. Congress is considering legislation to mandate a cap-and-trade program for greenhouse gas emissions nationally. Currently, the House has approved a version of the bill and the Senate is in debate.

At the state level, efforts to curb statewide and regional greenhouse gas emissions are underway. More than half of U.S. states have joined in regional efforts to reduce greenhouse gas emissions. Minnesota has committed (along with Illinois, Iowa, Kansas, Michigan, and Wisconsin) to long term greenhouse gas reduction targets of 60 to 80 percent below current emission levels as part of the Midwestern Greenhouse Gas Reduction Accord. Participants have agreed to pursue the implementation of a regional cap and trade system as well as a consistent regional greenhouse gas emissions tracking system.

In May 2008, the Governor of Minnesota signed legislation requiring the Minnesota Department of Commerce and the MPCA to track greenhouse gas emissions and to make interim reduction recommendations toward meeting the state’s goal of reducing greenhouse gas emissions to a level at least eighty percent below 2005 levels by 2050. Developments in Minnesota’s climate change and greenhouse gas policy will likely continue to take shape as Minnesota strives to meet the greenhouse gas reduction goals established in the Next Generation Energy Act.

In addition to policies directed at reducing statewide greenhouse gas emissions, Minnesota has recently instituted policies requiring the evaluation of greenhouse gas emissions as a part of the environmental review process for certain Projects that require stationary source air emissions permits. In July 2008, MPCA issued a General Guidance for Carbon Footprint Development in Environmental Review. The MPCA guidance requests that Project proposers, in the course of environmental review under the MEPA, prepare a greenhouse gas inventory for proposed Projects that will require stationary source air emissions permits. The purpose of the inventory is designed to encourage proponents to not only identify emission sources of greenhouse gases, but to evaluate each source in determining whether reductions (either in design or control) in the greenhouse gases have been incorporated into the Project.

Next to water vapor, CO_2 is the second-most abundant greenhouse gas and would be the primary greenhouse gas that would likely be emitted from the Project. CO_2 emissions from the Project are a function of fuel consumption and the use of limestone for neutralization (Barr 2009, NorthMet Project Greenhouse Gas and Climate Change Evaluation Report). Smaller quantities of CH_4 and N_2O emissions are a result of combustion emissions from the various processes. No HFC, PFC, or SF_6 emissions are expected from the Project.

It is estimated that the Project would potentially directly emit approximately 256,215 metric tons of CO_2-equivilent emissions (48,249 metric tons from the Mine Site and 207,967 metric tons from the Plant Site) or 0.25 million metric tons per year. The estimated direct CO_2 emissions do not account for any CO_2 removal from atmosphere that would occur through vegetation uptake, absorption, or other removal mechanisms. Potential indirect greenhouse gas emissions, primarily related to power production for the Project are estimated at 687,000 metric tons of CO_2-equivilent emissions (0.69 million metric tons per year). The Tribal cooperating agencies' position is that these emissions will have an effect on the Midwestern Greenhouse Gas Reduction Accord and their impact needs to be analyzed as to that effect.

Secondary impacts from the change in existing land cover can have the potential to emit carbon-trapped emission and the loss of carbon sequestration of CO_2 from the environment. Project impacts on cover types at the Mine Site, Tailings Basin, and rail road areas will range from removal of existing cover types to changes in existing land cover. The Mine Site consists almost entirely of native vegetation covering 3,016 acres. The primary cover types at the Mine Site are mixed pine-hardwood forest on the uplands and black spruce swamp/bog in wetlands. Aspen, birch, Jack pine, and mixed hardwood swamp comprise the remaining forest on the site. Impacts to vegetative cover types and species occur through clearing, filling, and other construction activities.

Wetland impacts occur primarily through excavation, filling, and other activities that result in wetland loss or loss of wetland functions. Approximately 850 acres of wetland resources will be directly impacted by the Project. Wetland impacts are expected to occur primarily at the Mine Site. Coniferous bog (Eggers and Reed Wetland Classification) is the most common type of wetland community that would be impacted (509 acres at the Mine Site), followed by open bog communities (76 acres at the Mine Site), coniferous swamp (62 acres at the Mine Site) and alder thicket (65 acres at the Mine Site). The Tribal cooperating agencies' position is that data from the wetland delineations suggest that bogs are *not* the most prevalent wetland type, and that forested rich peatlands and poor fens are the most prevalent. See language in the wetland section for particulars. However, while wetlands do sequester carbon in biomass, the anaerobic decomposition that occurs in wetlands and peatlands results in the release of carbon as methane.

Current research indicates that wetlands with permanently pooled water are net carbon sources due to methane production. Although it is difficult to quantify the amount of CO_2-equivilent emissions from the disturbance of these wetlands, the disturbance will not only allow for a relatively rapid release of these emissions, it also diminishes the potential for carbon sequestration.

Project impacts on non-wetland cover types are expected to occur primarily at the Mine Site and will include 459 acres of impacted mixed pine-hardwood forest, 84 acres of impacted Jack pine forest, 86 acres of impacted aspen forest/aspen-birch forest, and 245 acres of impacted grass/brushland. Forest clearing and disturbance may result in the loss of carbon sequestered in belowground biomass, in aboveground leafy biomass, and in aboveground woody biomass. The timescale of carbon lost from forest biomass depends on the end use of this material. Clearing and burning will result in a relatively rapid release of carbon to the atmosphere whereas manufacture of long-lived forest products such as lumber will delay the release. Because carbon accumulation in forest and grassland ecosystems occurs relatively quickly, afforestation, reforestation, and grassland restoration may offset forest disturbance over relatively short timescales.

The potential to minimize and mitigate greenhouse gases associated with secondary impacts from the change in existing land cover (i.e., release of carbon trapped emissions and the loss of carbon sequestration of CO_2 from the environment) is discussed in Section 4.6.3.4.

The Project will result in impacts to wetlands, forests, and other cover types that are likely to affect carbon storage and sequestration in these ecosystems. Although a quantitative assessment could not be conducted, proposed reclamation and mitigation activities described below can work to offset carbon losses caused by Project impacts.

Greenhouse gas reduction measures: PolyMet proposes to reduce greenhouse gases associated with the Project and decrease the carbon intensity of production by improving both energy and production efficiency. The potential to minimize and reduce greenhouse gases from change in existing land cover (i.e., release of carbon trapped emissions and the loss of carbon sequestration of CO_2 from the environment) is also discussed. The following provides a summary of the reduction measures.

PolyMet has chosen to select a hydrometallurgical process rather than a pyrometallurgical process which results in an expected reduction in energy usage. The use of the hydrometallurgical process is expected to reduce the energy demand by 50 percent over comparable pyrometallurgical processes. The resultant carbon intensity for this process, defined as the ratio of the carbon emissions to the unit production, is estimated at 0.24.

In addition, PolyMet will purchase premium efficiency motors rather than standard motors. Motor efficiencies will typically vary between 85 percent and 96 percent, depending upon the size and load of the motor. Gravity transport of process slurries will also be used where possible, instead of pumps. PolyMet intends to configure the Process Plant such that the overall power factor for the facility is as close to one as practical.

The primary production excavators and two of the three blast-hole drills would be electric rather than diesel powered, eliminating a direct source of greenhouse gas emissions. Instead of employing used conventional locomotives, PolyMet would purchase new Gen-Set locomotives, which are more efficient and use less fuel. Space heating in the Process Plant is a major contributor to total direct greenhouse gas emissions and PolyMet would employ natural gas-fired heaters, which emit less CO_2-equivalent emissions than other fuels in order to minimize these emissions.

PolyMet evaluated additional methods to reduce greenhouse gas emissions, but were found to be infeasible for the Project. These included electric drive mine haul trucks, electric locomotives, newer mill technology, flotation alternatives, smelting process, and the use of waste heat from autoclaves for space heating.

To mitigate greenhouse gas impacts associated with change in existing land cover (i.e., secondary impacts), PolyMet would undertake a compensatory mitigation for reasonably foreseeable impacts to wetlands. The primary goal of the planned wetland mitigation is to restore high quality wetland communities of the same type, quality, function, and value as those impacted by the Project. Given site limitations and technical feasibility, it is impracticable to replace all impacted wetland types with an equivalent area of in-kind wetlands. According to the PolyMet Mining Wetland Mitigation Plan (RS20T, Barr 2007) 1,123 acres of off-site wetland restoration mitigation have been planned. This mitigation will take place primarily at two sites in Northern Minnesota. Assuming a 1.25:1 replacement ratio for wetlands of the same type, a 1.5:1 ratio for wetlands of different types and 1:4 ratio for upland buffer, off-site mitigation is expected to provide direct compensatory wetland mitigation for projected impacts. In terms of total area, offsite mitigation acreage is expected to exceed impacted acreage for all wetland types except for Type 8 (open bog and coniferous bog). In terms of total compensated impacts, mitigated acres of wetland Type 1 (seasonally flooded), Type 2 (fresh wet meadow and sedge meadow), Type 3 (shallow marsh), Type 4 (deep marsh), Type 5 (shallow, open water), Type 6 (shrub-carr and alder thicket) and Type 7 (hardwood swamp and coniferous swamp) would exceed Project impacts on wetlands of these types. This additional mitigation of wetland types other than Type 8 (open and coniferous bog) will contribute to compensating for the Project's impacts on Type 8 wetlands. The Tribal cooperating agencies' position is not all wetlands are created equal in terms of carbon uptake and that the incorrect classified Type 8 (open bog and coniferous bog) are forested rich peatlands. With the wetland mitigation not restoring that particular type of lost wetland there is a net decrease in carbon uptake for GHG emissions even with the increase ratio of wetland mitigation.

Mercury Deposition

Total potential mercury emissions to air are estimated to be 8.3 lbs/year. The primary source of air emissions is expected to be two emission units that are part of the hydrometallurgical process: the autoclave vents and the autoclave flash vents. The combined air emissions from these two units are estimated to be 7.9 pounds per year. Most of the remaining estimated mercury emissions (0.4 pounds per year) are from natural gas used to fuel a package boiler and for space heating. Less than 0.1 pounds per year are estimated to be released by the mining, crushing, and milling processes and through wind erosion from the tailings basin. Additional information regarding each of these emission sources is summarized in *RS66 Facility Mercury Mass Balance Analysis* (Barr 2007). Overall, about 95 percent of the mercury originating in the ore is expected to remain within—or be adsorbed to—the flotation tailings and the hydrometallurgical residue, where it would remain isolated from further transport to the environment. The Tribal cooperating agencies' position is that the geotechnical stability of the tailings basin is in question and that pending catastrophic failure of the tailings dams and therefore the hydromet cells within the tailings basin would release this mercury into the environment and that that impact must be analyzed.

The low percentage of estimated mercury release to the air is primarily because (1) the moderate process temperatures in the autoclave (less than 500^{o} F) are below the temperatures at which most mercury is volatilized to air from the concentrate and (2) the oxidizing conditions in the autoclave would likely cause most of the mercury that is released to be in either the oxidized (Hg^{+2}) or particle bound (Hg(p)) form. Oxidized mercury is water soluble and would likely be efficiently captured in the facility's wet scrubber system. Particle bound mercury would be collected in any device designed to control particulate emissions, such as the autoclave scrubber system. As a result, most of the mercury emitted would be expected to be in the elemental (Hg0) form. Detailed calculations for all Process Plant emission units are provided in RS57A *Stationary Point and Fugitive Source Emission Calculations for the NorthMet Project Plant Site* (Barr 2007).

An evaluation was conducted on the potential deposition of mercury related to the Plant Site air emissions to assess the Project's potential effects upon mercury concentrations in fish and the potential health risks to a hypothetical recreational fisher as well as a subsistence fisher consuming locally-caught fish. The Plant Site's potential mercury air emissions were evaluated as they represent essentially all of the Project related mercury air emissions (RS61, Barr 2007). The Mine Site AERA did not assess potential local Hg deposition because potential emissions are less than one lb/yr (RS38A, Barr 2008).

The analysis was conducted for Heikkilla Lake, north of the Plant Site, using the MPCA's mercury risk estimation method (MMREM) to assess the potential incremental change in fish mercury concentrations and the potential incremental risks to human health. Two emission scenarios were evaluated for the local deposition analysis. In one scenario, it was assumed that 80 percent of the mercury would be in the elemental form, 10 percent in oxidized form, and 10 percent particle bound (RS61, Barr 2007). In the second scenario, it was assumed that 25 percent of the mercury would be in the elemental form, 50 percent in oxidized form, and 25 percent particle bound. The second emissions scenario is considered a worst-case estimate because wet scrubbers on the Hydrometallurical Plant would be expected to capture most of the particle-bound and oxidized mercury and the majority of the mercury would likely be elemental (RS61, Barr 2007). The Mine Site AERA did not assess potential local Hg deposition because potential emissions are less than one lb/yr.

For the worst case emissions scenario (50 percent oxidized mercury), the analysis estimated that the maximum potential incremental increase in mercury concentrations in the fish is 0.015 ppm, which is an order of magnitude lower than the mercury background concentrations estimated for Heikkilla Lake (0.65 ppm), which produce a risk quotient above 1.0 without any incremental increase, a common occurrence in a number of lakes in Minnesota. This accounts for a state-wide mercury Total Maximum Daily Load (TMDL), described below, being required that seeks to reduce deposition everywhere. The projected incremental risk quotient for a recreational or subsistence fisher is 0.07 and 0.33, respectively. These risks are below the MDH incremental risk guideline level of 1.0. Therefore, no significant impacts are expected from potential mercury deposition from the Project.

However, as part of the DEIS, a cumulative assessment of mercury emissions has been conducted at the request of the state. The results of this analysis have been addressed in Section 4.6.4.

In addition, in June, 2008, a stakeholders group made recommendations for reduction of mercury emissions in order to meet the state's Mercury TMDL standard required by federal regulations. In July, 2008 and June, 2009 specific recommendations were developed to limit the mercury emissions from new and expanding sources in order to meet the TMDL goal of 789 lb/year statewide by 2025. These recommendations include:

- Define and achieve best available control on mercury emitting sources;
- Conduct environment analysis for Project and cumulative impacts (included in the DEIS);
- New sources must seek and secure offsets on a 1:1 ratio with existing sources within the state;
- If no offsets are available, sources must develop a plan to achieve emission reductions of at least 90% by 2025 and secure offsets for any remaining increases; and
- The reductions will be enforceable by the MPCA permitting process.
- New or expanding facilities expecting to emit more than 3 lb/year will arrange for a reduction equal to the new emissions from existing sources in the state. These reductions must be beyond those otherwise required in the state's mercury emission reduction plan for existing sources.
- If equivalent mercury reductions from other facilities with Minnesota can not be identified, an alternative mitigation strategy must be developed in lieu of the in-state emission reduction requirements.

PolyMet will be required to meet these requirements as part of their permit application review process by the MPCA. PolyMet has developed a strategy for minimization and mitigation of mercury emissions utilizing best control of facility emissions. The strategy for minimization and mitigation of mercury emissions is discussed in Section 4.6.3.4.

4.6.3.2 No Action Alternative

Since this alternative would not involve introducing new emission sources, the No Action Alternative would have no air quality impacts either regionally or locally. Therefore, air quality would be substantially similar to existing conditions.

4.6.3.3 Mine Site Alternative

Relative to air quality issues, the Mine Site Alternative would require some additional "double handling" of waste rock, which could result in some additional vehicular and fugitive emissions at the Mine Site. Another element of the alternative is the addition of lime or limestone to the temporary stockpiles to neutralize acid formation prior to subaqueous disposal in the pit. Additional emissions due to the use of lime or limestone have been shown to be minimal.

As a result, the primary difference between this alternative and the Proposed Action is the variation of the haul traffic volumes for each year of the mining operations at the Mine Site. Since the haul truck fleet for this alternative is not expected to change from that of the Proposed

Action, an evaluation of the change in annual haul traffic volumes can be used to assess the impacts for this alternative. An analysis was conducted for each year of the mining operation to calculate the total annual ton-miles for both the Proposed Action and this alternative. Ton-miles (product of tons hauled and haul distance) was used as an indicator of truck traffic levels and associated emissions.

Based upon the analysis, the maximum annual haul truck ton-miles from the Proposed Action is estimated at approximately 135,516,400 ton-miles/year in Year 16. The maximum annual haul truck ton-miles from this alternative is estimated at approximately 134,488,200 ton-miles/year in Year 13. It should be noted that even though this alternative would have increased haul truck ton-miles over the lifetime of the Project, the annual maximum truck volume for this alternative is less than the maximum annual traffic volume used to assess maximum impacts in the Project analysis. As a result, the modeling analysis conducted for the in-pit disposal phase of the Project (Year 16) would be a conservative representation of the impacts associated with this alternative. Thus, the air quality impacts from the Mine Site Alternative would be similar to that of the Proposed Action and would, therefore, not have any significant air quality impacts.

4.6.3.4 Tailings Basin Alternative

The Tailings Basin Alternative has been developed for evaluation in the DEIS. This alternative involves the placement of wells and pumping equipment on the benches of the existing tailings basin and installation of a pipeline from the Tailings Basin to the Partridge River downstream from Colby Lake. Although there would be increased material added to the rock buttress construction in this alternative, the construction year does not coincide with the worst-case emissions year for the overall Project. In addition, the worst-case hourly and daily emissions would be identical to the Proposed Action. Therefore the air quality impacts from the Tailings Basin Alternative would be similar to that of the Proposed Action and would, therefore, not have any significant air quality impacts.

4.6.3.5 Mitigation Measures

Although no significant direct Project air quality impacts were identified in preparation of this DEIS, if during permitting it is determined that mitigation measures are necessary, the following measures could be considered.

PolyMet has proposed the following mitigation measures to reduce air quality impacts associated with Class I Area visibility. Although no significant impacts are expected from potential mercury deposition from the Project, PolyMet has developed a minimization and mitigation strategy for mercury emissions utilizing best control of facility emissions. Since mercury can be emitted as particulates (particle bound form), a fugitive dust control measure has also been developed as part of the mitigation strategy for mercury deposition. These minimization and mitigation measures are discussed below:

- ***Class I Area visibility mitigation measures*:** The Class I Area visibility analysis performed for the Project indicate that calculated visibility impacts greater than 5 or 10 percent could occur at some point within the BWCAW on a small number of days each year (Table 4.6-12). Air quality modeling analysis performed in February 2008 showed that NO_x emissions from the locomotives are predicted to account for 26 percent of the worst-case day impacts. As such, possible mitigation measures to reduce these emissions include the replacement of the older locomotives for newer, lower emitting engines. PolyMet proposes to replace the locomotives with gen-set units that will meet USEPA Tier-III emission requirements and are a viable mitigation measure for this Project. The use of the gen-set locomotives will result in improved fuel efficiency as well as reduced emissions, and ultimately reduced visibility impacts in Class I Areas. The air quality modeling results reported in this DEIS reflect the use of the gen-set locomotives.

PolyMet evaluated other potential mitigation measures to reduce NO_x emissions, but were found to be infeasible or non-viable for this Project. These measures include the use of low-NO_x burners in the heaters, switch to electric heating, and the use of waste heat for plant space heating requirements. For the low-NO_x burner technology, no information is available to demonstrate that it is commercially available for space heaters. In addition, energy conversion of natural gas combustion to heat energy is approximately 80 percent versus only 30 percent for electric energy to heat energy. This equates to approximately 2.6 times more electric energy generation that would be necessary to meet the current heating requirements, and therefore, is not a viable alternative. The use of waste heat from the autoclaves to assist in the space heating requirements could ultimately achieve a 65 percent reduction in the overall NO_x emissions. However, natural gas space heating may still be required during the early phase of the Project until the waste heat would be available for use. This option is no longer being considered due to concerns over possible changes to the Project water balance.

It should be noted that discussions are currently in progress with PolyMet, MPCA, and the Federal Land Managers to evaluate additional potential control measures that may be applicable to the Project. Once a final decision has been made by these agencies, a full evaluation of the final control measures will be presented in the Final EIS. The investigation is expected to be completed during the permitting process with MPCA and the FLMs.

It is the position of the Tribal cooperating agency that mitigation options should be aggressively pursued by the MPCA and the FLMs, as stated above. The Tribal cooperating agency should be included in these discussions to the extent possible.

- ***Fugitive dust control and mercury deposition minimization and mitigation strategy:*** In addition to the natural moisture content and large size of the material being mined, PolyMet proposes to control fugitive emissions associated with the mining process through:

    - Application of water down hole during drilling operations;
    - Application of water or MPCA approved dust suppressants on haulage and unpaved roads;
    - Minimization of drop distances during loading and stockpiling operations; and
    - Application of appropriate dust suppressants or use of similarly performing pollution control techniques during on-site contractor crushing operations.

    These controls represent the best control for fugitive emissions at the mine site. The specific procedures to be used for fugitive dust control at the Mine Site will be specified in the fugitive dust control plan that will be submitted to MPCA for approval.

    During crushing and milling operations at the Plant Site, PolyMet proposes to use BACT-like controls for the crushing plant in accordance with the USEPA's "top-down" approach, where control technologies are ranked in order of effectiveness, and each technology starting with the most stringent one is evaluated, until a technology cannot be ruled out on technological or economic grounds (RS58A, Barr 2007; RS58B, Barr 2007).

The "top-down" BACT-like controls review found the option with dry baghouse controls on the crushing plant to be the most effective in controlling particulate matter emissions. PolyMet has agreed to upgrade the particulate matter controls on crushing plant sources to baghouses. Which means about 99% of particles released during the crushing operation would be captured in air pollution control devices and reintroduced into the ball mills. It is estimated that less than 0.001 pounds per year of mercury would be emitted as particulates from this process step. All of the mercury that could be potentially emitted at this point in the process would be expected to be in a particle bound form. Therefore, these controls represent the best control for mercury emissions to the air during the crushing process. The milling process is a wet process, so no emissions occur from this operation and no mitigation is required.

Tailings generated by the flotation process are transferred to the Tailings Basin as wet slurry, carrying about 16 pounds per year of the mercury originally contained in the ore. In addition, some mercury will be introduced to the Tailings Basin in treated water from the WWTF located at the Mine Site. Based on bench studies, mercury in the treated mine water and flotation liquids sent to the Tailings Basin is expected to adsorb to the copper-nickel tailings, similarly to how mercury adsorbs to taconite tailings. Therefore, nearly all the mercury sent to the Tailings Basin would be isolated from further transport within the environment. A minor amount (0.02 pounds per year) of mercury would be released through fugitive emissions due to wind erosion off the Tailings Basin. PolyMet proposes to control fugitive emissions at the Tailings Basin through the application of water or MPCA approved dust suppressants to unpaved roads, and the seeding and mulching of tailing beaches and inactive areas. These controls represent the best control for the Tailings Basin area air emissions. The specific control practices will be described in the fugitive dust control plan which will be submitted for MPCA approval.

During the hydrometallurgical process, about 95% of the mercury air emissions would be from four autoclave emission units: two autoclave vents and two autoclave flash vents. Maximum potential air emissions from these units are estimated to be 7.9 lbs/year. Only a fraction of the mercury in the concentrate would be released into the air from the autoclaves, in part because elemental mercury (Hg^o) in a pressurized oxygen environment at low pH, will oxidize forming Hg^{2+}. This would then complex with anions, such as sulfate (SO_4^{2-}) and chlorine (Cl^-), in the slurry thereby preventing the mercury from volatilizing. While some chemical dissociation of mercury from these anions may occur in the slurry, this mercury will tend to partition to the solid and liquid components of the slurry material. Mercury emitted in vapor and steam emissions from the process would be present as Hg^{2+}. Wet pollution control devices effectively control this type of mercury emissions.

It has been conservatively assumed that at least 25% of the mercury that would be emitted from the autoclave vents would be captured in the Autoclave Scrubbers. In addition, based on Pilot Plant study data (RS32A, Part 4, Barr 2007), an estimated 72% of the mercury emitted from the autoclave flash vents would be captured by the Autoclave Scrubbers (RS57A, Barr 2008). This results in an estimated overall weighted mercury removal efficiency of 58% for the two emission units on each autoclave due to the Autoclave Scrubbers. All water would be recycled and reintroduced through the process. Hg^{2+} and particulate mercury [Hg(p)] are effectively captured in conventional pollution control systems (wet scrubbers) compared to Hg^o, therefore most of the mercury released to the ambient air would be as Hg^o. Therefore to the extent that Hg^o is transformed to either Hg^{2+} or exists as Hg(p) in the autoclaves, the staged control (i.e. the exhaust of the Autoclave Scrubbers reports to the inlet of the Final Gas Scrubber) of the autoclave emissions is expected to provide effective capture of mercury released from the concentrate to the air. These controls represent the best control for the hydrometallurgical process.

Dry controls are not feasible for the autoclaves and flash vents because of the high moisture content of the exhaust gas. Sorbent injection or elemental mercury oxidation are not a practical option for the autoclaves because of the low emission levels and the fact that most of the mercury is expected to be in the oxidized or particle bound form.

Downstream of the autoclaves, given process configuration and temperatures, any mercury emissions generated would be expected to be in an ionic form and the proposed wet scrubbers would be an effective control measure. Mercury emissions are estimated at 0.002 lbs/yr for the two scrubber stacks downstream of the autoclaves.

Potential mercury emissions from combustion sources are estimated to be 0.4 lb/yr. PolyMet proposes to minimize fuel usage through process efficiency and use of lower emitting fuels such as natural gas and propane for space heating. During testing and emergency operations, distillate oil would be used in stationary internal combustion engines including emergency generators and fire pumps. The heat needed in the autoclaves is generated from the exothermic oxidation of sulfide minerals. Heat is also recovered from the autoclaves for use elsewhere in the process. This results in minimal supplemental fuel usage in the hydrometallurgical process. A natural gas fired boiler is used to start up the autoclaves, but it is only used occasionally. A small natural gas fired heater will also be used in the oxygen plant. The remaining combustion sources are the zinc pots used for crusher maintenance, which are only used during maintenance periods. Overall, stationary source fuel usage for the Project would be quite low and the fuels that would be used are relatively low in mercury content.

Environmental Monitoring and Control

It is planned that after start up and commissioning the actual emission rates of the hydrometallurgical autoclave process would be monitored via stack emission tests. This would allow comparison to the calculated emissions used as the basis to establish the 7.9 lbs. per year mercury emission rate and enable further refinement of the total equivalent reductions that may be needed in future years.

In addition to the best available control strategies defined above, PolyMet is considering a range of additional strategies to accomplish further mitigation of mercury emissions.

In State Equivalent Reductions

One strategy under consideration is attempting to obtain reduction offsets from existing sources such as electrical generating units or taconite facilities. The approach would be for PolyMet to enter into a business agreement with an entity to purchase offsets of mercury emissions at a contractually specified yearly emission amount and likely for a confidential dollar amount. In order for these reductions to be creditable to PolyMet, these facilities will need to reduce their emissions either sooner or greater than called for by the stakeholder recommendations under the mercury TMDL for their specific sectors. This strategy is also based on the assumption that reductions at a facility due to decreased activity or closure would generate reduction units. It is planned that these facilities will be able to save these reduction units from year to year and use them to offset emissions through 2025.

Cross Sector Partnership

This strategy would entail pursuing a partnership with a sector such as crematoria. Crematoria in Minnesota currently emit approximately 100 pounds of mercury per year. Without action, cremations and emissions are expected to increase by about 50% before starting to decline in 2025 due to a decline in amalgam fillings. During the stakeholder input phase of the mercury TMDL, most of the largest crematoria had pledged to reduce emissions by 75% by 2025, work to better quantify emissions and explore near term reduction opportunities. Effective pollution control equipment does not appear to have been deployed to any crematoria in the United States.

The goal of this partnership would be to aid this sector by assisting with the design and implementation of a study to quantify their mercury emissions. Further aid would be to help them undertake research and evaluation of mercury control technologies. This may ultimately result in financially supporting the addition and operation of pollution control equipment and periodic monitoring. Alternatively, assistance may be provided in finding ways to reduce the amount of mercury entering the crematoria or switching to inherently lower emitting technology. Early reductions could be achieved by assisting a source in meeting its reduction target before 2025 and by exceeding a 75% reduction after that date. It is estimated the three largest crematoria sources emit approximately 20, 9, and 8 pounds per year.

Product Collections

The strategy under this option would be to facilitate further product collections of mercury containing household products. There are many consumer products that contain mercury including: fluorescent tube lights, compact fluorescent lights, thermostats, thermometers, and electrical switches and relays to name a few. An example would be to initiate a local program that promotes an awareness of what consumer products contain mercury, and what the alternatives to these are. This program would be expanded upon by facilitating local collection programs above and beyond what is already established with city, county or state governmental agencies. An example would be establishing additional drop off points or collection days for used fluorescent bulbs, switches, thermometers or thermostats. Additionally a targeted focus could be to promote a switch out program for an item like household thermostats, by providing a voucher to cover costs of replacing a current working thermostat with a non-mercury containing replacement.

Publically Owned Treatment Works

This strategy would entail working with an individual or group of local POTW such as the City of Hoyt Lakes, City of Aurora or the City of Babbitt to aid in identifying, researching, and mitigating mercury containing inputs and outputs from their facilities. The goal of the Minnesota Mercury TMDL is to address impairments of Minnesota's water due to mercury. Aiding either financially and / or technically in this research could help to identify further measures for either mitigating impaired waters or minimizing the discharge of mercury to public waters. This may also include providing matching or cooperative funding to a public agency to help in existing studies or initiating planned studies.

Research

Another mitigation strategy option may be the provision of funding for various entities to conduct research aiding in the reduction of mercury in a range of media. This could be coordinated research in new mercury air emission reduction technologies for different industries, or long range studies in the interaction of mercury in the environment such as lakes and streams. It would be expected these studies would lead to further air, water or soil reductions of mercury or provide further understanding of the interaction with these media. The results of these studies would be consistent with the goals of the TMDL.

Although there is uncertainty in the additional emission strategies identified above, PolyMet will be required to submit a specific emission control plan to meet the requirements of the guidelines and the Project will not be permitted until a verifiable plan can be approved by the MPCA.

4.6.4 Cumulative Effects

Air quality modeling analyses were conducted for cumulative effects to assess the impacts on NAAQS, MAAQS, PSD Class II Increments, and Class I Increments using a similar modeling approach discussed in Section 4.6.2.3 and Section 4.6.2.4. However, relative to NAAQS, MAAQS, and PSD Class II Increments, the receptors locations were restricted to areas at and beyond the former LTVSMC ambient air boundary as defined in the Final SDD. It should be noted that the report *Air Emissions Class II Area Cumulative Impacts Report (RS35)*, submitted in March of 2007, was written to address the Class II cumulative impacts requirement as identified in the Final SDD. However, the Class II modeling report for the Plant Site included a more detailed and up to date assessment of combined impacts at the Plant Site, so the results included in this report are presented in this section. For PSD Class I Increments, the cumulative analysis utilized the Project impacts in combination with the recently conducted cumulative analysis prepared for the Minnesota Steel EIS to assess overall impacts. The following sections describe the results of the assessments.

4.6.4.1 Cumulative Ambient Air Quality Impacts (NAAQS/MAAQS)

As stated earlier, an assessment at the Plant Site was conducted using the same modeling approach as presented in Section 4.6.2.3 with the exception that receptor locations were limited to at or beyond the boundary of the former LTVSMC facility. Figure 4.6-2 shows the former ambient air boundary for the former LTVSMC site. The analysis included potential emissions for all NorthMet Project sources and from nearby source in the cumulative NAAQS analysis as defined in the Final SDD and agreed upon with the MPCA. These included Mesabi Nugget, Cliffs Erie Pellet Yard, and the Syl Laskin Energy Center.

The Class II modeling results for the Mine Site in Section 4.6.3.1 could also be considered a "cumulative impacts" analysis because the modeling considers other nearby sources (Mesabi Nugget, Cliffs Erie Pellet Yard, Peter Mitchell Mines, and the Plant Site). The Tribal cooperating agencies' position is in disagreement with the assessment that the Class II modeling considered cumulative impacts. That analysis did not take into effect the full particulate emissions from the tailings basin. That analysis also did not factor in any emissions from the

Keetac Expansion Project which plans to increase production by 61% by reopening another furnace line nor is there any mention of the Essar Steel Expansion project that is planned.

Table 4.6-18 below summarizes results of the cumulative NAAQS model analysis. The H2H PM_{10} concentration for the five-year modeling period was used for comparison to the NAAQS PM_{10} 24-hour standard. Ambient air background concentrations were added to modeled concentrations to determine compliance with NAAQS and MAAQS. PM_{10} background concentrations represent the 2004-2006 average concentrations from the H2H 24-hour concentration and annual average concentration from Virginia, Minnesota. None of the cumulative NAAQS model results exceed NAAQS and MAAQS. The Tribal cooperating agencies' position is that this analysis is incomplete and that the 24-hour $PM_{2.5}$ modeling needs to account for emissions from the Keetac Expansion Project. Furthermore the Tribal cooperating agencies feel that the full cumulative effects may lead to violations of the $PM_{2.5}$ NAAQS standard. It should also be noted that the maximum concentrations reported in Table 4.6-18 are all due to impacts from Syl Laskin Energy Center. Impacts for which the NorthMet Project would be directly culpable are lower.

Table 4.6-18 Results of Cumulative Class II NAAQS Modeling

Pollutant	Averaging Time	Maximum Modeled Concentration (ug/m^3)	Background (ug/m^3)	Total (ug/m^3)	NAAQS and MAAQS (ug/m^3)
SO_2	1-hour	366	90	456	1300
	3-hour	285	25	310	915
	24-hour	140	11	151	365
	Annual	13	3	16	60
PM_{10}	24-hour	41	32	73	150
	Annual	4	16	20	50(1)
$PM_{2.5}$	24-hour	14	20	34	35
	Annual	5	6	11	15
NO_X	Annual	3	12	15	100

Note: The annual NAAQS for PM_{10} was rescinded on October 17, 2006.

4.6.4.2 Cumulative Class II Increment Impacts

Cumulative Class II Increment analysis was completed for PM_{10}, NO_X, and SO_2 for all increment consuming PolyMet sources at both the Plant and Mine Sites. The modeling included all sources at maximum emission rates plus all nearby increment consuming (and expanding) emissions sources, including Cliff's Erie Pellet Yard and LTVSMC). The Mine Site impacts were below the SIL on the receptor grid based on the former LTVSMC boundary, so the Mine Site is not included in the cumulative impacts modeling. The results of the increment analyses are shown in Table 4.6-19, along with a comparison to the allowable Class II PSD increments.

The data in Table 4.6-19 summarize the PSD Class II Increment modeling results and demonstrate that the Project, in conjunction with all other neighboring PSD sources, would comply with all state and federal increment limits. The Tribal cooperating agencies' position is that the Cumulative Class II Increment Impact is incomplete. This analysis did not take into effect the full particulate emissions from the tailings basin nor did it model PM 2.5 impacts.

Table 4.6-19 Results of Cumulative Class II PSD Increment Analysis

Pollutant	Averaging Time	Cumulative Modeled Concentrations (ug/m^3)	PSD Increment Limits (ug/m^3)
SO_2	3-hour	27	512
	24-hour	7	91
	Annual	1	20
PM_{10}	24-hour	9	30
	Annual	0	17
NO_X	Annual	1	25

Notes:
Modeled PM_{10} concentrations are based on operating scenarios at Year 8 and Year 16.
Plant Site modeled cumulative emissions include Plant Site, Mesabi Nugget, Cliffs Erie Pellet Yard, and LTVSMC.

4.6.4.3 Cumulative Class I Increment Impacts

Based upon the analysis presented in Section 4.6.2.6, the only Class I analysis that failed acceptable screening thresholds was associated with 24-Hour Class I Increments for PM_{10} at BWCAW, which requires a cumulative assessment. Recently, a comprehensive cumulative analysis of the BWCAW region was conducted as part of the Minnesota Steel EIS (MnDNR 2007, Minnesota Steel).

An assessment was conducted to assess the Class I 24-hour PM_{10} concentrations within the BWCAW boundary that exceed the 24-hour PM_{10} SIL. The maximum concentration within those receptor locations exceeding the SIL was added to the maximum 24-hour PM_{10} concentration from the Minnesota Steel comprehensive cumulative analysis. This is a conservative approach, since the maximum from the Project sources was not predicted at the same location as the maximum from the comprehensive assessment. Table 4.6-20 summarizes the results of the analysis, showing that the cumulative Class I 24-hour PM_{10} is below the Class I threshold limit, indicating that there is no significant impact. The Tribal cooperating agencies' position is in disagreement with the assessment that there is no significant impact. That analysis did not take into effect the full particulate emissions from the tailings basin. That analysis also did not factor in any emissions from the Keetac Expansion Project which plans to increase production by 61% by reopening another furnace line nor is there any mention of the Essar Steel Expansion project that is planned. This analysis also shows that there is little increment left for future Projects.

Table 4.6-20 Results of Cumulative Class I PSD Increment Analysis

Pollutant	Averaging Time	Maximum Modeled Air Concentration For NorthMet Modeled Emissions (ug/m^3)	Maximum Modeled Air Concentration For Cumulative Modeled Emissions (ug/m^3)	Total Cumulative Modeled Air Concentration (ug/m^3)	PSD Increment Limit (ug/m^3)
PM_{10}	24-hour	0.5	7.0	7.5	8

In addition to the quantitative evaluation of Class I PM_{10} increment, the Final SDD also requires a semi-quantitative assessment of overall trends related to Class I Increment. This analysis was completed by PolyMet (RS37, Barr 2006). The significant conclusions from this report are included in the section on Cumulative Visibility Impacts below.

4.6.4.4 Cumulative Impacts of Acid Deposition on Ecosystems

The potential for cumulative impacts of acid deposition on ecosystems were evaluated in terms of the potential increased acidification on the terrestrial and aquatic systems within a four county area (Itasca, Saint Louis, Lake and Cook Counties) from 1980 to 2015, as defined in the Final SDD (MDNR 2005). The pollutants of consideration included both sulfate depositions from air quality SO_2 emissions and nitrate deposition from NO_2 emissions.

Based upon the most recent information available at the time this cumulative analysis was conducted by PolyMet in June 2006, there are approximately 9 new projects for the four-county area, including the NorthMet Project. Collectively, without accounting for recent past reductions or expected future reductions, these sources could emit up to an additional 6,455 tons per year NO_2 and 2,340 tons per year SO_2, if all were constructed and operated (RS69, Barr 2007). This represents approximately a 12 percent and 6 percent increase in the current emissions for the two pollutants in the four county "zone of interest" (Itasca, St. Louis, Lake, and Cook Counties), respectively. However, due to the recent shutdown of the LTVSMC and the projected decreases in emissions from the Minnesota Power AREA proposal, the overall emissions would be reduced by 2,195 tpy and 5,710 tpy for the NO_2 and SO_2 respectively, since 2000 (RS70, Barr 2008). In addition, supplemental decreases in emissions from the two pollutants are expected to occur due to various federal programs, including the implementation of the Taconite and electric utility MACTs, the EPA's "Clean Air Interstate Rule, Best Achievable Retrofit Technology on Regional Haze (BART) Program and Clean Fuels Regulations.

As such, the emissions from the Project, in combination with other Projects, would emit increases in SO_2 and NO_2 emissions, resulting in a potential increase in acid deposition that may be too small to measure. However, due to the Project having relatively low emissions of SO_2 and NO_2 and potential deposition of sulfate and nitrate are below both the Minnesota standard threshold value and the federal Class I threshold values, in combination with the overall reduction in sulfate and nitrate-producing emissions cumulatively since 2000, the projects would not likely cause a cumulative significant impact on the ecosystems.

4.6.4.5 Cumulative Mercury Emissions

A cumulative assessment was conducted to assess the effects of mercury emissions from nine Projects of mercury emissions in combination with emission reductions from two additional facilities proposed and/or constructed since 2000 (RS70 Addendum 01, Barr 2007). The nine new facilities include the Excelsior Energy Phase I and Phase II Projects, Mesabi Nugget's Proposed DRI facility, Minnesota Steel Industries, Northshore Mining Company Furnace 5 Reactivation Project, the Project, United Taconite Emissions and Energy Reduction Project, US Steel Keewatin Taconite Fuel Diversification and Pollution Control Equipment Upgrade, UPM/Blandin Paper Mill Expansion, and the Laurentian Wood-Fired Energy Project. Emission reductions are associated with the LTVSMC Plant closure and the Minnesota Power AREA project. Table 4.6-21 summarizes the emission increases due to the nine new foreseeable Projects (RS70 Addendum 01, Barr 2007). The Tribal cooperating agencies' position is that this Table is incomplete. There is no mention of the Keetac Expansion Project which will be producing 64 lbs Hg/yr controlled or 90 lbs Hg/yr uncontrolled. (Cumulative Impacts Analysis Local Mercury Deposition and Bioaccumulation in Fish, Keetac Expansion Project April 2009)

Table 4.6-21 Maximum Potential Mercury Emissions from Projects Proposed Since 2000

Project	Location	Potential Emissions (pounds/year)	Mass Balance Completed/ Controls Evaluated	Estimated Speciation of Air Emissions[12]
Excelsior Energy[1]	Subject to State Site Process	42	Pending	Hg(0): 100%
Mesabi Nugget DRI Plant[2]	Hoyt Lakes	75	Yes	Hg(0): 99.3% Hg(II): 0.5% Hg(p): 0.2%
Minnesota Steel Industries[3]	Nashwauk	81	Yes	Hg(0): 99.8% Hg(II): 0% Hg(p): 0.2%
Northshore Mining Company: Furnace 5 Reactivation Project[4]	Silver Bay	1	Yes	Hg(0): 100%
PolyMet Mining, NorthMet Project[5]	Hoyt Lakes	8	Yes	Hg(0): 100%
United Taconite: Emissions and Energy Reduction Project[6]	Forbes	0	No	--
US-Steel Keewatin Taconite Fuel Diversification and Pollution Control Equipment Upgrade[7]	Keewatin	-40	Yes	--
UPM/Blandin Paper Mill Expansion[8]	Grand Rapids	2	Yes	Hg(0): 100%
Laurentian Wood-Fired Energy Project[9]	Virginia/Hibbing	12	Yes	Hg(0): 100%
LTV Steel Mining Company (LTVSMC): Facility Closure (2001)[10]	Hoyt Lakes	-83	NA	NA
Minnesota Power AREA proposal[11] (implemented by 2009)	Taconite Harbor	-64	NA	NA
Total Emission Increases		221		
Total Emission Decrease		-187		

NA = Not Applicable

Adapted from: Table 1, Cumulative Impact Analysis, Mercury Deposition and Evaluation of Bioaccumulation in Fish in Northeast Minnesota, RS70; November 2006 draft:

1 Preliminary emission estimates, total for Phase I and Phase II, based on emission factors and heat inputs provide on Excelsior Energy Web site, www.excelsiorenergy.com, accessed on October 28, 2005.

2 Mesabi Nugget's Proposed Facility: Receive concentrate from off-site, Rotary Hearth Furnace: Air Permit Application, May 2005. Mercury mass balance completed; HG-2003 form completed.

3 Minnesota Steel Industries, Draft Permit Application and HG-2003 Form submittal to the MPCA, September 2006. Based on data from Minnesota Steel's drill core analysis, the 95% confidence level high-end estimated emissions of mercury to air = 81 pounds. The "average" potential estimated emissions of mercury to air = 61 pounds. For this cumulative analysis, the high-end estimate of 81 pounds per year is used. If the average of 61 pounds per year is used in this analysis, the "net" increase in potential Hg emissions is 49 pounds/year, not taking into account the emissions reduction from Butler Taconite.

4 Northshore Mining's Furnace 5 Project: reactivating 2 crushing lines, 9 concentrating lines, one pellet furnace (Furnace 5); new sources emissions only; EAW Table 6 (May 20, 2005). A "Total Facility Mercury Evaluation" was completed in 1999 for a direct reduced iron Project. This total facility evaluation included an assessment of potential control technologies for reducing mercury releases to air, water, and land. The evaluation included Furnace 5. This 1999 evaluation was considered relevant and valid for the Furnace 5 Reactivation Project and was used as a reference in lieu of completing the HG-2003 form.

5 NorthMet Project: crushing/grinding of ore, reagent and materials handling, flotation, hydrometallurgical processing. Emission estimate is an update to EAW based on preliminary analysis of 2005 and 2006 pilot-plant stack test data using standard EPA Method 29; conservatively assumes non-detects are one-half the detection limit.

6 United Taconite Emissions and Energy Reduction Project; this Project did not involve a change in potential mercury emissions. MPCA, Permit Change/Modification Application Forms, Line 1 Emissions and Energy Reduction Project (EERP), September 2004.

7 U.S. Steel Keewatin; Technical Support Document Permit Action #13700063-003, Dated 2/28/05. A total facility mercury mass balance was completed for the Project. MPCA determined that there would be no change in the total facility mercury emissions. Recent testing by Minnesota DNR show a decrease in mercury emissions from Keetac due to modification of the air pollution control scrubber. Collected solids are no longer routed to the front of the plant for reprocessing, but rather sent to the tailings basin. This has shown to lower mercury emissions by 28%.

8 Draft EIS, UPM/Blandin Paper Mill Project Thunderhawk, January 2006, Table 6-29; (PTE Increase due to expansion).

9 Laurentian Energy Project, Technical Support Documents for Virginia Public Utilities (MPCA Permit # 13700028-005) and Hibbing Public Utilities (MPCA Permit #13700027-003); Combined PTE for two new wood fired boilers (one at each site). The permit technical support documents estimate that actual Hg emissions are likely to be reduced by about one pound per year due to wood use in new boilers displacing coal in existing boilers.

10 LTVSMC: Permitted emissions (potential to emit) information from Technical Support Document for Air Emissions Permit No. 13700009-001, Table 1. From http://www.pca.state.mn.us/data/edaAir/index.cfm; downloaded on December 14, 2005. Emission reductions due to the shutdown of Butler Taconite in 1985 were not included because statewide mercury inventory comparison data starts in 1990. Mercury emissions from Butler Taconite peaked at 59 pounds per year in 1971 (Berndt, 2003, Appendix 3).

11 MPCA, January 17, 2006, Review of Minnesota Power's Arrowhead Regional Emission Abatement (AREA) Project. Table 12 (MPCA 2006a). Just prior to the MDNR's Final Decision Document being made available to the public on October 25, 2005, Minnesota Power announced a major initiative to reduce pollutant emissions, including mercury, at several of its power plants in northern Minnesota. Due to the significance of the AREA Project, it was included in the analysis.

12 Speciated mercury air emissions for the Projects are from available information. As a point of comparison, speciation of taconite processing emissions has been characterized by the MPCA and MDNR for 2001 emissions (unpublished data):

Hibbing Taconite*: 93.3% elemental; 6.6% oxidized; 0.1% particle-bound
United Taconite*: 93.3% elemental; 6.6% oxidized; 0.1% particle-bound.
U.S. Steel Minnesota Ore Operations (MinnTac)* 93.3% elemental; 6.6% oxidized; 0.1% particle-bound
U.S. Steel - Keewatin Taconite 80% elemental; 10% oxidized; 10% particle-bound
*Note: speciation for Hibbing Taconite, United Taconite, and MinnTac is based on Ontario Hydro test data from Hibbing Taconite (2000).

Recognizing uncertainty in the estimated speciation for the Projects, deposition calculations in Section 6.0 of this report are also conducted with the following mercury speciation for all of the Projects: 93% elemental, 5% oxidized, 2% particle-bound.

The MPCA currently estimates that total statewide mercury emissions are about 3,340 pounds per year. Taconite emissions were 551 pounds in 1985, while recent emissions have been averaging approximately 670 pounds (Table 4.6-22).

Table 4.6-22 Mercury Emissions Summary Related to Projects in the Study Area

Description	Mercury Emissions (lbs/year)
Total Statewide Emissions in 2000[1]	3,638
Total Statewide Emissions in 2005[2]	3,314
Potential Emission Increases from proposed Projects in study area not accounted for in 2005 inventory[3]	221
Potential Emission Decreases from proposed Projects in study area not accounted for in 2005 inventory[4]	-187
Net Change in Mercury Emissions in study area Due to Reasonably Foreseeable Actions[5]	34

Source: Adapted from: Table OV-1, Cumulative Impact Analysis, Mercury Deposition and Evaluation of Bioaccumulation in Fish in Northeast Minnesota, RS70; November 2006 draft

1 Statewide emissions of 3,638 pounds/year from the MPCA's "2005 Mercury Reduction Progress Report to the Legislature". (MPCA 2000).

2 Total statewide emissions in 2005 in "Report on the Mercury TMDL Implementation Plan Stakeholder Process" http://www.pca.state.mn.us/publications/wq-iw1-20.pdf

3 Projects are listed in Table 1 in Section 1.1 of this report.

4 Future emission reductions in the study area are listed in Table 1 of Section 1.1.

5 The TMDL goal is to reduce Minnesota mercury emissions to approximately 789 pounds per year. Based on the estimated "Total" emissions of 2,332 pounds per year, an additional reduction of 1,543 pounds per year (a 66% reduction) will be needed to meet the TMDL goal.

Mercury emissions on a statewide and national basis are expected to continue to decline over the next decade due to proposed regulatory actions such as the EPA's Clean Air Mercury Rule.

In the period of time between the completion of the cumulative impacts analysis background study from Minnesota Steel and Polymet, Minnesota stakeholders created an implementation plan for Minnesota's mercury TMDL.

Stakeholders have recommended that for new and expanding sources of mercury in Minnesota, sources seek offsets equal to the mass of new mercury being emitted to Minnesota's atmosphere. Under this plan, new sources of mercury would not be putting the achievement of the mercury TMDL reduction goal of 789 pounds at risk. Polymet would therefore need to secure mercury offsets of up to 8 pounds of mercury each year the facility is operating. The MPCA proposes to include such requirement in the operating permit for the Project.

4.6.4.6 Cumulative Visibility Impacts

Regional haze is a phenomena of visibility degradation caused by the long range transport of pollutants combined from many sources, both natural and anthropogenic, affecting a relatively large region, rather than a localized area. An extensive evaluation of cumulative regional haze impacts from existing and future programs have been conducted for the BWCAW and VNP and are presented below.

In August 1999, EPA developed the Regional Haze Rule (RHR), in accordance with amendments to the Clean Air Act in 1977, Congress added Section 169 (42 U.S.C. §§ 7491), setting forth a national visibility goal of restoring pristine conditions in national parks and wilderness areas. Each state is required participate in the haze reduction efforts if the state has Class I regions above their natural background visibility levels or if a state contributes to regional haze degradation to a Class I region in another state. The RHR is intended to achieve national visibility goals by 2064.

As stated in the Clean Air Act, "natural conditions includes naturally occurring phenomena that reduce visibility as measured in terms of light extinction, visual range, contrast, or coloration" (40 CFR 51.301(q)). Regional Haze SIPs must contain measures that make "reasonable progress" toward the natural visibility goal by reducing anthropogenic emissions that cause haze. For each Class I area, there are three metrics of visibility that are part of determining reasonable progress:

- Baseline conditions;
- Natural conditions; and
- Current conditions.

Each of the three metrics includes the concentration data of the visibility pollutants as individual terms in the light extinction algorithm, with respective extinction coefficients and relative humidity factors. Total light extinction when converted to deciviews (dv) is calculated for the average of the 20 percent best and 20 percent worst visibility days. Baseline conditions represent visibility for the 20% best (B20%) and 20% worst (W20%) visibility days for the initial five-year baseline period of the regional haze program. It is the average of Baseline conditions were calculated using the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring data for 2000 through 2004. For the BWCAW, data from the IMPROVE monitoring site (BOWA1) were evaluated. The baseline conditions for VNP were evaluated from the IMPROVE VOYA2 monitoring site.

BWCAW has a baseline visibility of 6.4 deciviews for the cleanest 20 percent of the sample days and 19.9 deciviews for the 20 percent worst visibility days. The average visibility for all days across the baseline period is 12.3 deciviews. Similarly, VNP area has baseline visibility of 7.1 deciviews for the cleanest 20 percent of the sample days and 19.5 deciviews for the 20 percent worst visibility days. The average visibility for all days across the baseline period is 12.6 deciviews.

Natural visibility is determined by estimating the natural concentrations of visibility impacting pollutants and then calculating total light extinction with the light extinction algorithm. The EPA allows states to either utilize default visibility levels calculated using the algorithm defined in a 1990 National Acid Precipitation Assessment Program report or to calculate refined natural visibility levels using the new IMPROVE algorithm, which incorporates a non-linear equation that accounts for different light scattering efficiency characteristics of sulfate, nitrate, and organic mass carbon material (OMC).

Minnesota relied on natural visibility conditions calculated with the new IMPROVE algorithm by the Visibility Information Exchange Websystem (VIEWS) staff. Using the refined equation, the MPCA has determined that natural visibility conditions for BWCAW are best represented by an average of 11.6 deciviews for most impaired days and 3.4 deciviews for the least impaired days. Natural visibility conditions for VNP are best represented by 12.2 deciviews for most impaired days and 4.3 deciviews for the least impaired days.

The comparison of initial baseline conditions to natural visibility conditions indicates the amount of improvement necessary to attain natural visibility by 2064. In accordance with the Regional Haze Rule, Minnesota has determined that emissions sources within Minnesota have or may have impacts both on the Class I areas within Minnesota (BWCAW and VNP) and on the Isle Royale Class I area in the state of Michigan. Therefore, Minnesota has submitted their Regional Haze State Implement Plan (SIP) to fulfill the requirements of the Regional Haze Rule and help reduce visibility impairment in the northern Class I areas mentioned above.

Current conditions are the visibility levels at any given year, starting in 2004 and ending in 2064. If states achieve visibility improvement at a constant rate over 60 years, visibility conditions will improve at a Uniform Rate of Progress (URP). Reasonable Progress Goals (RPGs) are designed to assess visibility improvement between current conditions and ultimate natural conditions. Currently, RPGs are to be reassessed every five years. Due to long-term nature of visibility improvement, the first URP goal is designed for 2018. Using the linear reduction from 2004 an 2064, the 2018 URP goal for BWCAW and VNP are 17.9 deciviews and 17.8 deceviews, respectively.

Regional modeling was conducted to assess the potential for visibility improvements for the projected 2018 URP. The Comprehensive Air Quality Model (CAMx) simulates atmospheric and surface processes affecting the transport, chemical transformation and deposition of air pollutants and their precursors. CAMx is an Eulerian model that computes a numerical solution on a fixed grid. Minnesota used version 4.42. Emission inventories for NO_x, SO_x, and PM_{10} have been developed for the most current year available (2002) and represents the baseline inventory. Projected emissions for 2018 have been estimated accounting for expected growth and reductions to existing emissions. In evaluating the 2018 inventory, three new taconite facilities in northeast Minnesota; Mesabi Nugget, and a proposed "east mine" and "west mine" that reflect emissions Projections for the NorthMet Project and MSI, were added. Controls incorporated into the 2018 inventory include:

- On-Highway Mobile Sources
  - Tier II/Low sulfur fuel
- Off-Highway Mobile
  - Federal control programs incorporated into NONROAD model (e.g. nonroad diesel rule), and the evaporative Large Spark Ignition and Recreational Vehicle standards;
  - Heavy-duty diesel (2007) engine standard/Low sulfur fuel;
  - Federal railroad/locomotive standards; and
  - Federal commercial marine vessel engine standards.
- Electrical Generating Unit
  - Title IV Acid Rain Program (Phases I and II);
  - Clean Air Interstate Rule; and
  - Clean Air Mercury Rule.
- Other Point Sources
  - VOC 2-, 4-, 7-, and 10-year MACT standards;
  - Combustion turbine MACT;
  - Industrial boiler/process heater/RICE MACT; and
  - The MRPO also included control factors to reflect settlement agreements for petroleum refineries and other non-EGU sources in Minnesota.

Based upon the future growth and reductions, modeled visibility for the 2018 inventory year showed projected visibility levels of 18.7dv and 19.0 dv for BWCAW and VNP, respectively. These are above the 2018 URP levels for BWCAW (17.9 dv) and VNP (17.8 dv). As a result, Minnesota is establishing as an emission reduction target or goal a reduction in combined SO_2 and NO_x emissions from the larger sources in this region of 20% by 2012 and 30% by 2018. Although most of the largest sources in this region are subject to BART and CAIR, this reduction target aims for overall larger emission reductions than are likely to result from either of those programs.

Based on the BART analyses, MPCA has determined that the six taconite facilities may be under-controlled, and that very few control technologies are known to be effective on the industrial processes involved in taconite production. Minnesota will therefore require these facilities to investigate control technologies and pollution prevention practices for their indurating furnaces through pilot tests or other mechanisms during the 2008 – 2011 time period, and report to MPCA on the feasibility and cost effectiveness of said technologies and practices.

MPCA will conduct a BART-like review of the taconite facilities' reports on control strategies and pollution prevention options investigated by the taconite facilities. If it appears that other (non-taconite) facilities will need to implement control strategies in order for the emission reduction target to be met, the MPCA will do a preliminary cost analysis of feasible pollution prevention and control options to evaluate whether any further analysis by those facilities is warranted.

Potential control strategies will be evaluated using the statutory factors (cost of compliance, time necessary for compliance, energy and non-air environmental impacts, the source's remaining useful life, and visibility impact) and considering a sixth factor: the progress towards the emission target. The progress towards meeting that target will become a sixth factor considered in determining which control strategies are reasonable.

If reasonable emission reductions measures are found at the taconite facilities, those measures would be required to be implemented as part of the state's long-term strategy, regardless of whether the overall emission target is being met. The status of the emission target will be used primarily to inform the consideration of cost-effectiveness – if the overall regional emission reduction target is being met, the maximum cost/ton cost-effectiveness level considered to be reasonable would likely be lower. Should more reductions be needed to meet the emission target, then a higher cost/ton figure may be considered reasonable.

If, after all voluntary EGU reductions and reductions at the taconite plants have occurred, additional emission reductions are needed to meet the target, the MPCA would set limits for other sources with reasonable control strategies available. Minnesota would implement this requirement for additional emission reduction measures through a "state retrofit" requirement that would ultimately apply an emission limit to each facility where additional controls have been found to be reasonable. This limit could be set through a state rule or through amendments to each facility's Title V air emission permit, which would be submitted in the Five Year SIP Assessment.

In consultation with the FLMs, the MPCA has developed a strategy for reporting progress towards these emission reduction goals. The reporting for this plan is designed to mesh with the requirements of the Five Year SIP report. In that report, the MPCA will compare actual emissions to the emission target and determine 1) if the 2012 target has been met and 2) if the 2018 target is likely to be met. The MPCA will also look at the difference between actual emissions and the target, plans for emission reductions between 2013 and 2018, the trends in nitrate and sulfate concentration and visibility in BWCAW and VNP, modeled visibility for 2018, and the availability of cost-effective emission reduction strategies.

If either target is not met, MPCA will consult with the FLMs, tribes and other stakeholders to determine what actions are needed to meet the 2018 target, taking into account the other factors mentioned above. Actions could range from simply continued tracking to further assessment and potential implementation of additional emission reduction measures by facilities.

In the event that additional emission reduction measures are required by the MPCA, emissions from the Project would be included for reduction consideration through MPCA RHR and permitting programs.

4.6.5 Amphibole Mineral Fibers

4.6.5.1 Existing Conditions

Background

The Project would be mining ore from the Duluth Complex. Taconite ore mined from the Biwabik Iron Formation at Peter Mitchell Mine, processed at the Silver Bay plant, has received public attention with regard to potential releases of fibers formed from amphibole mineral crystals, a class of silicate minerals containing iron and magnesium such as those found with taconite ore on the east end of the Mesabi Iron Range in northeast Minnesota. The Duluth Complex does not contact the Biwabik Iron Formation at the NorthMet deposit, but the Biwabik Iron Formation is presumed to be related to the Duluth Complex. Amphibole minerals have been found in the Duluth Complex.

Northshore Mining's Silver Bay processing plant was formerly operated by Reserve Mining Company. In a landmark ruling in 1974 regarding the dumping of taconite tailings from the Silver Bay plant into Lake Superior, the United States District Court for the District of Minnesota found that evidence existed regarding the potential for exposure to amphibole mineral fibers to cause cancer and other health effects [*United States. v. Reserve Mining Company*, 380 F. Supp. 11, 17 (D. Minn. 1974)]. This led to the construction of a tailings basin in 1980. As discussed below, amphibole mineral fibers incorporate asbestos,[1] and non-asbestos amphibole fibers. The court concluded that exposure to amphibole mineral fibers (regardless of whether the fibers are technically classified as asbestos or not), can produce some of the same health effects that can result from asbestos exposure, such as asbestosis, mesothelioma, or other cancers (described below). Scientific work, including health effects, on the question of exposure to non-asbestos amphibole mineral fibers is still ongoing at the present time.

Regulatory definitions for classifying fibers vary. The USEPA defines the dimensions of an asbestos fiber as a particle 5 micrometers (µm)[2] in length or longer with an aspect ratio of at least 20:1 (USEPA 1993). The National Institute for Occupational Safety and Health (NIOSH) defines an "occupational fiber" as a particle 5 µm in length or longer with an aspect ratio of at least 3:1 (NIOSH 1994). The Minnesota Agencies define a Minnesota regulated fiber (MN-fiber) as an amphibole or chrysotile mineral particle with an aspect ratio of 3:1 or greater with no limit on length (MDH Methods 851 and 852). This definition, which includes amphibole mineral fibers that can either be asbestos or non-asbestos, is consistent with the findings of *United States v. Reserve Mining Company*.

Asbestos Fibers. Asbestos is made up of fiber bundles with two or more of the following features:

- Parallel fibers occurring in bundles
- Fiber bundles displaying splayed ends
- Matted masses of individual fibers
- Fibers showing curvature

Bundles have splaying ends and are extremely flexible. When pressure is applied to an asbestos fiber, it bends much like a wire, rather than breaks. These long, thin fibers, called "fibrils," often less than 0.5 µm in width, can be easily separated from each other, which is one of the most

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1 The term "asbestos" is not a mineralogical definition; it is a regulatory and commercial term designating mineral products that possess high tensile strength, ability to be separated into long, thin, flexible fibers, low thermal and electrical conductivity, high mechanical and chemical durability, and high heat resistance. The fibers can be woven into various commercial products because of their flexibility. Asbestos refers to the fibrous variety of several naturally occurring silicate minerals.

2 A micrometer (µm) is one millionth (10^{-6}) of a meter.

important characteristics of asbestos (MSHA 2005). The mean aspect ratio for fibers can range from 20:1 to 100:1 or higher for fibers longer than 5 µm. Asbestos exposure has been identified as the cause of both malignant and non-malignant diseases.

The USEPA Integrated Risk Information System (IRIS) has classified asbestos as a Group A Human Carcinogen (USEPA 2008). This classification means that there is sufficient human and animal carcinogenicity data to support the weight-of-evidence characterization of asbestos as a human carcinogen from the inhalation route of exposure. The Group A classification is based on observations in occupationally-exposed workers of increased mortality and incidence of lung cancer, mesothelioma, and gastrointestinal cancer. Evidence of carcinogenicity via the ingestion pathway was not supported in the animal studies reviewed for the USEPA IRIS classification in 1988 (USEPA 2008). A review of the toxicological literature for asbestos was performed for the MnDNR (ERM 2009). A brief description of potential human health effects from inhalation exposure to asbestos fibers, summarized from this toxicological literature review, follows.

Lung cancers caused by asbestos are mainly bronchial carcinomas and are indistinguishable from those caused by smoking or other agents (Doll and Peto 1985). Carcinomas do not generally form until several years after the initial exposure. ***Mesothelioma*** is a form of cancer almost always associated with a previous exposure to asbestos. The cancer forms in the mesothelium, most commonly in the pleura, the outer lining of the lungs and chest cavity. Symptoms take 15 to 50 years after exposure to appear and include shortness of breath and coughing. There is no cure for human mesothelioma (Suzuki and Yuen 2002).

Asbestosis is a disease associated with occupational levels of exposure to asbestos (Atkinson, 2006). Most patients with asbestosis suffer from shortness of breath and a dry cough (Mossman and Churg, 1998). It is characterized by chronic inflammation of the parenchymal tissue of the lungs. The increase of fibrous tissue reduces tissue elasticity and gas diffusion, which reduces oxygen transfer to the blood and removal of carbon dioxide. Asbestosis appears to be associated with a high level of aggregate exposure, either a very high level over a short period or a low level for an extended period (Atkinson 2006). The level of exposure seems to control the latency period between initial exposure and the development of disease. Mossman and Churg (1998) indicate that asbestosis requires a threshold level of exposure; the lower the exposure, the longer it takes to reach the threshold. Historically, asbestosis progresses even after workers are no longer exposed to asbestos dust (Atkinson 2006).

There are two groups of minerals that can crystallize as asbestos: serpentine and amphibole. Serpentine and amphibole minerals can have fibrous and nonfibrous structures. While there are approximately 100 minerals that may contain asbestos fibers, there are six regulated types of asbestos. The six regulated minerals and their associated mineral group are:

- Chrysotile (Serpentine)
- Crocidolite (Reibeckitte) (Amphibole)
- Amosite (Cummingtonite-grunerite) (Amphibole)
- Anthophyllite Asbestos (Amphibole)
- Tremolite Asbestos (Amphibole)
- Actinolite Asbestos (Amphibole)

Mineralogically, amphibole minerals are distinguished from each other by the amount of sodium, calcium, magnesium, and iron that they contain.

A mineral can be analyzed for asbestos using a microscope. Chrysotile asbestos is easily identified by microscopic analysis because of its distinct particle shape. For amphiboles, the distinction between asbestos and non-asbestos fibers is much less clear. Amphibole particles have a spectrum of shapes from blocky to prismatic to acicular to asbestiform.[3] Amphiboles also break (or cleave) into smaller fragments when finely ground. Long, thin cleavage fragments[4] resemble asbestos fibers. An analyst can compare amphibole particle shapes to asbestos reference materials and determine whether a sample is asbestiform with a fair degree of certainty. However, unless a fiber bundle has splaying ends, it is impossible to determine if a single long, thin particle is an asbestos fiber or a cleavage fragment (USGS 2001, Berman and Crump 2003). It is more difficult to classify individual fibers as asbestiform or cleavage fragments because individual fibers do not exhibit all the characteristics of a population. Cleavage fragments tend to be roughly twice as thick as asbestos fibers (Addison and McConnell 2008). The aspect ratio distributions (i.e., length-to-width ratio) of a population of cleavage fragments and a population of asbestos fibers can overlap. This overlap means that some fibers may be classified as either cleavage fragments or asbestos fibers (Millette 2006). The state of Minnesota does not distinguish cleavage fragments from other fibers if they meet the 3:1 aspect ratio.

Non-Asbestos Fibers. The toxicological literature review prepared for the MDNR also discussed non-asbestos fibers. A brief summary follows.

Palekar et al. (1979) found non-asbestiform particles to be cytotoxic (meaning toxic to cells); however, epidemiological studies have found limited potential for carcinogenesis from cleavage fragments. Gamble and Gibbs (2008) provided a review of several epidemiological studies regarding exposure to cleavage fragments including several involving taconite miners. They found that there was no statistically significant increase in either lung cancer or mesothelioma from exposure to taconite mining. Ilgren (2004) reviewed animal and human studies and came to the same conclusion. Additionally, Gylseth et al. (1981) performed a study in which non-asbestiform amphibole dust in the lungs of taconite miners was examined. Whereas these researchers concluded that exposure to the miners constituted a minor carcinogenic risk, they could not exclude exposure to taconite as a contributing factor to the lung cancer found in the miners examined. Asbestosis and mesothelioma latency periods of 15-50 years are not uncommon, creating uncertainties in the interpretation of studies performed to date.

The MDH is currently updating an epidemiological study of workers in Minnesota's iron mining industry, as described in Section 4.6.5.2.

Potential for Exposure to Amphibole Mineral Fibers at Proposed Site

[3] Asbestiform refers to a specific type of mineral fibrosity in which crystal growth is primarily in one dimension and the crystals form as long, flexible fibers. The fibers form in bundles and can be separated into smaller bundles and ultimately single fibers or fibrils.

[4] A cleavage fragment is a particle formed by comminution (i.e., crushing, grinding, or breaking) of minerals, often characterized by parallel sides. In contrast to fibers from an asbestos mineral, elongated mineral fibers in a population of cleavage fragments are generally wider and shorter, have generally lower aspect ratios, and do not exhibit fibrillar bundling.

Northshore Mining's Peter Mitchell Mine and Silver Bay processing plant has been associated with releases of amphibole mineral fibers to air and water. PolyMet's proposed mine is in close proximity to Northshore Mining's existing mine. Ore in intrusive rocks to be mined from the NorthMet deposit in the Duluth Complex is 700 million years younger than the taconite ore obtained from Peter Mitchell Mine in the Biwabik Iron Formation, and was formed under different conditions (Barr 2007d).

The Minnesota Environmental Quality Board (MEQB) has reported that the Duluth Complex contains minor amounts of amphibole minerals, but did not identify chrysotile as a mineral of concern (MEQB 1979).[5] The MEQB (1979) identified that the concentration of asbestiform amphibole minerals in the Duluth Complex ore is expected to be low, "…less than 0.1 ppm by weight in the mineralized areas of the Duluth Complex…" Composite samples using ore from the NorthMet deposit collected during flotation pilot plant studies in 2000 conducted for PolyMet (SGS 2004)[2] provided results for amphibole and serpentine minerals representative of the MEQB (1979)[2] conclusions. Recognizing the differences between the NorthMet deposit versus the Biwabik Iron Formation, the MPCA, MDNR, and MDH requested that PolyMet provide additional information on fiber-related data for its mining and processing operations in the NorthMet deposit.

PolyMet conducted additional flotation pilot testing in July and August 2005. Collected samples considered to be representative of the head feed, tailings, and flotation process water associated with processing ore from the NorthMet deposit were prepared for analysis by Transmission Electron Microscopy (TEM) by additional grinding of the ore and tailings samples with mortar and pestle to produce a very fine powder. Stevenson (1978)[2] states that the finer a material is ground, the higher the number of "fibers" identified by MDH counting rules (MDH Methods 851 and 852). According to the laboratory conducting this analysis, this only affects fiber counts, not the identification of asbestiform fibers since asbestiform fibers have high tensile strength and flexibility (Barr 2007d). The results of the July/August 2005 flotation pilot testing are summarized below:

- A small amount of amphibole minerals are likely to be associated with the processing of ore from the NorthMet deposit; approximately 9% of MN-fibers identified in the samples were characterized as amphibole and 91% were characterized as non-amphibole.
- One of the MN-fibers identified in the samples (or 0.2% of the MN-fibers) met the USEPA definition of an "asbestos fiber," but it was a non-amphibole fiber.
- No chrysotile fibers, the asbestos form of serpentine, were identified in the samples analyzed by TEM.
- The MN-fibers identified in the samples were predominately less than 2.5 µm in aerodynamic diameter (99.6% less than 2.5 µm), placing them in the fine fraction of particulate matter ($PM_{2.5}$).

These data suggest a low probability of asbestos fiber generation from the proposed operations. However, with the presence of amphibole minerals in the Duluth Complex and the presence, albeit low, of MN-regulated fibers from analysis of NorthMet deposit samples, the potential

5 References to MEQB (1979), SGS (2004), and Stevenson (1978) are as cited by Barr (2007d).

exists for the release of amphibole mineral fibers from the proposed operations, which could pose a potential public health risk of uncertain magnitude.

4.6.5.2 Impact Criteria

As summarized in Section 4.6.5.1, there are many factors that contribute to carcinogenesis and disease from exposure to asbestos and non-asbestos fibers via inhalation. The literature review prepared for the MDNR (ERM 2008) summarizes the results of many toxicological studies presenting varying conclusions as to the significance of fiber aspect ratios, fiber lengths, and cleavage fragments in the expression of human health effects. However, in the case of amphibole cleavage fragments, the literature review suggests a minor carcinogenic risk though some researchers could not exclude exposure as a contributing factor to lung cancer. In addition, the MDH is currently updating an epidemiological study of workers in Minnesota's iron mining industry. There have been 59 cases of mesothelioma documented among the 72,000 workers in the study (MDH 2008). The University of Minnesota is leading a research effort that will lead to a greater understanding of taconite worker health issues, including an evaluation of which will look at the health of the workers and examination of samples of dust and iron ore in mines and particulate matter throughout the Iron Range.

Although a risk assessment protocol for evaluating asbestos by type and dimensions has been developed for the USEPA by Berman and Crump (2003), it may never be formally adopted. This model also does not consider fibers shorter than 10 micrometers in length. To date, there is no accepted methodology for performing a formal health risk assessment for the quantitative assessment of human health impacts from airborne fibers emitted from the proposed operations.

However, amphibole minerals are present in the Duluth Complex and in close proximity to the NorthMet deposit. Thus, there remains an uncertain level of potential health risk from airborne amphibole fibers for the Project.

4.6.5.3 Environmental Consequences

Proposed Action

Section 4.6.5.1 described a likelihood of exposures to airborne amphibole mineral fibers from the proposed mining and processing operations. MN-fibers identified in samples collected from the 2005 flotation pilot testing of material representative of processing NorthMet deposit ore (Barr 2007d) were predominately less than 2.5 µm in aerodynamic diameter (99.6% less than 2.5 µm), placing them in the fine fraction of particulate matter ($PM_{2.5}$). A small fraction of these fibers were identified as amphibole (approximately 9%).

Although not calculated from the flotation pilot testing data (Barr 2007d), the probability of amphibole mineral fibers released from the Project is not zero. Potential airborne fibers could contain asbestos fibers, which have known health effects. However, based on the samples analyzed from the NorthMet deposit (Barr 2007d) and from other data collected by the MEQB (1979) for the Duluth Complex, the probability of amphibole asbestos being released to air is very low. Non-asbestos amphibole mineral fibers in these emissions have less well known health effects; however, these fibers are regulated as MN-fibers under the MPCA permits. These fibers have been regulated by MPCA air and water permits at the Northshore Mining Company (formerly Reserve Mining Company) operation in Silver Bay since the Reserve decision. The

MPCA and the MDH have emphasized additional control of fine particles to minimize potential exposure to amphibole mineral fibers.

PolyMet's June 2007 Fibers Data Report (Barr 2007a) included an assessment of alternative control technologies for the proposed Plant Site operations. These data were taken from a Best Available Control Technology (BACT)-like analysis for PM2.5 for the Plant Site prepared for PolyMet (Barr 2007c). At the time that the BACT report was submitted (February 2007), PolyMet's intention was to permit the project as a PSD major source, so the Plant Site would have been subject to BACT requirements for PM_{10}.

Under the USEPA's PSD regulations, BACT is defined at 40 CFR 52.21(b)(12) as:

> *"**Best available control technology** means an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant. In no event shall application of best available control technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 40 CFR parts 60 and 61. If the Administrator determines that technological or economic limitations on the application of measurement methodology to a particular emissions unit would make the imposition of an emissions standard infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of best available control technology. Such standard shall, to the degree possible, set forth the emissions reduction achievable by implementation of such design, equipment, work practice or operation, and shall provide for compliance by means which achieve equivalent results."*

Since MN-fibers are predominately in the PM2.5 size range a PM2.5 BACT-like analysis for the proposed PolyMet operations was performed in accordance with the USEPA's "top-down" approach (USEPA 1990), where control technologies are ranked in order of effectiveness, and starting with the most stringent technology, each are evaluated until a technology can not be ruled out on technological or economic grounds. At the time this review was conducted PM2.5 was not regulated under PSD and the project is not subject to PSD so BACT does not apply. Rather the analysis was done to determine the best control for PM2.5 and thus for fibers.

The "top-down" BACT review found the option with dry baghouse controls on the crushing plant to be the most effective in controlling fine particulate matter emissions (PM2.5). Baghouse controls are better than wet scrubbing at controlling the $PM_{2.5}$ fraction on a particle count basis. The BACT like analysis will be updated prior to the Final EIS to ensure baghouses are still the best control for PM2.5 at the crushing plant.

In a September 2007 Supplemental Fibers Data Report (Barr 2007b), PolyMet incorporated project changes made in a July 2007 Supplemental Detailed Project Description (DPD) (Barr 2007g) to further reduce particulate matter and fugitive dust emissions from the Plant and Mine Sites, as well as additional changes related to particulate matter control and monitoring for amphibole MN-fibers following August 2007 discussions.

PolyMet also submitted an updated control technology review in October 2007 (insert reference). In the time since the previous report, PolyMet had decided to propose permitting the project as a synthetic minor source with respect to PSD regulations. This means that BACT requirements do not apply. However, PolyMet agreed to install "BACT-like" pollution control equipment in the crushing plant for fine particulate matter. The control technology report includes the determination of BACT-like controls using the top-down BACT approach.

The main points related to potential amphibole MN-fiber emissions in the supplemental Fibers Data Report are summarized below:

- PolyMet has agreed to upgrade the particulate matter controls on crushing plant sources to baghouses. This is the most stringent level of fine particulate matter control possible with current technology,.MN-fibers are predominately in the $PM_{2.5}$ size range. Baghouse controls achieve the highest degree of collection efficiency for $PM_{2.5}$ particles.
- The Tailing Basin will be operated to minimize all fugitive particulate emissions by management to minimize exposed beach areas, and wind erosion fugitive dust by treatment of Tailings Basin roads, and inactive beach areas. The deposition of wet tailings will keep the active work area wet and prevent wind erosion. Capillary action near the pond edge is expected to keep the fines wet and minimize the potential for entrainment of the fines into the air.
- The potential for the release of amphibole mineral particles to the air at the Mine Site is low because the ore will not be crushed at the Mine Site and the unpaved road surfaces will be constructed of material that is not likely to contain amphibole minerals. PolyMet's decision to use larger haul trucks at the Mine Site as well as the incorporation of an updated mine plan into the emission calculations has reduced the estimated fugitive particulate emissions, further reducing the potential for emissions of airborne amphibole mineral particles.

The modeled air concentrations presented earlier in Section 4.6.3 incorporated these project changes and emission control technology commitments. The Tribal cooperating agencies' position is in disagreement with this statement. That analysis did not take into effect the full particulate emissions from the tailings basin.

The operational and air pollution equipment controls agreed to by PolyMet represents the highest feasible level of fine particulate matter emissions control. This coupled with the 5 miles to the closest residential community, Hoyt Lakes, provides additional protection for potential exposure to airborne amphibole mineral fibers. To monitor the effectiveness of this protection, PolyMet has agreed to pre-construction and post-operation ambient monitoring for MN-fibers in the community of Hoyt Lakes. The MPCA approved locating the monitor near the wastewater treatment plant in the southwest portion of Hoyt Lakes, near a residential area. Pre-construction monitoring began on May 12, 2008. The $PM_{2.5}$ modeling done to date has been preliminary and includes other sources including other mines. The preliminary modeling shows that PM2.5 concentrations drop off in all directions except for the northeast direction which may be influenced from another mine source.

The baseline sample period will continue for a period of one year. The monitor will run every 12 days to collect a 96-hour sample on a 47-millimeter filter to capture the airborne material. Samples will be forwarded to the MDH for fiber analysis. After initial startup of the PolyMet facility, the monitor will be run again for another one-year period using the same sample protocol as the baseline monitoring. The measured baseline levels of airborne amphibole MN-fibers will be compared to the levels measured during the one-year operational monitoring period.

Alternatives

No Action

Since this alternative would add no new operations, potential new amphibole mineral fiber emissions would not occur. Therefore, ambient fiber levels would be the same as those associated with existing conditions.

Mine Site Alternative

As described in Section 4.6.3.2, the major difference between this alternative and the Proposed Action is the variation of haul traffic volumes for each year of the mining operations at the Mine Site. Section 4.6.3.2 concludes that air dispersion modeling for the Project is representative of haul road fugitive dust impacts for this alternative. Therefore, this alternative is not expected to have significantly different amphibole mineral fiber impacts from the Proposed Action.

Tailings Basin Alternative

This alternative involves the placement of wells and pumping equipment on the benches of the existing tailings basin, installation of a pipeline from the Tailings Basin to the Partridge River downstream from Colby Lake, and the addition of large boulders to the east end of the rock buttress to account for these additions. Although amphibole mineral fibers are not expected to be emitted directly from the boulders, slight increases in fibers may be generated during the loading of the boulders at the site due to rock breakage or disturbance of the LTV tailings. However, the mitigation measures (i.e., watering, soil stabilization, etc.) defined for the Proposed Action will also be used in this alternative to minimize any loss of fibers to the atmosphere. Therefore, the Tailings Basin alternative is not expected to have significantly different fiber impacts from the Project.

4.6.5.5 Mitigation and Monitoring Measures

The Project includes emission control technologies to minimize the potential impacts from amphibole mineral fibers; therefore, no additional mitigation measures are recommended.

4.7 NOISE

This section discusses potential effects of noise on humans in the Project area. The effect of noise on wildlife is discussed in Section 4.4.

Noise is generally defined as unwanted sound. Sound travels in mechanical wave motion and produces a sound pressure level. This sound pressure level is commonly measured in decibels (dB), representing the logarithmic increase in sound energy relative to a reference energy level. Sound measurement is further refined by using an A-weighted decibel scale to emphasize the range of sound frequencies that are most audible to the human ear (i.e., between 1,000 and 8,000 cycles per second). Therefore, unless otherwise noted, all decibel measurements presented in this DEIS are A-weighted (dBA) on a logarithmic scale. A sound increase of 3 dBA is barely perceptible to the human ear, a 5 dBA increase is clearly noticeable and a 10 dBA increase is heard twice as loud. For example, if sound energy is doubled, there is a 3 dBA increase in noise, which is just barely noticeable to most people. This indicates that two sound levels are added logarithmically, not linearly or arithmetically (e.g., 70 dBA plus 70 dBA equals 73 dBA, not 140 dBA). If noise increases to where there is 10 times the sound energy level over a reference level, then there is a 10 dBA increase and it is heard twice as loud.

4.7.1 Existing Conditions

The Project is located in a sparsely populated rural region in northeast Minnesota. The Plant Site is located west of the Mine Site and the noise sources at both sites are approximately 8 miles apart. The region has traditionally supported various mining activities as well as logging on federal, state, county, industrial, and private forest lands. The Peter Mitchell Mine is located approximately one mile north of the proposed Mine Site. Dunka Road, which provides access to the Mine Site, is an existing private road with no public access and little usage.

The closest noise-sensitive receptor from the Mine Site is the city of Babbitt[1] located approximately six miles to the north. Other noise-sensitive receptors in the general area of the Mine Site include Skibo (a small residential area), approximately eight miles to the south-southwest; and the city of Hoyt Lakes, approximately nine miles to the southwest. The Boundary Waters Canoe Area Wilderness (BWCAW) is part of the national wilderness preservation system where sensitivity to human-caused sound and noise impacts are important considerations. It is approximately 20 miles (in a northeasterly direction) from the Mine Site to the closest portion of the BWCAW.

It is the position of the tribal cooperating agencies that noise contour maps should be developed for inclusion in this PDEIS. Noise contour mapping would allow reviewers to assess the impacts of noise to all publicly accessible lands in the vicinity of the project which include large sections of the Superior National Forest immediately adjacent to the mine site (See figure 4.9-1). An assessment of noise impacts to all public access lands is important information for assessing cultural impacts to tribes with hunting, fishing and gathering rights in the 1854 ceded territory.

[1] Survey data used for noise modeling at the Mine Site indicated that the closest noise-sensitive receptor was a Boy Scout camp located 5 miles away from the Mine Site. The City of Hoyt Lake's clerk indicated that the only Boy Scout camp within the Project area is located on Colby Lake, which is closer to the Plant Site (i.e., approximately 5 miles south-southwest of the Plant Site and much further away from the Mine Site).

The closest noise-sensitive receptors to the Plant Site consist of a few private residences located approximately 3.5 miles north, the city of Hoyt Lakes located approximately five miles south, and a Boy Scout camp that is only used occasionally, located approximately five miles south-southwest. Figure 4.7-1 shows the location of all receptors relative to the Mine and Plant Sites.

A comparison of typical outdoor noise levels by land use category is shown in Table 4.7-1.

Table 4.7-1 Typical Outdoor Sound Levels by Land Use Category

Land Use Category	Daytime (L_{eq}, dBA)	Nighttime (L_{eq}, dBA)
Rural	45	35
Suburban	50	40
Urban	55	45
Urban with some workshops, business premises and main roads	60	50
Central business	65	55
Industrial	70	60

Source: AK06 Diamond Mine Project – EIA (AK06, 2007)

Since the Mine and Plant sites are located in a rural environment, the existing ambient steady equivalent noise levels (L_{eq}) for all nearby sensitive receptors such as homes around both sites are not expected to exceed 45 dBA (daytime) and 35 dBA (nighttime) (Table 4.7-1). In comparison with the Plant Site, the Mine Site is located in a more undeveloped area. This means the Mine Site has a tendency of having lower background noise levels. However, due to the Mine Site's proximity to the Peter Mitchell Mine, noise impact from the Peter Mitchell Mine as well as noise from the existing railway connecting the Mine and Plant sites are expected to contribute to the background noise level at the Mine Site. Therefore, the existing outdoor ambient L_{eq} levels for homes around the Mine Site are also anticipated to be 45 dBA and 35 dBA for daytime and nighttime, respectively.

Noise exposures in communities usually have a noise level distribution that may be closely approximated by a normal statistical distribution. The estimated L_{eq} for the distribution was converted to other noise percentile metrics such as L_{50} and L_{10} using a USEPA calculation methodology (USEPA 1974). The calculation was based on an assumed standard deviation of 3 dB for the sound level distribution. L_{50} is the sound level exceeded for 50 percent of the measurement period. L_{10} is the sound level exceeded for 10 percent of the measurement period. A summary of the estimated existing daytime and nighttime ambient levels (i.e., L_{eq}, L_{50}, and L_{10}) expected at the Project site are presented in Table 4-7-2.

Table 4.7-2 Summary of Estimated Existing Ambient Noise Levels at the Plant and Mine Sites

Ambient Noise Levels	Daytime (dBA)	Nighttime (dBA)
L_{eq}	45	35
L_{50}	44	34
L_{10}	48.8	37.8

4.7.2 Impact Criteria

Noise impacts are commonly judged according to two general criteria: the extent to which a Project would exceed federal, state, or (where applicable) local noise regulations; and the estimated degree of disturbance to people. It is the tribal cooperating agency position that the Army Corps has not completed consultation with potentially affected tribes. Therefore, this document does not estimate the potential degree of disturbance to tribal members who may be involved in traditional natural resource harvest harvests on national forest lands.

According to the noise standards for Minnesota (*Minnesota Rules*, part 7030.0040, subpart 2), permissible noise levels are generally classified according to residential, commercial, and industrial areas. The standards further distinguish between daytime and nighttime noise, with less noise permitted at night. The standards list the sound levels not to be exceeded for more than 10 and 50 percent of the time (L_{10} and L_{50}) during any one hour. A summary of the applicable Minnesota Noise Standards is shown in Table 4.7-3.

Table 4.7-3 Applicable Noise Standards for Different Land-Uses in Minnesota

Noise Area Classification	Noise Standard dB(A)			
	Daytime (7 a.m. to 10 p.m.)		Nighttime (10 p.m. to 7 a.m.)	
	L_{50}	L_{10}	L_{50}	L_{10}
Residential	60	65	50	55
Commercial	65	70	65	70
Industrial	75	80	75	80

As shown in Table 4.7-3, the most stringent standard is the nighttime (10 p.m. to 7 a.m.) standard in a residential area, which is 50 dBA for no more than 50 percent of the time (L_{50}). In other words, a nighttime L_{50} of 50 dBA means that during nighttime, noise levels may not exceed 50 dBA more than 30 minutes in an hour. Similarly, a nighttime L_{10} of 55 dBA means that during nighttime, noise levels may not exceed 55 dBA more than 6 minutes in an hour. As another point of reference, the U.S. Department of Housing and Urban Development (HUD) has developed standards for use in evaluating activities under its jurisdiction. The HUD standard for "acceptable" day-night average sound levels (L_{dn}) in residential areas is 65 dBA and instructive as a guide to human disturbance (HUD 1984). The day-night average sound level (L_{dn}) is the 24-hour equivalent measure of cumulative noise exposure during a 24-hour period, with a 10 dBA weighting applied to nighttime equivalent sound levels between the hours of 10 p.m. and 7 a.m. to account for people's greater sensitivity to sound during nighttime hours.

In addition to the state standards, the degree of disturbance becomes a key factor in the evaluation of noise effects, which, in this case, includes a focus on residents in the vicinity of the Project. The concept of human disturbance is known to vary with a number of interrelated factors, including changes in noise levels; the presence of other, non-project-related noise sources in the vicinity; people's attitudes toward the project; the number of people exposed; and the type of human activity affected (e.g., sleep or quiet conversation as compared to physical work or active recreation).

There are no specific local noise regulations that would apply to the Project.

Because the state noise level standards are more stringent than the federal HUD standards, Project-related noise effects will be evaluated at sensitive receptors (residential areas) using the State nighttime L_{50} and L_{10} of 50 and 55 dBA, respectively. The noise standards would apply to the Project throughout its mine operational years (Year 1 to 20) when noisy operations from mining and crushing activities would occur. It should be noted that the noise standards would also apply to any potential noise source (if any) during Closure and Post Closure (i.e., after Year 20).

Effects of air overpressure and ground vibrations from blasting operations must meet the requirements of the *Minnesota Rules*, part 6132.2900, subpart 2. According to the Rules:

- Air overpressure on lands not owned or controlled by the permittee shall not exceed 130 dB as measured on a linear peak scale, sensitive to a frequency band ranging from six cycles per second to 200 cycles per second; and
- The maximum peak particle velocity from blasting shall not exceed one inch per second at the location of a structure located on lands not owned or controlled by the permittee.

Ground vibration and air blast (overpressure) from rock blasting is primarily related to the weight of explosive detonated during any one instant and distance to a structure or sensitive receptor.

4.7.3 Environmental Consequences

4.7.3.1 Proposed Action

The primary noise sources at the Plant Site are approximately eight miles west of the primary noise sources at the Mine Site. Due to the distance between the Plant Site and Mine Site noise sources, it is more practical and reasonable to conduct individual noise modeling for receptors at each site.

4.7.3.2 Mine Site

The primary sources of noise from the Mine Site are blasting, haul trucks, and train horns. Noise from auxiliary and support equipment such as wheel dozers, graders, water trucks, fuel trucks etc are expected to be less dominant. A sound propagation model, SPM 9613 (Power Acoustics, Inc.), which is based on International Standard ISO 9613 methods was used to assess noise impacts associated with mine haul trucks, as they are the most dominant and steady noise source at the Mine Site.

The model computes outdoor noise propagation based on meteorological conditions favorable to sound propagation (i.e., downwind propagation with wind speeds between 1 and 5 meters/second when measured 3 to 11 meters above the ground) as specified in ISO 9613. This is a conservative approach as not all receivers may be located downwind of the haul trucks (i.e., receivers located upwind would experience a lesser noise impact since noise propagates faster downwind than upwind). The model accounts for the octave band attenuation from ground effects, hemispherical spreading, and atmospheric absorption that occur during propagation from the point sound source to the receiver. Ground effects were modeled by assuming that the area around the source and the receiver is hard non-absorptive ground such as concrete or asphalt.

This is also a conservative assumption as the ground around the haul trucks and residential locations is more likely to be mixed or soft ground with some absorptive capacity that can attenuate noise levels. Temperature and relative humidity of 15ºC and 70 percent, respectively were used in estimating the attenuation due to atmospheric absorption as specified in ISO 9613-1. Attenuation due to hemispherical spreading is mainly a function of the distance between the sound source and the receiver.

The Mine Site assessment predicted impacts at five different receptor locations or noise sensitive areas (NSAs): the city of Babbitt to the north, the city of Hoyt Lakes to the southwest, Skibo to the southwest, and two separate boundary locations for the BWCAW (directly north and to the northeast). Noise emissions levels were developed for the Cat 793C trucks proposed for the Project based on information provided by the Caterpillar Company and by separating the sound level into octave bands using truck noise spectrum data from the Minnesota Copper-Nickel Study (Minnesota State Planning Agency 1979). A total of 16 conventional 240 ton diesel-powered dump trucks (initial amount of trucks proposed by PolyMet), each with a sound power level of approximately 121 dBA, were assumed to be in concurrent operation. The modeling analysis did not include any potential shielding effects from pit walls, stockpiles, or berms.

Modeled sound levels from the 16 haul trucks heard at the five nearest NSAs to the Mine Site (i.e., NSA #4 to NSA #8) are shown in Table 4.7-4 and Figure 4.7-1. Based on a recent decision by PolyMet to use only 8 equivalent sized trucks, the noise modeling analysis, which was based on 16 Cat 793C trucks, is conservative.

When the projected noise levels at the NSAs are combined logarithmically with the existing ambient noise levels at the Mine Site, the total cumulative nighttime L_{50} and L_{10} would remain below 35 and 39 dBA, respectively. Due to the eight mile distance between the noise sources at the Plant and Mine Sites, noise levels from the Plant Site would have no significant impacts on the predicted noise levels at the Mine Site.

Table 4.7-4 and Figure 4.7-1 indicates the projected nighttime noise levels at the nearest NSAs are expected to be well within the Minnesota noise standards. The most stringent L_{50} standard of 50 dBA (i.e., nighttime; residential) would not be exceeded beyond 8,200 feet (1.55 miles) from the Mine Site; residential areas and other sensitive receptors are well outside this radius.

The highest nighttime L_{50} and L_{10} levels (including background levels) projected for a residential area around the Mine Site were 34.3 and 38.2 dBA, respectively, at the city of Babbitt. The nighttime noise impact of the Mine Site on Babbitt is an increase of 0.3 dBA (L_{50}) and 0.4 dBA (L_{10}) from background levels. These estimates are considered very conservative because there is a ridge (Giant's Range Ridgeline) located between the Mine Site and Babbitt that would topographically shield noise from the Mine Site. Since the total predicted nighttime L_{50} and L_{10} are well within the most stringent Minnesota noise standards, it is anticipated that typical mining operations at the Mine Site would have an insignificant effect on the noise environment.

Although ore would be delivered from the Mine Site to the Plant Site by train, noise from train horns is expected to be minimal because the railroad route near the Plant and Mine Sites is far (about 4 to 5 miles) from the nearest NSAs. There is one private at-grade crossing between the mine and the processing plant, and the rail line has been used in other mining operations for many years. While up to 22 trains per day are expected to deliver ore to the Plant Site, this frequency of traffic is less than that previously experienced on the rail line.

Table 4.7-4 Predicted Nighttime Noise Levels for the Project

Noise Sensitive Areas (NSAs)	Distance/ Direction of NSA to Project Site (miles)	Existing Ambient or Background Noise Levels (dBA)			Predicted Project Noise Levels at NSAs (dBA)			Total Project Plus Ambient Noise Levels - Cumulative (dBA)[2]			Minnesota Nighttime Noise Level Standards for Residential Areas	Project Compliance with Minnesota Nighttime Noise Standards? (Yes/No)
		Nighttime, L_{eq}	Nighttime, L_{50}	Nighttime, L_{10}	Nighttime, L_{eq}	Nighttime, L_{50}	Nighttime, L_{10}	Nighttime, L_{eq}	Nighttime, L_{50}	Nighttime, L_{10}		
Plant Site												
Private residences (NSA #1)	3.5 miles - north of Plant Site	35.0	34.0	37.8	32.0	31.0	34.8	36.8	35.7	39.6	L_{50} of 50 dBA; L_{10} of 55 dBA	Yes
The city of Hoyt Lakes - South (NSA #2)	5 miles - south of Plant Site	35.0	34.0	37.8	26.9	25.9	29.7	35.6	34.6	38.4	L_{50} of 50 dBA; L_{10} of 55 dBA	Yes
Boy Scout Camp (NSA #3)	5 miles – south southwest of Plant Site	35.0	34.0	37.8	26.9	25.9	29.7	35.6	34.6	38.4	L_{50} of 50 dBA; L_{10} of 55 dBA	Yes
Mine Site												
The city of Babbitt (NSA #4)	6 miles - north of Mine Site	35.0	34.0	37.8	24.3	23.3	27.1	35.4	34.3	38.2	L_{50} of 50 dBA; L_{10} of 55 dBA	Yes
Skibo (NSA #5)	8 miles - southwest of Mine Site	35.0	34.0	37.8	16.4	15.4	19.2	35.1	34.0	37.9	L_{50} of 50 dBA; L_{10} of 55 dBA	Yes
The city of Hoyt Lakes - Southwest (NSA #6)	9 miles - southwest of Mine Site	35.0	34.0	37.8	12.3	11.3	15.1	35.0	34.0	37.8	L_{50} of 50 dBA; L_{10} of 55 dBA	Yes
BWCA - Northeast (NSA #7)	20 miles - north of Mine Site	35.0	34.0	37.8	0	0	0	35.0	34.0	37.8	L_{50} of 50 dBA; L_{10} of 55 dBA	Yes
BWCA - North (NSA #8)	> 20 miles - northeast of Mine Site	35.0	34.0	37.8	0	0	0	35.0	34.0	37.8	L_{50} of 50 dBA; L_{10} of 55 dBA	Yes

Notes:

[1] Noise levels were based on the most stringent Minnesota noise level standards i.e., nighttime noise standards for residential areas. Predicted equivalent steady sound levels (L_{eq}) were converted to L_{50} and L_{10} using the calculation methodology described in Appendix A of EPA's *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Safety Margin* (EPA 1974).The calculation was based on an assumed standard deviation of 3 dB for the sound level distribution.

[2] Total Project Plus Ambient Noise = 10 Log ($10^{(\text{Ambient Noise}/10)} + 10^{(\text{Project Noise}/10)}$).

The other potential source of noise emissions is the blasting at the Mine Site. The environmental impacts of blasting at non-ferrous mining operations are regulated by the MnDNR under *Minnesota Rules*, part 6132.2900 to ensure that effects of air overpressure and ground vibrations from production blasts would not be injurious to human health or welfare and property outside the mining area. The distance from the Mine Site to the nearest receptors is such that impacts from blasting are expected to be minimal. Much of the area currently experiences blasting at the Peter Mitchell Mine and has previously experienced blasting during the operation of other mining activities over the years. Blasting noise is not included in the noise level estimates shown in Table 4.7-4 and Figure 4.7-1 because mine blasting is typically an extremely brief event (not continuous or steady), and would occur only during daytime periods. PolyMet expects that blasting of ore and waste rock would take place approximately once every two three days. This would usually include separate blasts of ore and waste rock benches. Typically, rock blasting could potentially have single event noise levels (SEL) ranging from 111 to 115 dBA at 50 feet from the blasting site. With modern blasting techniques, the blasting would be experienced by people at the nearby receptors, as a faint warning whistle or siren, followed by a very brief, muted clap of thunder. Public acceptance is generally improved by scheduling blasting at the same time every day to further reduce the startle factor.

Because the closest receptors and structures would be located at least six miles away from the Mine Site, effects of air overpressure and ground vibrations from blasting operations are expected to meet the requirements of *Minnesota Rules*, part 6132.2900, subpart 2. Once PolyMet develops blast data and blasting experience at the Mine Site, specific estimates of ground motion and air overpressure can be determined.

As required by law, PolyMet would implement a seismic monitoring program, including monitoring at a location adjacent to the nearest structure located on lands not owned or controlled by PolyMet and where the MnDNR would consider necessary to investigate complaints. Minnesota Rules would also require that PolyMet monitor all open pit blasts. As with ground vibration, the air blast monitoring station would be required to be located adjacent to the nearest structure located on lands not owned or controlled by the mining company to monitor atmospheric conditions for air blast effects. Mitigation measures that may be necessary for blast source areas closest to receptors are discussed in Section 4.7.3.5.

During Closure and Post-Closure (i.e., after Year 20), the major noise sources at the Mine Site (i.e., blasting, haul trucks, etc) would cease and noise levels in the area is expected to return to background levels.

4.7.3.3 Plant Site

The primary sources of noise from the Plant Site would be crushers. PolyMet proposes no changes to the existing crushing systems at the Plant Site except for pollution control equipment and possibly associated ventilation systems. These changes are not expected to significantly affect noise levels from the crushers. Sound power level for the crushers was estimated to be 116 dBA (McArthur River Mine Project, 2005). Sound propagation modeling was performed for the crushers using methods and assuming meteorological conditions for downwind propagation as specified in ISO 9613. This is a conservative approach as not all receivers may be located downwind of the crushers (i.e., receivers located upwind would experience a lesser noise impact since noise propagates faster downwind than upwind). The model accounts for the octave band attenuation from ground effects, hemispherical spreading, and atmospheric absorption that occur during propagation from the point sound source to the receiver. Ground effects were modeled by assuming that the ground around the source and the receiver is hard non-absorptive ground such as concrete or asphalt. This is also a conservative assumption as the ground around the crushers and residential locations is more likely to be mixed or soft absorptive ground conditions that can attenuate noise levels. A temperature and relative humidity of 15ºC and 70 percent, respectively were used in estimating the attenuation due to atmospheric absorption as specified in ISO 9613-1. Attenuation due to hemispherical spreading is mainly a function of the distance between the sound source and the receiver.

It is expected that the crushers would be located no closer than approximately 18,500 feet (i.e., 3.5 miles) away from a few private residences to the north (NSA #1), approximately 26,400 feet (i.e., five miles) away from the city of Hoyt Lakes to the south (NSA #2); and approximately 26,400 feet (i.e., five miles) away from a Boy Scout camp (NSA #3) to the south-southwest. The predicted L_{eq} levels at noise sensitive receptors around the Plant Site were converted to L_{50} and L_{10} levels. Table 4.7-4 and Figure 4.7-1 indicates the total estimated L_{50} and L_{10} levels at the closest receptors to the Plant Site are expected to be well within the most stringent Minnesota noise standards. The highest nighttime L_{50} and L_{10} levels (including background levels) projected for the closest private residences (i.e., NSA #1) north of the Plant Site were 35.7 and 39.6 dBA. The nighttime noise impact of the Plant Site on NSA #1 is an increase of 1.7 dBA (L_{50}) and 1.8 dBA (L_{10}) from background levels. Due to the 8 mile distance between the noise sources at the Plant and Mine Sites, noise levels from the Mine Site would have no significant impacts on the predicted noise levels at the Plant Site. During Closure and Post Closure (i.e., after Year 20), the major noise sources at the Plant Site (i.e., crushers) would cease and noise levels in the area is expected to return to background levels.

Summary

Based on the above information, it is anticipated that the continuous generation of noise at the Plant and Mine Sites would have an insignificant effect on the noise environment during mine operations, Closure, and Post Closure. Tribal cooperating agencies disagree with this conclusion. This document does not present enough information to make this claim.

4.7.3.4 Alternatives

No Action Alternative

Under the No Action Alternative, there would be no increase in noise levels at the Plant or Mine Sites or change in noise levels at sensitive receptors.

Mine Site Alternative

The type, quantity, and location of noise sources for Mine Site alternative would be similar to that for the Proposed Action (i.e., crushers, haul trucks, blasting, etc). Therefore, the subaqueous disposal of high sulfide waste rock (i.e., Category 2, 3, and 4 waste rock) would not significantly change noise generation at the Mine or Plant Sites or modify noise effects on NSAs relative to the Proposed Action.

Tailings Basin Alternative

Under the Tailings Basin Alternative, additional noise is expected from the placement of wells and pumping equipment on the benches of the existing Tailings Basin and installation of a pipeline (including horizontal direction drilling [HDD] under streams and railroad tracks) from the Tailings Basin to the Partridge River downstream from Colby Lake.

The loudest noise under this alternative would occur during HDD activities, which are associated with the pipeline installations. The primary sources of noise during HDD activities would be HDD drill rig/pipe puller, mud handling (shaker and pump) and an excavator. Other construction equipment used during well placement is expected to be less noisy. The HDD equipment would be used during pipeline crossings at Second Creek and CN Railroad. The HDD crossings at both locations would not occur at the same time. An assessment of the noise impact of the HDD activities on the closest NSAs has been performed. Sound power levels per octave band center frequency for the HDD equipment were taken from manufacturer's specification (FERC 2008). The overall sound power level for all the HDD equipment operating concurrently was estimated to be 125 dBA. Sound propagation modeling was performed for the HDD equipment using methods set out in the ISO 9613. The model assumes meteorological conditions for downwind propagation as specified in ISO 9613-2. This is a conservative approach as not all receivers may be located downwind of the sound source (i.e., receivers located upwind would experience a lesser noise impact since noise propagates faster downwind than upwind). The model accounts for the octave band attenuation from ground effects, hemispherical spreading, and atmospheric absorption that occur during propagation from the point sound source to the receiver. Ground effects were modeled by assuming that the ground around the source and the receiver is hard non-absorptive ground. This is also a conservative assumption as the ground around the HDD equipment and closest receptors is more likely to be mixed or soft absorptive ground conditions that can attenuate noise levels. Attenuation due to hemispherical spreading is mainly a function of the distance between the sound source and the receiver.

For the HDD crossing at the CN Rail Road, it is expected that the HDD equipment would be located no closer than approximately 6,336 feet (i.e., 1.2 miles) away from the closest NSAs to the south – the City of Hoyt Lakes and the Boy Scout Camp. The predicted L_{eq} levels at the closest NSAs were converted to L_{50} and L_{10} levels and each noise metric or percentile was logarithmically combined with the existing background levels shown in Table 4.7-2. Table 4.7-5 indicates the total estimated L_{50} and L_{10} levels at the closest receptors to the HDD activity at the CN Rail Road are expected to be less than Minnesota daytime and nighttime noise standards (see Table 4.7-3). The L_{50} and L_{10} levels (including background levels) projected for the closest NSAs south of the HDD activities were 49.1 and 52.9 dBA, respectively. The short-term noise impact of the HDD activity at the CN Rail Road on the closest NSAs is an increase of 15.1 dBA (L_{50} and L_{10}) from background levels.

Table 4.7-5 Predicted Noise Levels from HDD Activities at the CN Rail Road

Source/ Attenuation/ Sound Levels	Octave Band Center Frequency									
	63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1000 Hz**	**2000 Hz**	**4000 Hz**	**8000 Hz**	**Linear Sound Levels (dB)**	**A-weighted Sound Levels (dBA)**
HDD Drill Rig/Pipepuller	125	123	120	121	120	116	109	105	130	124
Mud Handling (Shaker and Pump)	119	117	110	108	107	104	103	97	122	112
Excavator	113	114	110	110	110	107	102	102	119	114
Total Sound Power Level, PWL (dB)	**126**	**124**	**121**	**122**	**121**	**117**	**111**	**107**	**131**	**125**
Ground attenuation (assume hard ground), A_{gr} (dB)	-5.87	-5.87	-5.87	-5.87	-5.87	-5.87	-5.87	-5.87	--	--
Geometrical divergence (from hemispherical spreading), A_{div} (dB)	73.7	73.7	73.7	73.7	73.7	73.7	73.7	73.7	--	--
Atmospheric absorption, A_{atm} (dB)	0.20	0.73	2.17	4.55	7.88	16.9	51.4	183	--	--
Equivalent Continuous Sound Pressure Levels, SPL (L_{eq}) at closest NSA, with attenuation (dB)	58.2	55.8	50.8	49.1	44.9	32.0	-8.59	-144	61.0	50.0
L_{50} at closest NSA, with attenuation (dB)	57.1	54.8	49.8	48.1	43.9	30.9	-9.63	-145	60.0	49.0
L_{10} at closest NSA, with attenuation (dB)	61.0	58.6	53.6	52.0	47.7	34.8	-5.79	-141	63.9	52.8
L_{eq} at closest NSA plus existing background Levels (dB)	--	--	--	--	--	--	--	--	--	**50.1**
L_{50} at closest NSA plus existing background Levels (dB)	--	--	--	--	--	--	--	--	--	**49.1**
L_{10} at closest NSA plus existing background Levels (dB)	--	--	--	--	--	--	--	--	--	**52.9**

1. Distance from the HDD activity to the closest NSAs (City of Hoyt Lakes and the Boys Scout Camp) is approximately 1.2 miles (6,336 feet).
2. Existing background levels at the closest NSAs are 35 dBA as L_{eq}, 34 dBA as L_{50}, and 37.8 dBA as L_{10} (see Table 4.7-2)

For the HDD crossing at Second Creek, it is expected that the HDD equipment would be located no closer than approximately 21,120 feet (i.e., 4 miles) away from the closest NSAs to the south, which are the City of Hoyt Lakes and the Boy Scout Camp. The predicted L_{eq} levels at the closest NSAs were converted to L_{50} and L_{10} levels and each noise metric or percentile was logarithmically combined with the existing background levels shown in Table 4.7-2. Table 4.7-6 indicates the total estimated L_{50} and L_{10} levels at the closest receptors to the HDD activity at Second Creek are expected to be less than Minnesota daytime and nighttime noise standards (see Table 4.7-3). The L_{50} and L_{10} levels (including background levels) projected for the closest NSAs south of the HDD activities were 35.7 and 39.5 dBA, respectively. The short-term noise impact of the HDD activity at Second Creek on the closest NSAs is an increase of 1.7 dBA (L_{50} and L_{10}) from background levels.

Table 4.7-6 Predicted Noise Levels from HDD Activities at Second Creek

Source/ Attenuation/ Sound Levels	Octave Band Center Frequency									
	63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1000 Hz**	**2000 Hz**	**4000 Hz**	**8000 Hz**	**Linear Sound Levels (dB)**	**A-weighted Sound Levels (dBA)**
HDD Drill Rig/Pipepuller	125	123	120	121	120	116	109	105	130	124
Mud Handling (Shaker and Pump)	119	117	110	108	107	104	103	97	122	112
Excavator	113	114	110	110	110	107	102	102	119	114
Total Sound Power Level, PWL (dB)	**126**	**124**	**121**	**122**	**121**	**117**	**111**	**107**	**131**	**125**
Ground attenuation (assume hard ground), A_{gr} (dB)	-5.96	-5.96	-5.96	-5.96	-5.96	-5.96	-5.96	-5.96	--	--
Geometrical divergence (from hemispherical spreading), A_{div} (dB)	84.2	84.2	84.2	84.2	84.2	84.2	84.2	84.2	--	--
Atmospheric absorption, A_{atm} (dB)	0.68	2.42	7.24	15.2	26.3	56.5	171	611	--	--
Equivalent Continuous Sound Pressure Levels, SPL (Leq) at closest NSA, with attenuation (dB)	47.3	43.8	35.4	28.2	16.2	-17.9	-139	-582	49.1	31.9
L_{50} at closest NSA, with attenuation (dB)	46.3	42.7	34.3	27.1	15.1	-19.0	-140	-583	48.1	30.9
L_{10} at closest NSA, with attenuation (dB)	50.1	46.6	38.2	31.0	19.0	-15.1	-136	-579	51.9	34.7
L_{eq} at closest NSA plus existing background Levels (dB)	--	--	--	--	--	--	--	--	--	**36.7**
L_{50} at closest NSA plus existing background Levels (dB)	--	--	--	--	--	--	--	--	--	**35.7**
L_{10} at closest NSA plus existing background Levels (dB)	--	--	--	--	--	--	--	--	--	**39.5**

1. Distance from the HDD activity to the closest NSAs (City of Hoyt Lakes and the Boys Scout Camp) is approximately 4 miles (21,120 feet).
2. Existing background levels at the closest NSAs are 35 dBA as L_{eq}, 34 dBA as L_{50}, and 37.8 dBA as L_{10} (see Table 4.7-2)

During operations at the Plant Site, including the Tailings Basin, several well water pumps would generate noise, but such noise is not expected to be significant since the pumps would likely be underground. Therefore, noise from these pumps that would be located along the northern embankment of the Tailings Basin is expected to be less than noise from the crushers at the Plant Site. Because the crushers would still be the dominant noise source during operations at the Plant Site, additional noise from the pumps are not expected to significantly change noise generation at the Plant Site/Tailings Basin or modify noise effects on NSAs relative to the Proposed Action.

During Closure and Post Closure periods, the well water pumps would still be operational (i.e., well water would be pumped directly to the Partridge River), but the Plant Site crushers would no longer be operational. During these periods, the pumps would be the dominant noise source. Noise from the pumps-only would be lower than noise from the crushers during the mine's operational years since the pumps would likely be underground. In comparison to the Proposed Action, the Tailings Basin Alternative would generate more noise during the Closure and Post Closure periods due to the additional noise from the pumps; however, the additional pump noise is not expected to worsen noise effects on NSAs relative to the Proposed Action since the pumps would likely be underground and located more than a mile away from the closest NSAs.

Based on the noise impact assessment above, the Tailings Basin Alternative would not significantly change noise generation at the Plant Site and would have no effect at the Mine Site, during the mine operational years relative to the Proposed Action. The additional pump noise generated during Closure and Post Closure periods would be less than the total noise generated during the mine operational years and is therefore, not expected to worsen noise effects on NSAs relative to the Proposed Action. Noise associated with HDD activities at the CN Rail Road and Second Creek during pipeline installation is expected to generate noise increases relative to background levels (particularly the HDD crossing at the CN Rail Road); however, the impacts of the noise increases on the closest NSAs located 1.2 and 4 miles away are expected to be minor, short-term (a few days), and less than Minnesota State daytime and nighttime noise standards. In addition, the HDD activities would likely occur during daytime periods only when noisy operations are more tolerable.

4.7.3.5 Proposed Mitigation Measures

There would be no significant continuous noise-related impacts from the Plant and Mine Sites. However, for noise levels associated with extremely brief events (i.e., non-continuous noise) such as blasting at the Mine Site, the following mitigation measures may be necessary for blast source areas closest to receptors:

- It may be necessary to adjust drill hole density along with delay weights to keep vibrations below the MnDNR prescribed limits;
- Air overpressure levels should be maintained through a reduction of delay weights, appropriate stemming depth, use of shock tubes, and depth of burden (distance of blast from free bench face);
- Unfavorable atmospheric conditions, such as low level inversions or winds toward nearby buildings, should be avoided during blasting; and
- Blasting would be scheduled at the same time every day to minimize startle effect.

4.7.4 Cumulative Impacts

The anticipated ambient or background noise levels shown in Table 4.7-4 for the Plant and Mine Sites account for other contributing noise sources in the vicinity such as the Peter Mitchell Mine, which is the closest major noise source - approximately one mile north of the Mine Site. Because these other noise sources are at least a mile away or more from the Project (i.e., Plant and Mine Sites) and sound levels generally diminishes significantly with distance (approximately 6 dBA decrease per doubling of distance), noise contributions from these other sources are not expected to significantly increase current background levels or change the noise level at the project site from that of a typical rural environment. Traffic from public roads and highways are negligible noise contributors due to their distances from the Project. The closest public roads to the Project are forest roads located approximately two to three miles to the southeast and County Highway 21 located more than five miles to the north and northwest. State Highway 135 is located more than 10 miles to the west and southwest of the Project site. Dunka Road, which provides access to the Mine Site, is an existing private road with no public access and little usage. In addition, noise from the existing railway that connects the Plant and Mine Sites have also been accounted for as contributors to the background levels shown in Table 4.7-4.

The cumulative effects of a few reasonably foreseeable projects (i.e., future developments) within a 10 mile radius of the Project area were also assessed. Tribal cooperating agencies are not aware that such an assessment has been conducted. Contour mapping of cumulative noise sources should be presented in this section. Such reasonable foreseeable projects include the Hoyt Lakes to Babbitt Roadway Connection Project proposed by the St. Louis County. Noise levels at residences and other sensitive receptors close to such future developments (when in operation) would likely increase; however, these cumulative increases or impacts are not expected to be significant as the noise levels would reduce with an increase in distance from the source. Even if we conservatively assume that the combination of all nearby contributing noise sources plus any noise associated with future developments in the area (excluding the Project) would increase the daytime and nighttime background L_{eq} at sensitive receptors to 55 and 45 dBA, respectively (which represents ambient levels for an urban environment as shown in Table 4.7-1), the total cumulative noise levels (i.e., including the Project noise) would still remain below Minnesota daytime and nighttime noise level standards for residential areas. For such a scenario, the cumulative L_{50} and L_{10} during the daytime would remain below 55 dBA and 58 dBA, respectively at all sensitive receptors close to the Plant and Mine Sites. Similarly, the cumulative L_{50} and L_{10} during the nighttime would remain below 45 dBA and 49 dBA, respectively at all sensitive receptors close to the Plant and Mine Sites. In addition, during the EIS scoping process (see Section 2.1 of the Final SDD), no cumulative impact issues associated with noise were identified. Tribal cooperating agencies do not believe that an adequate cumulative impact of noise impacts analysis has been done. Meeting ambient noise standards is a different question than assessing impacts. Impacts should be fully characterized in this document and contour maps showing overlapping noise pollution from different projects provided. Without this information, it is not possible for the public to review the cumulative impacts of noise. In addition, the cumulative impacts of mine related vibration have not been assessed.

4.8 CULTURAL RESOURCES

Cultural resources include material remains of past human activities, both from historic and Pre-European contact. In addition, cultural resources include traditional cultural properties, such as areas used for ceremonies or other cultural activities that may leave no material traces and may have on-going uses important to the maintenance of cultural practices. Cultural resources management seeks to identify and protect all of these types of cultural resources with the goals of enhancing understanding of human behavior and protecting cultural practices. For cultural resources qualifying as historic properties, protection is afforded under the National Historic Preservation Act (NHPA). Tribal cooperating agencies note that a citation is needed here. The enacting regulations of the NHPA defines an historic property as follows:

> ~~*…any Pre-European contact or historic district, site, building, structure, or object included in, or eligible for listing on the National Register, including artifacts, records, and material remains related to such a property or resource (46 CFR 800, as amended 2006, Title III, Section 301, #5).*~~
>
> Tribal cooperating agencies note that the above quotation and citation are incorrect and should be replaced with the quotation and citation below. Tribal cooperators also note that citation formats should be standardized throughout the document.
>
> . . . any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria (36 C.F.R. § 800.16 (l)(1)).

The term "historic property" is used in the sense defined here throughout this chapter.

The criteria for evaluating eligibility for listing on the National Register of Historic Places (NRHP) are as follows:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association, and:
>
> A. That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> B. That are associated with the lives of persons significant in our past; or
>
> C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic

values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. That have yielded, or may be likely to yield, information important in prehistory or history ~~(National Register Bulletin 1997).~~ Replace with: (36 C.F.R. § 60.4). Tribal cooperators request that primary, rather than secondary, sources be used for all citations.

To qualify for protection under NHPA, a cultural resource must meet the rigorous criteria for National Register eligibility, thereby qualifying as an historic property.

If a cultural resource can be demonstrated to meet the criteria for listing on the NRHP, it qualifies as an historic property, and impacts to that historic property must be avoided or mitigated appropriately. Historic properties are protected from both direct and indirect effects. Direct effects physically alter the historic property in some way. Indirect effects diminish some significant aspect of the historic property, but do not physically alter it. The Area of Potential Effect (APE) is the area within which the proposed undertaking has the potential to either directly or indirectly impact historic properties that may be present. Under 36 C.F.R. § 800.4(a), the first step in the process of identifying historic properties is defining the APE. Only after that can a comprehensive identification of historic properties take place If an effect on an historic property is identified within the direct or indirect APE, consulting parties must agree on whether the effect is adverse. If an effect is adverse, either avoidance of the effect or mitigation for the effect is required under NHPA. As discussed above, citations are needed for clarity throughout the text.

Within the direct APE for the Project, three cultural resources that merited review for potentially qualifying as an historic property have been identified to date: a previously unknown Pre-European contact archaeological site and two previously known historic resources – the LTVSMC mill facilities and a railroad associated with these facilities. Consideration of the potential of each of these cultural resources to qualify as an historic property, warranting NHPA protection, is offered in this chapter. The USACE is consulting with three ~~Native American~~ Indian tribes regarding identification of historic properties within the direct APE for the Project. The tribal cooperating agencies note that the term "Indian tribes" reflects the language used in relevant federal law and request that this change be made throughout this section.

One type of cultural resource that, if present, also warrants consideration as an historic property is a traditional cultural property (TCP). The tribal cooperating agencies' position is that "Traditional Cultural Property" should be replaced with "Historic Property of religious and cultural significance to Indian Tribes." However, if traditional cultural property is going to be used, it should be abbreviated (TCP) after the first occurrence. A traditional cultural property must consist of a tangible property such as a district, site, building, structure, or object, and must meet the criteria listed above to be considered an historic property per the NHPA. For natural resources to qualify for protection under the NHPA, they would have to constitute a definable traditional cultural property, that is, a specific site or district associated with traditional events, activities, or observances, of a significance warranting inclusion on the NRHP (Parker and King 1999). No traditional cultural properties have been identified to date during research, field studies, or tribal consultation. Consultation among the USACE and Indian tribes, however, is ongoing and a significant amount of consultation and survey work remains. Despite the requirements of 36 C.F.R. § 800.4(a), the APE for the Project was not determined until August 11, 2009, and the Corps has not yet confirmed that position in writing. Therefore, historic and current Tribal uses have not been determined for either the Plant or Mine Sites or for large portions of the direct and indirect APE.

The ~~Native American~~ Indian tribes that are signatories to the 1854 Treaty of LaPointe (10 Stat. 1109) ~~Treaty of 1854~~, including the Grand Portage, Bois Forte, and Fond du Lac Bands, have ~~rights~~ usufructuary rights, or the right to hunt, fish, and gather, on ~~public~~ (Tribal cooperators note that the treaty itself contains no such limitation) lands within the territory ceded by that treaty (the Ceded Territory):

> ARTICLE 1. The Chippewas of Lake Superior hereby cede to the United States all the lands heretofore owned by them in common with the Chippewas of the Missisippi . . .
>
> ARTICLE 11. . . . And such of [the Chippewas of Lake Superior] as reside in the territory hereby ceded, shall have the right to hunt and fish therein, until otherwise ordered by the President.

~~Tribal efforts to coordinate natural resource monitoring within the lands covered under the 1854 Treaty include entities such as the 1854 Treaty Authority, which acts as an inter-tribal natural resource management agency and manages the off-reservation hunting, fishing, and gathering rights of the Grand Portage and Bois Forte Bands of the Lake Superior and Minnesota Chippewa Tribes in the territory ceded under the Treaty of 1854.~~

The Ceded Territory includes over five million acres described as the Arrowhead Region of Minnesota. The Grand Portage and Bois Forte Bands jointly manage their treaty resources through the 1854 Treaty Authority. The Fond du Lac Band maintains its own treaty management authority. In addition, the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) assists the Fond du Lac tribe in coordinating natural resource monitoring and use within treaty lands. Fish and moose harvest management is an example of cooperative management between tribes and federal and state agencies within treaty lands. ~~The Project is proposed to be located on a combination of private and public land, and USFS would require PolyMet to acquire the public land, thus converting it to private land. This public land lies within ceded territory boundaries and is therefore subject to 1854 Treaty rights. Replacement public land has not been identified to date or analyzed for natural or cultural resources.~~ [Tribal cooperators note that this section assumes, improperly, that it is only on public lands that Band members may exercise treaty rights. This is incorrect as a matter of law, as further discussed below. Additionally, there has been no discussion of a land transfer or its effect on treaty resources with the Tribal cooperating agencies. This misunderstands the meaning of the Ceded Territory and should not be included.]

In traditional tribal culture and cosmology, natural resources hold a great significance. Consulting tribal representatives have emphasized the importance of natural resources to their tribes, stating that natural resources are integral to their culture and cannot be separated from cultural resources. The tribal view of natural resources as cultural resources is acknowledged. In order for any cultural resource to be afforded protection under the NHPA, however, it must meet the NRHP criteria and qualify as an historic property. But Section 106 first mandates Tribal consultation to even begin the evaluation of whether a Tribal resource, whether on- or off-reservation, qualifies.

Natural resources impacts do have the potential to impact culture. These impacts can manifest themselves in myriad ways, such as the loss of significant cultural landscapes, the loss of ancestral and/or sacred sites, and deterioration in the health or availability of animal and plant populations culturally associated with traditional diets, hunting practices, or spiritual practices. Consideration of these natural resources of concern to the tribes in the cultural context of general use and access are addressed in this chapter.

The Tribal cooperators' position is that within the Section 106 Process, the appropriate terminology for sites of importance to Indian tribes is "historic properties of religious and cultural significance to an Indian tribe." Unlike the term TCP, this phrase appears in NHPA and the Section 106 regulations. It applies strictly to tribal sites, unlike the term TCP. Furthermore, Section 101(d)(6)(A) of NHPA reminds agencies that historic properties of religious and cultural significance to Indian tribes may be eligible for the National Register. Thus, it is not necessary to use the term TCP when considering whether a site with significance to a tribe is eligible for the National Register as part of the Section 106 process. The National Register Bulletin No. 38 guidelines are helpful, however, in providing an overview of how National Register criteria are applied.

Another issue with the term TCP is that Bulletin 38 has sometimes been interpreted as requiring an Indian tribe to demonstrate continual use of a site in order for it to be considered a TCP. This requirement could be problematic in that tribal use of a historic property may be dictated by cyclical religious or cultural timeframes that do not comport with mainstream conceptions of "continuous" use. In many other cases, tribes have been geographically separated from and/or denied access to historic properties of religious and cultural significance to them. Therefore, it is important to note that under NHPA and the Section 106 regulations, the determination of a historic property's religious and cultural significance to Indian tribes is not tied to continual or physical use of property.

Cultural Background

The Tribal cooperators' position is that the Cultural Background position is very brief, and there was no input from Bois Forte, Fond du Lac, or Grand Portage Bands as to the accuracy of the Cultural background to provide context to the evaluation. The result is that the section lacks relevant expertise and reflects little knowledge of the present-day Bands. Again the Tribal cooperators should have reviewed and commented on this chapter before the PDEIS was sent out.

Pre-European Contact

The earliest inhabitants of Minnesota date back about 10,000 years, moving into the area after the last glaciation of the Pleistocene (Risjord 2005). The archaeological remains of these Paleo-Indian people are difficult to locate, since the sites are small, contain few artifacts, are few in number, and are usually deeply buried beneath more recent sediments. These sites are recognized by archaeologists by scatters of lanceolate (lance-like) projectile points (Dobbs 1990a; Dobbs 1990b).

The Paleo-Indian people were followed by Archaic people, likely Paleo-Indian descendants. This cultural transition occurred about 6,000 years before present. The tribal cooperators note that 6000 years before present is within the Archaic period. The sentence should read 6000 years BCE. Material remains of activities of Archaic people, including large notched and stemmed projectile points, have been more frequently discovered and excavated by archaeologists than Paleo-Indian material (Anfinson 1987; Wilford 1941, 1955, and 1960). Archaic Period people developed woodworking tools including axes and adzes, as well as punches to facilitate manufacture of clothing from animal skins. Trade networks connected the Archaic Period people of Minnesota with resources as far away as the Gulf of Mexico. Later during the Archaic Period, people in the Great Lakes region began making tools from copper, which was found as a raw material in the form of nuggets. Tools fashioned from copper include spear points, knives, fishhooks, and awls—the first metal tools known in the New World (Risjord 2005).

The Tribal cooperators' position is that copper tools appear in archaeological contacts during the initial Archaic between 6,000 and 7,000 years ago (Beukens 1992).

During the Woodland Period, beginning around 1000 BC, people began making pottery and burying their dead in mounds. Woodland people continued to make and use copper tools and also favored tools made of antler and bone. Very late during the Woodland Period, people began using the bow and arrow. Minnesota was occupied by people related to the present-day Sioux Nation, who followed a typical Eastern Woodland subsistence pattern. The Sioux maintained a seasonal cycle, practicing maple sugaring in the spring, fishing and small-game hunting and gathering in the summer, and large-game hunting in winter. The seasonal cycle included congregating into larger groups during the summer when resources were more plentiful, and then separating into smaller bands during the winter, to be supported by stored supplies and fresh large game (Risjord 2005). Based on analysis of plant residues found on ceramic food vessels from archaeological sites, wild rice is known to have been used for food since the Woodland Period (Thompson et al. 1994).

The practice of these Eastern Woodland lifeways was disrupted during the mid-17th Century, as European explorers and trade goods began to enter the region. Wild rice, however, remained a staple food. In addition, European settlements further east began pushing other tribes into the area, creating new pressures on the Sioux people of the region (Risjord 2005).

Post-European Contact

It is the position of the tribal cooperating agencies that this entire section lacks sufficient information from a tribal perspective. Further consultation is mandated in order to properly consider tribal oral histories and tribal creation stories, which is standard under ACHP guidance (*see, e.g.*, Bulletin No. 38).

French fur traders were among the first Europeans to arrive in northeastern Minnesota in the 1650s. As early as 1660, Sault Ste. Marie, traditionally a seasonal gathering place during the whitefish run, became a year-round stopping place for tribes due to the opportunity to trade with Europeans (Meyer 1994). European trade, primarily for furs created new pressures among the tribes of the region. As the Ojibwe moved westward, Sioux tribes were pushed southward, and possibly further west (Gibbon 2002).

The Ojibwe people moved westward along the shores of Lake Superior from the St. Lawrence River Valley. Pressures from European trade and from their Iroquois neighbors is often cited as motivation for this move. A citation for this statement is needed.

The Tribal cooperators' position is that this is not the reason for the westward movement. Oral tradition tells us differently. The author of this should have contacted Tribal cooperators to review this before sending it out to others. Tribal cooperators were told they would be able to review and comment before this was sent out, and that never happened.

The Ojibwe have also been known as Outchibouec (French), Chippewa (American), and Anishinabe (their own name for themselves) (Risjord 2005). According to Anishinabe tradition, the five original clans emerged from the Atlantic Ocean, and migrated through the Great Lakes watershed, guided by a vision of a *miigis* (cowrie shell) or Sacred Megis (turtle shell) (Meyer 1994; Benton-Banai 1979).

The Tribal cooperators' position is that this is true, but not the reason for the migration. We did not leap out of the ocean and start sprinting west. And, have never heard of a Sacred Megis being called a turtle shell, this is incorrect! Obviously, the interpreter of this paragraph did not understand the difference between a Megis shell and a turtle shell. Again, Tribal cooperators should have been allowed to preview and comment on this section of the Cultural Resources chapter.

The objective of this migration was to find a place where food grows on water (wild rice). Anishinabe oral tradition relates a 500-year journey, beginning in 900 AD, with some groups settling along the way at each of seven main stopping places. Three important groups developed during this time: 1) the *Ish-ko-day'-wa-tomi*, who maintained the Sacred Fire and were later called the *O-day'-wa-tomi*, and later the *Potawatomi*, 2) the *O'daw-wahg'*, who provided goods and were later called the *Ottawa*, and 3) the *Ojibway*, who were the Faith Keepers. The Anishinabe became known as the Nation of the Three Fires in recognition of these three groups. The migration ended at *Mo-ning-wun'-a-kawn-ing* (Madeline Island, southernmost of Apostle Islands and location of La Pointe Wisconsin), when the turtle-shaped island of prophecy was recognized (Benton-Banai 1979).

The Tribal cooperators' position is that this is not true! If the migration ended at Madeline Island, why are there Ojibwe bands located in Canada and across the Northwestern Border of the

United States? Again, Tribal cooperators should have been involved with the review and should have been able to comment on these issues. We continued to migrate westward to different areas where we settled. Eddie Benton-Banai is not the only reference you should cite here. The whole upper part of the second paragraph, page 4.8-4, should be rewritten with proper Tribal consultation.

After battles between the Sioux and Ojibwe people in 1768, the Sioux moved further west and south onto the prairies and river valleys of southern Minnesota, seeking big game and less combat with neighbors. Skirmishes continued into the mid-19th century, but not on as large a scale (Risjord 2005).

The Ojibwe people ~~like the Sioux people,~~ seasonally harvested fish, game, including moose, caribou, bear or rabbit, and deer after logging began, along with maple sugar, fruit, berries, roots, and wild rice. [The Tribal cooperators' position is that "like the Sioux people" should be removed. Comparison of all tribes as the same is labeling them as "Indian" not as a specific tribal group who have their own customs and traditions. Additionally, there is no mention of moose, caribou, deer, bear, or rabbit, and the draft only mentions game in passing.] Fish were harvested by netting and spearing, both from canoes and through ice. Fish were preserved by salting, smoking, or drying (Risjord 2005). Even without agriculture, the plentiful wild rice and fish around Lake Superior and inland allowed the Ojibwe people to live in villages for several months of the year, usually right at the lakeshore.

The Tribal position is that they did not stay in a single camp for many months. They had four major camps that they utilized throughout the year. Why are you talking about the people who lived on the shore of Lake Superior? Why is there no mention of the inland migration or the people who came to the PolyMet area?

Birch bark was employed in home and canoe construction and container manufacture. Cedar wood and bark were also used for these purposes. Sweet grass was also harvested, and often burned for medicinal and spiritual purposes (McClurken et al. 2000). These natural resources are cultural resources and are still used today. To Tribal people cultural resources include natural resources, to hunt, fish and gather is cultural which requires natural resources to be able to carry on traditional Ojibwe lifestyles. ~~According to t~~The Ojibwe participating in consultation for the Project state that sage was used and is still used today used in ceremonies and sweat lodges. These and other natural resources are cultural resources and are still used today. To Tribal people, cultural resources include natural resources; to hunt, fish, and gather is cultural, and requires natural resources to be able to carry on traditional Ojibwe lifestyles. This is discussed further below.

Beginning in 1837, Ojibwe treaties with the U.S. government opened the way for European–American settlement. First fur trading, then logging, agriculture, and mining attracted Euro-American settlers to Minnesota (Risjord 2005). Minnesota became a Territory of the United States in 1849. In 1854 and 1855, treaties between the Ojibwe people and the U.S. government allocated permanent reservation lands within ceded territories to the tribe, a rare provision at the time. Annuities to tribal members established by treaties helped fund the development of cities in Minnesota, as traders were paid by tribal members for goods, and then invested in real estate and construction in developing areas, accounting for as much as $4.2 million in the 1850s (Risjord 2005).

Historic treaty rights in ceded indigenous territories apply to the public lands within the ceded territory. The Project area is located within one historic, treaty-ceded territory, the Ceded Territory under the 1854 Treaty between the Chippewa (Ojibwe) of Lake Superior and the United States.

In 1985, the Grand Portage Band sued the state of Minnesota in federal court claiming that the 1854 Treaty gave them the right to hunt and fish in the Ceded Territory free of state regulation; the Fond du Lac and Bois Forte Bands later joined the lawsuit. A settlement between all parties was reached. In the later case of *Fond du Lac Band of Chippewa Indians v. Carlson*, the Eight Circuit allowed the Fond du Lac Band (which had pulled out of the settlement) to sue state officials for alleged violations of treaty usufructuary rights under the 1854 Treaty. 68 F.3d 253 (8th Cir. 1995). This was because the Eighth Circuit recognized that these treaty rights were "important federal rights." *Id.* at 256. Although the settlement agreement was approved by the federal court in 1999, this agreement does not commit to a legal conclusion as to whether the 1854 Treaty harvest rights remain valid (MnDNR 2005, Legal History; Edwards et al. 2004). Tribal cooperators note that this language implies that there is doubt about whether the treaty rights remain legally enforceable. But there is none, as counsel for the Grand Portage Band, Sara Van Norman, stated in a letter to the Corps on March 9, 2009. The cited language appears to be drawn from a standard settlement clause, not a substantive legal position, and, indeed, such a position would be directly contrary to federal law. Subsequently, in 1990, the Mille Lacs Band sued the state claiming harvest rights in the 1837 Ceded Territory, situated adjacent and south of the 1854 Treaty territory. In 1992, the Fond du Lac Band also sued the state under both the 1837 Treaty and the 1854 Treaty (the band was a signatory on both). In 1994, a U.S. District Court decision upheld the Mille Lacs Band treaty rights in the 1837 Ceded Territory (Mille Lacs Band v. State of MN)[1]. A 1996 ruling also found that the Fond du Lac Band retained their treaty rights to hunt, fish, and gather in the 1854 Ceded Territory (Fond du Lac Band v. Governor of Minnesota[2]. Most recently, in 1999, the U.S. Supreme Court upheld the rights of the Mille Lacs Band and other signatory Bands within the 1837 Ceded Territory. These legal rulings have confirmed that tribal communities do retain rights to hunt, fish, and gather on tribal and public lands within ceded territories (Edwards et al. 2004). The Tribal cooperators' position is that the DEIS excludes private lands by assuming that legal rulings confirming tribal communities' retained rights to hunt, fish and gather refer only to public and tribal lands in ceded territories. In

1 Mille Lacs Band of Chippewa Indians et al. v. State of MN et al., 861 F. Supp. 784, 841 (D. Minn. 1994

2 Fond du Lac Band of Chippewa Indians; Robert Peacock; Peter Defoe; Clifton Rabideaux; Herman Wise; George Dupuis, Plaintiffs-Appellees, v. Arne Carlson, Governor of Minnesota; Rodney Sando, Commissioner of the Minnesota Department of Natural Resources; Raymond B. Hitchcock, Assistant Commissioner of Operations, Minnesota Department of Natural Resources, Defendants-Appellants., 68 F.3d 253 (8th Cir. 1995),Federal Circuits, 8th Cir. (October 18, 1995), Docket number: 94-3709

actuality, there has been no court decision regarding the extent of treaty rights on private land in the 1854 ceded territory. A statement casting doubt on the Band's treaty rights has no place in the EIS. Moreover, the *Mille Lacs* cases are not directly relevant. To the extent that further consultation is required to explain the regulatory agreement that operates between the DNR and the Bands, it should be undertaken. However, given that public lands can provide ready access to natural resources used by tribes, the loss of those acres must be evaluated. In addition, it is the position of the tribal cooperators that replacing a certain number of acres of land in another location is unlikely to adequately mitigate impacts to the exercise of treaty rights. As discussed more fully below, tribes are oriented more toward space than toward time. Thus, the importance or use of a geographic place can no more be moved to a different location than an important event in European history can be moved to a different time.

Tribal cooperators realize the heading states "Cultural Background," therefore we have provided below a brief cultural background to provide context to our evaluation. The PDEIS states in section 2.3.4, Issues Incorporated into EIS After Scoping**:**

> During an EIS process, changes to the Project, changes in the regulatory framework, heightened public concern, or availability of new information related to potential impacts, may make it necessary to refine the scope or structure of an EIS. ***Accordingly, this DEIS will contain greater emphasis on the following issues than was envisioned at the time of the Final SDD***:
> • *Groundwater hydrology and impacts to groundwater;*
> • *Potential for methylation of mercury in wetland or lake systems*;
> • ***Cultural resources from a Native American tribal perspective;. . .***

The Tribal cooperators' position is that this "greater emphasis than was envisioned at the time of the Final SDD" should have been taken into consideration at the beginning of the writing of this chapter. The Tribal cooperators' concerns have not been included since starting consultations with the Tribal Historic Preservation Officers. Therefore, despite the fact that they are jointly making comments now, it is the Tribal cooperators' position that even if all the comments are incorporated, this chapter remains inadequate. It is impossible to correct the mistakes in this chapter without beginning again with full Tribal consultation and consultation. So far, the Tribal cooperators concerns have not been included.

Unlike the June 2008 draft of the PDEIS, there are no longer sections entitled *1854 Ceded Territory* and *1854 Treaty Authority* that purport to summarize existing treaty and tribal regulatory rights. But the language used to discuss the 1854 Treaty is still inaccurate.

The PDEIS has no basis to conclude that there is no adverse effect on "any historic property" within the APE.[3] It contains no evidence that any sufficient TCP study has been done. Indeed, such a study cannot be done properly without tribal consultation and there was no tribal cultural consultation of any kind before the supposed finalization of cultural review on the project. The Band is extremely troubled that the PDEIS nevertheless represents that the Section 106 process has been completed. Further consultation is needed.

History of Iron Range

Minnesota became the 32nd state in 1858. These changes were accompanied by an ever-increasing flow of European-American settlement and the establishment of towns, cities, and non-fur trade-related enterprises (Mason 1981). Wheat surpassed corn as the principal crop in 1860, with much of it being exported out of state. White pine and red pine were sought after by loggers, and were harvested in the Fort Snelling area as early as 1820. By 1870, there were 207 saw mills in Minnesota. In 1877, a law allowing sale of timber off state lands further opened the state for logging. The logging boom had tapered off by the early 1900s (Risjord 2005).

In 1865, the newly appointed Minnesota state geologist, Augustus Hanchett, with the help of his assistant, Thomas Clark, issued a report generally describing copper ore deposits in the Lake Superior area, and iron ore deposits at Lake Vermilion. The following year, Henry H. Eames replaced Hanchett as state geologist, and issued a report confirming the presence of gold ore around Lake Vermilion, creating a short-lived Minnesota gold rush, during which other Minnesota ores were ignored (Lamppa 2004). Discovery of iron ore in the Vermilion Range led the Pennsylvania industrialist Charlemagne Tower to buy large tracts of land on the Vermilion Range. In 1882, Tower organized the Minnesota Iron Company and by 1884 shipped the first ore from the Soudan Mine by rail on the company's Duluth and Iron Range Railroad to Lake Superior (Risjord 2005).

The Merritt brothers of Duluth laid groundwork for their Mountain Iron Mine through their explorations during 1890s (Minnesota Historical Society 2008). Up to that point, only the far eastern portion of the Mesabi Range had been mined for iron, and not on a large commercial scale, with mostly hand-tools being employed (Walker 1979; Atkins 2007). They opened their second mine in 1891 near Biwabik. By 1892, they shipped their first carload of ore on their Duluth, Missabe and North Railroad to dock in Superior, Wisconsin (Minnesota Historical Society 2008). A loan from John D. Rockefeller to the Merritts to expand the railroad ultimately led to the transfer of all of their mining and rail properties to Rockefeller. Shortly thereafter, all of the mining interests in Minnesota were owned by eastern interests, with J.P. Morgan acquiring Rockfeller and Carnegie holdings in 1901 under US Steel (Risjord 2005).

By 1890, when the Mesabi Iron Range deposits were discovered, nearly 300 iron mining companies had been incorporated in Minnesota. By 1900, the Mesabi Range was the most

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[3] *See* PDEIS at § 4.8.3.

extensive iron ore district in the world, supplying increasing demand by steel mills throughout the Great Lakes states (Hall 1987). Early mining ventures in the Mesabi Iron Range focused on hematite, a soft granular rock rich in iron that could be mined with steam shovels and required limited processing. More than 95% of the iron deposits in the Mesabi Range consist of taconite, a hard iron-bearing rock that must be pulverized and processed for mineral extraction (Risjord 2005).

In the late 1920s, increased mechanization reduced the number of workers needed and increased productivity. However, due to the Great Depression, iron ore production in the Iron Ranges dropped dramatically by the early 1930s (Lampp 2004). A cost-effective technology for taconite processing was developed by the late 1930s. Taconite mining was made even more economically feasible by two factors: 1) legislation passed in 1941, replacing property taxes within the Iron Range with taxes on actual ore mined, and 2) by increased demand due to World War II. The Reserve Mining Company was formed in 1942 (Risjord 2005). In 1964, when interest in taconite pellet use in steel manufacture prompted interest in increasing taconite pellet production, an amendment was passed that guaranteed that the tax advantages of the 1941 taconite legislation would be maintained (Lampp 2004).

In 1957, the Erie Mining Company opened its concentration plant at Hoyt Lakes. This plant was Minnesota’s second large-scale taconite plant, and it remained in operation through 2001, with a change in ownership to LTV Steel Corporation in the 1980s, and then to Cleveland Cliffs in 2001 (Zellie 2007). While six new taconite plants were built on the Iron Range in the 1960s and 70s, inexpensive imports changed the industry and decreased demand by two-thirds (Risjord 2005).

4.8.1 Existing Conditions

Existing conditions were defined by several cultural resources studies for the Project. Foth and Van Dyke (1999) produced a study of environmental resources within the Mine Site to support exploratory drilling. As part of this study, a Phase I archaeological survey of the mine pit area was conducted. No cultural resources were identified within the mine pit area along the proposed exploratory drilling transects. Research identified four previously recorded cultural resources located within two miles of the mine pit, including Knot Camp, a historic logging camp (SNFIN 01- 314), two additional logging camps, and a mill located further east.

The 106 Group (2004) conducted a study for the Project, including research, selective visual reconnaissance, and an evaluation of archaeological potential for the lease area (an area approximating the Mine Site); the processing facility; the Tailings Basin; and three proposed railroad interconnection alternatives. Large portions of the studied area were found to have low potential for archaeological resources, meaning that based on available data, intact buried cultural resources are unlikely. Other portions of the studied area were found to have unknown potential for archaeological resources, meaning that not enough data were available to estimate the likelihood of encountering intact buried cultural resources. Upland areas in the vicinity of the Partridge River or larger wetlands were considered to have high potential for archaeological resources. The study identified the LTVSMC processing facility, associated mining features, and railroad as the only existing structural resources at the Plant and Mine Sites. In addition, the study identified the Knot Camp, but described it as outside the area that would be directly affected by the Project.

Soils Consulting (RS75, Soils 2006) prepared the Phase I Archaeological Survey by selectively sampling landscape types considered to have the highest potential for pre-contact archaeological sites, a strategy developed through coordination with the State Historic Preservation Office (SHPO) and the USACE. A single archaeological site, the "NorthMet Site", was identified based on four lithic non-tool artifacts found in four different shovel tests. While no diagnostic artifacts were recovered, the investigators suggested that the lithic raw material types and the landform on which the site is located are consistent with expectations for Late Paleo-Indian or Archaic archaeological sites. Additional studies, conducted in 2008 by Soils Consulting, demonstrated that the "NorthMet Site" does not appear to be potentially eligible for listing on the NRHP, and therefore does not qualify as an historic property and requires no further consideration. SHPO concurred with this finding in 2009.

The Tribal cooperators' position is that only a Phase I archaeological study has been performed at or around the Project site, indicating little to no field work, despite the discovery of potentially significant archaeological sites. There is no discussion of the fact that these discoveries indicate the need for more comprehensive fieldwork in order to avoid these areas.

Soils Consulting found the previously identified Knot Camp and verified that it is outside of the direct APE. Furthermore, the site was found to have been impacted by modern logging activities, significantly compromising its integrity. Scattered surface debris consistent with a historic logging camp use was noted; however, no structural remains of a camp or associated cultural features were identified. The Knot Camp does not appear to be potentially eligible for listing on the NRHP, and therefore does not qualify as an historic property, and requires no further consideration for direct or indirect effects. While two Indian trails reported to pass through the vicinity were mentioned in the literature, attempts to locate either of these trails in the field were unsuccessful.

The Tribal cooperators' position is that no attempt was made to consult with any cooperating tribe's THPO to locate either trail.

It is surprising that this language remains in this draft of the PDEIS, given that the Corps has received comments regarding the inappropriateness of the conclusion. That the literature or even independent field research without tribal assistance might not include sufficient detail to identify historic trails that the Bands are very familiar with is unremarkable—it is precisely this type of tribally-important property that TCP surveys is meant to encompass. This treatment of tribal concerns demonstrates a lack of familiarity with the TCP evaluation process and with tribal consultation requirements.

Landscape Research LLC (Zellie 2007) evaluated the LTVSMC facilities as an historic property and its eligibility for listing on the NRHP. Because the pelletizing plant, a key element in the process and crucial to the interpretation of the facility, has been demolished, the report recommended that the LTVSMC facilities did not appear to meet the criteria for listing on the

NRHP as an historic district. The report recommended that the LTVSMC Concentration Plant and Railroad is eligible and SHPO concurred in 2009. Detailed documentation of key Concentration Plant buildings and structures, including the coarse and fine crusher, conveyor and drive house, general shops, and reservoir was recommended should demolition be planned. The Closure Plan calls for building demolition in accordance with *Minnesota Rules*, part 6132.3200 (RS52, Barr 2007).

In summary, cultural resources studies to date have identified the following resources within the direct APE for the Project (Table 4.8-1).

Table 4.8-1 Cultural Resources Identified in the Project area

Cultural Resource	SHPO and USACE Recommendations
LTVSMC processing facility structures and associated cultural features	• Overall, not NRHP eligible as district • Alone, the LTVSMC Concentration Plant is eligible
LTVSMC railroad	• Overall, not NRHP eligible • Portion associated with Concentration Plant is eligible
The "NorthMet Site" (archaeological site)	Not NRHP eligible

As a whole, the LTVSMC processing facility and associate features is considered by SHPO and USACE as ineligible for listing on the NRHP as an historic district. However, the LTVSMC Concentration Plant and Railroad is considered by SHPO and USACE to be eligible for listing on the NRHP, warranting consideration as an historic property. The LTVSMC Railroad is considered ineligible overall, but portions of the mine/plant track are considered eligible. The "NorthMet Site" is considered ineligible by SHPO and USACE.

Natural Resource Use

As discussed above, no traditional cultural properties or other potentially significant historic properties within the ~~Project Area~~ APE have been identified to date during tribal consultation, but the APE has only been designated for a short time. However, tribal consultation is on-going and no tribal TCP studies have yet been completed. Potential tribal activities involving the use of natural resources of concern to tribal representatives include hunting, fishing, and gathering, amongst other activities. Tribal concerns regarding impacts on and access to plant and animal resources have been identified during tribal consultation. Tribal use of 384 species of plants has been documented (Meeker et al. 1993). Although not quantified in the Project area, these plants occur in a broad range of habitats, including cover types within the Project area (see Section 4.3). However, specific tribal use of any specific areas within the Project area for natural resource exploitation has not been documented and must be part of further consultation. Additional discussion of natural resources is provided in various resource sections of this DEIS (see Sections 4.1-4.5).

The Tribal cooperators' position is that the Natural Resources as Cultural Resources section appropriately acknowledges the tie between natural resources and culture, but the section should be expanded. In this regard, the cooperators offer the following information based on previous work in this area with ethnohistorians examining the issue in the context of other proposed mines within the 1837 and 1842 Ceded Territories.

In 1998, the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) commissioned a report entitled "*Cultural and Economic Importance of Natural Resources Near the White Pine Mine to The Lake Superior Ojibwa*." While the report focuses primarily on natural resource use in the Ontonagon, Michigan area, the themes of the report are relevant to Ojibwe natural resource use throughout the region. More specifically, the importance of a wide variety of natural resources and the broad area from which they were and continue to be gathered, are reflected in the recollections of the tribal members interviewed for the report. A copy of the report is enclosed, and several excerpts are included here to demonstrate the potential impact that a large industrial site may have on the exercise of treaty-reserved rights. The report also contains recommendations that should be followed in order to develop a fuller understanding of the ways in which Ojibwa people have used and continue to use the land. The report states:

> The documentation shows that Ojibwa economy from earliest recorded history to modern times rests upon hundreds of resources spread over a large area. Ojibwas found some resources close to the [White Pine] mine and traveled hundreds of miles for others. Hundreds of plant and animal species provided essential resources in their season.

Any negative impact to tribal harvest of natural resources in a particular location is not simply a matter of inconvenience to the tribal member. It has significant cultural implications. A publication about the potential threats of sulfide mining discusses the importance of particular locations in Ojibwa culture.[2]

> The Indian view of land sharpens the importance of maintaining the sustainability and environmental integrity of the relatively small land base left to the tribes. As distinguished from traditional European thinking, the general Indian orientation is more towards space than towards time. Thus the importance of a particular geographic spot can no more be moved to a different location than the importance in European history of a particular event can be moved to a different time. . . . Commonality of place, as much as of past, defines an Indian tribe. The ties that bind society and culture together are tethered to the earth. If a tribe's traditional lands lose the ability to support life, those ties can badly fray.

In addition, the report entitled "*Cultural and Economic Importance of Natural Resources Near the White Pine Mine to The Lake Superior Ojibwa*" explains why damage to a particular resource or damage to a resource in a particular place, equates to cultural damage:

> The harvest of natural resources is not strictly an economic pursuit from the Ojibwa perspective. Ojibwa cosmology links all animate and inanimate inhabitants of the world in personalized relationships. The Anishinabeg (pl. of

> Anishinabe) treat many beings of the world as kin to humans who give themselves to humans for food, provide healing knowledge, or advise people about the events of their lives. Harvesting rice, venison, berries, maple sugar, and other resources become[s] a critical mechanism by which the Ojibwa perpetuate themselves physically and culturally and regenerate the natural cycle of life. Ojibwas' natural resource use patterns have changed since Americans came to Michigan and Wisconsin after 1820. Still, the Ojibwa cultural identity rests upon a person-to-person relationship with natural resources. . . The Ojibwa fear that processes used to extract metals from the earth threaten these resources.

4.8.2 Impact Criteria

Impacts to cultural resources, including historic structures, archaeological sites, and traditional cultural properties, would be considered significant if they result in adverse effects to historic properties that are eligible for listing on the NRHP. Once a cultural resource is identified, the historic significance of the property must be evaluated in terms of its ability to meet the National Register criteria (36 CFR § 800.4 (c)(1)). A cultural resource that meets the criteria is considered an historic property entitled to the consideration afforded by Section 106 of the NHPA, as outlined in the Advisory Council on Historic Preservation's implementing regulations (36 CFR § 800 *et seq.*).

Impacts to a ~~traditional cultural property~~ TCP, as for any cultural resource, would be evaluated in terms of the specific significance of the resource in terms of its eligibility for listing on the NRHP and the potential for the Proposed Project to detract from that significance.

The impact criteria should also recognize the importance of natural resources to tribal cultural practices, even when tribal use of natural resources does not qualify those resources as traditional cultural properties. The right to hunt, fish, and gather on ~~public~~ lands within the 1854 Treaty Ceded Territory is protected by the 1854 Treaty. Limitation or elimination of access to public lands within the 1854 Treaty Ceded Territory for these purposes as provided by the Treaty, ~~without appropriate replacement~~, would be considered an impact to treaty rights. In addition, the impact criteria should recognize that replacement of these sites may not adequately replace their cultural value, since, as discussed above, in Ojibwe culture commonality of place is essential.

It is the position of the tribal cooperators that this is far from a sufficient analysis of impacts to the Ceded Territory. See other comments below.

4.8.3 Environmental Consequences

4.8.3.1 Proposed Action

If a cultural resource can be demonstrated to meet the criteria for listing on the NRHP, it qualifies as an historic property, and impacts to that historic property must be avoided or mitigated appropriately. The APE is the area within which the Project has the potential to either directly or indirectly impact historic properties that may be present. The direct APE for the Project includes the physical footprint of the proposed undertaking. The LTVSMC concentration plant and railroad are the only historic properties identified to date within the direct APE. The extent of the indirect APE is dependent on the extent of potential impacts to various resources (for example, water, visual, or noise impacts). The extent of the indirect APE is the subject of on-going consultation, and may include all or portions of the Embarrass River, Partridge River, and Dunka River watersheds. ~~No historic properties have been identified to date in the indirect APE. Efforts to identify potential historic properties within the indirect APE are continuing as part of tribal consultation.~~ The position of the tribal cooperating agencies is that given the recent designation of the APE as including the St. Louis River, no such conclusion can be included here.

The Tribal cooperating agencies' position is that the indirect APE extends to the mouth of the St. Louis River. Moreover, the Corps has adopted this position by its August 11, 2009 statements. Therefore, this section must be properly revised and significant cultural and environmental surveys re-done to properly reflect the extent of the APE.

USACE has conducted consultation with the Minnesota SHPO (USACE 2007; USACE 2009; SHPO 2007) regarding potential impacts to historic properties. Based on strategic sampling of the Project area, the SHPO and USACE concur that no further efforts are required to identify historic properties within the direct APE. The "NorthMet Site", which would be impacted by the Project, does not appear to be eligible for listing on the NRHP. SHPO has found that the LTVSMC Concentration Plant and Railroad, considered potentially eligible for listing on the NRHP, would be adversely affected by the proposed modifications for reuse and by the demolition to occur after facility closure. This adverse effect would be mitigated by Historic American Building Survey/Historic American Engineering Record documentation of the LTVSMC Concentration Plant and Railroad prior to initiation of significant modifications. A Memorandum of Agreement, currently in development, will detail the specifics of the mitigation.

Beyond the potential impacts to historic properties, impacts to the cultural use of some natural resources would occur. Signatory tribes are entitled access to these natural resources on public lands to the extent rights are afforded by the 1854 Treaty. ~~The 1854 Treaty provides the right to hunt, fish, and gather on public lands within ceded territory.~~ In the course of consultation, tribes have expressed concern that wetlands and other water resources would be impacted by the Project, which could modify the natural resources available for their use ~~on public lands~~. Tribal cooperators note that this language is incorrect as a matter of law. Although wetlands impacts would be mitigated, most of the proposed compensatory wetlands mitigation would be located outside the ~~ceded 1854 Treaty area~~ Ceded Territory. These natural resource impacts are evaluated elsewhere in this document.

Tribal cooperators would like citations for the sections where these impacts are evaluated.

Notwithstanding these impacts, the USFS position that PolyMet must acquire surface ownership of the land before mining could be conducted, thereby removing it from public ownership would preclude public or tribal access to current public lands within the Mine Site. The loss of hunting, gathering, and fishing rights on the public land that would become private land resulting from the Project may be compensated for, at least in part, by the proposed land exchange in which new land would be acquired for inclusion in the National Forest System lands in exchange for the land occupied by the Project. Should this occur, access to natural resources on the additional land by 1854 signatory tribes may be made available. The extent to which this measure would be effective in offsetting these natural and cultural resource impacts may depend on the location of the exchanged lands and the type and degree of specific resources that it would contain. The effects of this land exchange would be evaluated in a separate analysis prepared by the USFS. The USFS is consulting with the tribes regarding this land ownership issue.

Of particular concern to tribal representatives is the potential impact to wild rice beds. According to inventory information as reported by the MnDNR, the Embarrass River has been identified as one of approximately 1,200 water bodies in Minnesota where wild rice is or has occurred. The closest wild rice bed is located on Hay Lake, a downstream tributary to the Embarrass River located approximately 5.5 miles west of the LTVSMC Tailings Basin (MnDNR 2008, Natural Wild Rice in Minnesota). It is the position of the tribal cooperating agencies that this is incorrect and underscores the need for further consultation and surveys, especially considering the recent designation of the APE. Wild Rice has been found on the Partridge River, north of the Hwy 110 Bridge, and it is closer than Hay Lake. Environmental consequences of the Project that may impact the wild rice beds are discussed in Section 4.1. Discussion of other specific natural resources and their use occurs within the appropriate natural resources chapters.

4.8.3.2 No Action Alternative

The No Action Alternative would provide no benefit to historic properties, other than the retention of the NorthMet archaeological site, which would be impacted under the Proposed Action. This site does not appear to be eligible for listing on the NRHP. The No Action Alternative would require the complete dismantling of the existing processing facilities under the LTVSMC reclamation plan, while the Proposed Action would retain and reuse the facility, which is preferable from an historic preservation standpoint. However, demolition of the processing facilities are still proposed at Closure under the Proposed Action.

Under the No Action Alternative, the LTVSMC site would be restored, although public access to the site for natural resource use would require the site be converted from private to public land. Access to existing public lands within the Project area would continue, allowing access for the traditional use of natural resources by Ojibwe people to occur.

4.8.3.3 Mine Site and Tailings Basin Alternatives

The Mine Site and Tailings Basin Alternatives would not modify the APE, nor would they result in added benefit or impact to historic properties as compared to the Proposed Action. No historic properties would be impacted by the footprint of these alternatives, and no impact would be avoided that would otherwise occur, such as to the LTVSMC Concentration Plant and Railroad, as discussed above. The impact to natural resources under these Alternatives, including those with the potential for traditional use by Ojibwe people pursuant to the 1854 Treaty, are described in the corresponding natural resource sections of this DEIS.

4.8.3.4 Mitigation Measures

The Project would potentially impact a historic property eligible for listing on the NRHP through construction and operation of the Plant Site and the 1854 signatory tribes through the potential loss of access to lands and natural resources within the 1854 Ceded Territory. The following mitigation measures are recommended to mitigate these impacts:

- The USACE is working with PolyMet to develop a recordation mitigation plan for the Concentration Plant building, prior to its renovation as part of the Project.
- It is currently unknown if the proposed land exchange would be within the ceded territory; therefore, signatory tribes could incur a net loss of access to public lands within the ceded territory from the Project. As part of its NEPA process for the proposed land exchange, the USFS is consulting with ~~Native American~~ Indian tribes regarding effects to treaty rights, including possible mitigation measures such as seeking lands for exchange that occur within the ceded territory.

Consultation between the USACE and ~~Native American~~ Indian tribes to identify an indirect APE for the Project is ongoing. Once the indirect APE is identified and an analysis of indirect impacts is completed, further mitigation planning may occur.

4.8.4 Cumulative Impacts

The Final SDD (MnDNR 2005) did not identify any cumulative effects associated with cultural resources. ~~Subsequent analysis in this DEIS concludes that the only adverse effect resulting from the Project on historic properties identified to date that are listed on, or eligible for listing on, the NRHP would be the modification and eventual demolition of the LTVSMC Concentration Plant and Railroad, which would also occur under the other identified alternatives. The Project would not contribute to any other cumulative effects on historic properties.~~ It is the position of the tribal cooperating agencies that this entire conclusion is premature based upon the designation of the APE and must be deleted. They also note that Tribes were not involved as Cooperating Agencies during the Scoping Process or when the Final SDD was issued.

Tribal representatives have indicated that the Project would have an effect on its usufructuary treaty rights by removing the Project site from public ownership within the Ceded Territories. The tribes have also raised concerns regarding the location of proposed wetland mitigation being outside the Ceded Territories. We address the potential cumulative effects related to these land use-related treaty issues, as distinct from historic properties discussed herein, in Section 4.14 (Cumulative Effects).

The Tribal cooperating agencies' position is that although there have been numerous requests to evaluate cumulative effects for groundwater quality, drawdown and inundation that has not been included in the DEIS analysis. Therefore, it is impossible to identify cumulative effects to wetlands (and the vegetation and wildlife therein) that may occur within the Project APE.

Tribal representatives have ~~recently~~ suggested over the course of the discussions and Section 106 consultations on this project that the 1854 Ceded Territory may qualify as a TCP and therefore may meet the criteria for listing in the National Register (see also Van Norman 2009). ~~The USACE has determined that the Ceded Territory does not meet the criteria for listing in the National Register.~~ The Corps is continuing to consider this question. [The tribal cooperating agencies note that by the Corps' own admission, discussions between the Corps and the Bands are ongoing. The Grand Portage Band sent a letter through legal counsel on May 15, 2009 regarding this question and asked for further consultation and no written response has yet been received. The Corps has stated that it still plans to issue a response and until that time this conclusion cannot be included here.]

The Tribal cooperating agencies' position is that further consultation that includes the Advisory Council on Historic Preservation and other cultural resource professionals to discuss the issue is likely to occur as a result of the dispute resolution process.

This chapter cannot be completed without significant additional consultation with the Tribal cooperating agencies, development of full, Tribal TCP surveys, proper evaluations of natural and cultural resources based upon the recently-defined (and much expanded) APE, and much more research. Therefore, the Tribal cooperating agencies take the position that even with the inclusion of all changes and comments made here, the chapter will be far from ready for publication in the Draft EIS. The Tribal cooperating agencies expressly condition their comments on this position and maintain the position that Section 106 consultation is incomplete and inadequate, as to nearly every section. The Corps' evaluation of the 1854 Ceded Territory as a TCP is far from sufficient. The Tribal cooperators have made similar comments on all PDEIS cultural resources chapter drafts, with little effect, and therefore incorporate all earlier comments here as if made directly herein. The Tribal cooperators also reiterate their request for direct contact with the drafters of this chapter in order to efficiently address these problems. Finally, the Tribal cooperators again ask that the Corps follow the ACHP Handbook, "Consultation with Indian Tribes in the Section 106 Review Process" (Nov. 2008). Citation formats should be made consistent throughout, i.e., either using "§" or "Section" consistently in the text and placing all publication titles either in italics or in quotation marks. All laws, regulations, publications, or other references should include full citations, not just document titles.

4.9 COMPATIBILITY WITH PLANS AND LAND USE REGULATIONS

4.9.1 Existing Conditions

The Project area currently falls under a variety of land use jurisdictions, including federal (USFS Superior National Forest Plan), state (Minnesota Forest Resource Council Landscape Management Plan), county (St. Louis County Comprehensive Land Use Plan and zoning ordinance including the County Water Plan), and municipal (City of Babbitt Comprehensive Plan and zoning ordinance and the Hoyt Lakes zoning ordinance) land management plans (Figure 4.9-1).

4.9.1.1 Federal Land Management

The USFS and PolyMet are currently working on a land exchange, which would remove Project lands from the National Forest System; therefore, the USFS Superior National Forest Plan would no longer apply to Project lands. This analysis is based on a successful completion of the land exchange and elimination of National Forest System lands from the Project.

There are roads used by the USFS throughout the Project area. The main road is the privately-owned Dunka Road, along the south border of the Mine Site, which would be used for Project access for vehicles and equipment. Several Forest Service system roads including Road 108 (branches A, B, D, AA, BA, BB, BC, and BD) and Road 109 (branches A, B, and C) lie within the proposed lease property for the Mine Site and are currently used to as a southern access point to the Minnesota state lands to the northeast of the Mine Site.

4.9.1.2 State Land Management

The Minnesota Forest Resource Council (MFRC) Landscape Management Plan was published in March 2003 and identifies the desired conditions for the forests of northeastern Minnesota (Northeast Landscape Region). The goals of the plan include moving toward the potential range of variability for natural plant communities; achieving spatial structure consistent with the ecology of northeastern Minnesota; and providing diverse habitat to maintain natural communities and viable populations for the plant and animal species in northeastern Minnesota.

4.9.1.3 Local Land Management

St. Louis County has a comprehensive land use plan, which includes the St. Louis County Water Plan (Section 20), that was adopted in January 1996 and sets general development goals for those portions of the county outside of incorporated municipalities. The majority of the Project area is within the incorporated limits of the cities of Hoyt Lakes and Babbitt; however, a small portion of the Tailings Basin is within the unincorporated Waasa Township and therefore subject to jurisdiction under this plan.

The Mine Site and portions of the Project transportation corridors are within the incorporated limits of the City of Babbitt, whose comprehensive plan includes provisions for the development of mineral resources within its borders.

The Plant Site and portions of the Project transportation corridors are within the incorporated limits of the city of Hoyt Lakes. Within these limits, the local planning commissions regulate land use by means of zoning ordinances, including areas specifically zoned for mining operations and mining-related activities. Hoyt Lakes has not developed a comprehensive plan.

The tribal cooperating agencies' position is that the St. Louis River Management Plan, approved by the St. Louis River Board on February 6, 1994, should also be included in the evaluation of this project's consistency with local land use and management plans. The Fond du Lac Reservation was actively involved in the creation of this Board and Management Plan, because there were serious concerns raised about land use management, fish and wildlife, water quality, recreation, and archeological and cultural areas within the watershed. Key principles defined in this plan include protection of wetlands and the identification and protection of Scientific and Natural Areas.

4.9.2 Impact Criteria

Impacts to land management would occur if the Proposed Action or Alternatives are incompatible or inconsistent with existing land use plans, regulations, or policies adopted by local, state, or federal governments.

4.9.3 Environmental Consequences

4.9.3.1 Proposed Action

Federal Land Management

The USFS and PolyMet have been working together to complete a land exchange to resolve the current divided ownership. The USFS has identified approximately 6,700 acres of National Forest land (including the NorthMet Project lands) to exchange for yet to be determined non-federal land such that there would be no net loss of USFS land. Tribal cooperating agencies understand that the land exchange is based on value, not acreage, so there is no guarantee that there would be no net loss. In addition, there could be other types of losses based on differences in the natural resources found on the original versus exchanged lands. A separate EIS or NEPA analysis will be prepared for the proposed land exchange (as appropriate) in compliance with all applicable rules and regulations. A land exchange for land adjustment is consistent with the Superior National Forest Land and Resource Management Plan (USDA 2004, Forest Plan pages 2-51 - 2-52). The land exchange would convert National Forest System lands to private lands; therefore, Project lands would not be subject to the Superior National Forest Plan.

Development of the proposed Mine Site would require removal of USFS Roads 108 and 109, including their branches; however, following successful completion of the land exchange there would be no Forest Service lands in this area to access. Development of the Mine Site would also involve logging in preparation for mining activities; therefore, there would be no immediate need for logging roads in this area once mining activities begin.

State Land Management

PolyMet proposes clearing of uplands and wetlands, and a revegetation plan comprised primarily of non-native and potentially invasive species, which would prevent the Project area from meeting the goals of the MFRC Landscape Management Plan to promote diverse, natural floral and faunal communities and populations and maintain a spatial structure consistent with northeastern Minnesota ecology.

Comment [N1]: Please cite the section where the revegetation plan and its impacts are described in more detail.

The Dunka Road is jointly owned by PolyMet, Cliffs Erie, and Minnesota Power and would continue to be a private road; therefore, there would be no change in terms of access to State land. The State of Minnesota has also indicated that Project would not create any access hardships to State lands (Magnusun 2008, Personal Communication).

Local Land Management

The Mine Site, Plant Site, and portions of the transportation corridors are within the incorporated limits of the cities of Babbitt and Hoyt Lakes. The mining activities and transportation (along the existing road and railroad corridors) of ore from the mine to the plant are consistent with the Babbitt comprehensive plan (MnDNR 2005, Personal Communication with Jim Lasi, city of Babbitt, as cited in the EAW). These activities are proposed in the portion of Babbitt zoned for mineral mining activities, including exploration, extraction, processing, and tailings disposal. The portion of the Project area within the City of Hoyt Lakes is currently zoned for mining and mining-related activities; therefore, the Project is consistent with the Hoyt Lakes planning regulations.

The portion of the Tailings Basin in Waasa Township is currently zoned for industrial use under the St. Louis County Comprehensive Land Use Plan. According to the plan, industrial use includes mining and all associated processing and transportation activities; therefore, use of the area for the Project is consistent with the county comprehensive land use plan, including the St. Louis County Water Plan.

Summary

The USFS and PolyMet are working to complete a land exchange, which would convert Project lands within the National Forest System to private lands; therefore, the Federal land management guidelines would not apply to Project lands. The mine reclamation plan would ultimately revegetate much of the Mine Site; however, it proposes the use of non-native, potentially invasive species which is inconsistent with the MFRC Landscape Management Plan. Therefore, the Project would be inconsistent with State land management plans. We discuss potential mitigation measures for these in Section 4.9.3.4.

The Project would be consistent with the St. Louis County Comprehensive Plan, City of Babbitt Comprehensive Plan, and Hoyt Lakes zoning ordinance; and, therefore, would be compatible with local land management plans and regulations.

4.9.3.2 No Action Alternative

Continued current uses and activities at the NorthMet Site under the No Action Alternative would be compatible and consistent with existing land management plans, regulations, and practices. It is the tribal cooperating agencies' position that this section should include discussion of the remediation that would occur at the site under this alternative, and it's compatibility with the MFRC Landscape Management Plan.

4.9.3.3 Mine Site and Tailings Basin Alternatives

Similar to the Proposed Action, under the Mine Site and Tailings Basin Alternatives, the USFS and PolyMet would work together to complete a land exchange to resolve the current divided ownership. Following successful completion of the land exchange, this alternative would not be subject to Federal land management guidelines. This alternative would also propose to revegetate the site with a seed mix that includes non-native and invasive species, which would be in consistent with the MFRC Landscape Management Plan. As with the Proposed Action, this alternative would require removal of USFS Roads 108 and 109, including their branches. As with the Proposed Action, this alternative would be consistent with all local land use policies.

4.9.3.5 Potential Mitigation Measures

The FSDD identified a potential mitigation measure for impacts from the Project, one of which has the potential to affect Compatibility with Plans and Land Use Regulations.

PolyMet currently proposes to stabilize disturbed areas during Project operations and at the time of Mine Closure using a seed mix that includes several non-native and potentially invasive species. This seed mix has been selected in order to quickly and effectively stabilize disturbed areas and re-establish soil nutrients. To mitigate the potential use of non-native, invasive species would be to reseed with native non-invasive species as long as they can perform as effectively as the non-native species. The tribal cooperating agencies' believe that this section should discuss or cite to a document that discusses the standards by which performance of the native seed mix would be judged. The use of a native seed mix during reclamation would be consistent with the goals of the MFRC Landscape Management Plan promoting diverse floral and faunal habitat and a spatial structure consistent with northeastern Minnesota ecology.

4.9.4 Cumulative Impacts

The Project, as proposed, would comply with the local land management plans and regulations for St. Louis County, the city of Babbitt and the city of Hoyt Lakes. Provided PolyMet and the USFS agree to a land exchange, the Project would no longer be subject to the management guidelines and policies of the Superior National Forest Plan. In addition, implementation of the above-referenced mitigation measures (e.g., a native seed mix) would allow the Project to comply with the long-term goals of the MFRC Landscape Management Plan. Therefore, there would be no long-term or cumulative impacts from the Project relative to Compatibility with Plans and Land Use Regulations. It is the tribal cooperating agencies' position that because the Proposed Action does not contain the native seed mitigation measure, this section should discuss long-term and cumulative impacts from the Proposed Action.

4.10 SOCIOECONOMICS

St. Louis County, the East Range (the eastern portion of the Mesabi Iron Range) communities (the cities of Aurora, Babbitt, Biwabik, Hoyt Lakes, Tower, Ely, and Soudan), and their surrounding areas would experience some portion of the Project's socioeconomic effects. Labor and materials for the Project are also projected to come from urban centers such as Duluth and Minneapolis. This assessment focuses on St. Louis County and the East Range communities.

St. Louis County has a long mining heritage. Portions of the county are commonly referred to as the Iron Range. The East Range communities were established as a result of numerous iron mining operations dating back to the 1800s. In response to a marked drop in employment in the Iron Range between the 1920s and 1932, former Minnesota Governor Harold Stassen and the Minnesota legislature formed the Iron Range Resources and Rehabilitation Board (IRRRB) in 1941. The organization has subsequently changed its name to Iron Range Resouces (IRR). The objective of IRR is to help diversify the economy of the region away from its initial high dependence on high-grade ore mining by public funding of social and economic development projects with a focus on taconite mining, timber, tourism, and technology-related education. Funded by taxes on mining operations, the IRR provides grants and other programs to foster community redevelopment in the Iron Range region.

The Project would be the first non-ferrous mine and processing plant permitted in Minnesota. There are several similar known deposits in the state. While no other deposits are currently in the environmental review or permitting phase, many are in advanced stages of exploration, which may reflect an expansion of mining in the region in addition to the existing taconite iron mining industry.

4.10.1 Existing Conditions

4.10.1.1 Population and Population Trends

The population of St. Louis County is centered in Duluth (located approximately 65 miles south of the Project), with smaller, secondary centers in the central Iron Range communities of Hibbing and Virginia (located approximately 40 and 20 miles west of the Project, respectively). The population trends for the East Range communities are somewhat similar to the population trends of St. Louis County. As the population data in Table 4.10-1 illustrates, the county and the communities have experienced a population decline since 1980, although the county decline is less than one-quarter that of the East Range communities. In addition to a decline in population since 1980, the East Range communities have experienced an increase in median age relative to St. Louis County and the state of Minnesota (Table 4.10-2).

Table 4.10-1 Population of St. Louis County and Select East Range Communities, MN 1980 to 2004

	St. Louis County, MN	Select East Range Communities, MN						
		Aurora	Babbitt	Biwabik	Ely	Hoyt Lakes	Soudan	Tower
1980	222,229	2,670	2,435	1,428	N/A	3,186	N/A	640
1990	193,433	1,965	1,562	1,097	3,968	2,348	502	502
2000	200,528	1,850	1,670	954	3,724	2,082	372	469
2001	200,431	1,831	1,661	943	N/A	2,070	N/A	476
2002	200,854	1,815	1,651	934	N/A	2,055	N/A	473
2003	199,887	1,791	1,642	905	N/A	1,987	N/A	504
2004	198,799	1,777	1,630	904	N/A	1,961	N/A	504

Source: U.S. Bureau of the Census, Population Estimates and Population Distribution Branches, CO-EST2003-01 as reported in RS72, PolyMet 2006.
Note: Data for Soudan and Ely, MN was not found for years other than the 1990 and 2000 decennial census.

Table 4.10-2 Age of Residents of Selected East Range Cities in St. Louis County, MN, in 2000

	Aurora	Babbitt	Biwabik	Ely	Hoyt Lakes	Tower	All Cities	St. Louis County	State of MN
Median age	45.2	46.8	41.5	40.8	45.6	45.3	44.2	39	35.4
18 years and over	1,483	1,320	756	3,061	1,669	390	8,679	155,699	3,632,585
Percentage	80.2%	79.0%	79.2%	82.20%	80.2%	81.4%	80.4%	77.6%	73.8%
65 years and over	442	479	192	803	444	119	2,479	32,274	594,266
Percentage	23.9%	28.7%	20.1%	21.60%	21.3%	24.8%	23.4%	16.1%	12.1%

Source: U.S. Bureau of the Census, Census 2000 Demographic Profile Highlights as reported in RS72, PolyMet 2006, modified for inclusion of the city of Ely, Minnesota. Data unavailable for the city of Soudan, Minnesota.

In terms of racial distribution, the East Range communities are predominantly Caucasian (Table 4.10-3). This is somewhat consistent with the racial composition of St. Louis County and the state; however, other races in the communities are underrepresented by comparison.

Table 4.10-3 Racial Characteristics of Residents of Selected East Range Cities in St. Louis County, MN, in 2000

	Aurora	Babbitt	Biwabik	Ely	Hoyt Lakes	Tower	All Cities	St. Louis County	State of MN
White	1,820	1,651	931	3,607	2,064	468	10,541	190,211	4,400,282
Percentage	98.4%	98.9%	97.6%	96.9%	99.1%	97.7%	98.0%	94.9%	89.4%
African American	1	2	0	32	6	0	41	1,704	171,731
Percentage	0.1%	0.1%	0.0%	0.9%	0.3%	0.0%	0.5%	0.8%	3.5%
American Indian	8	5	20	20	4	7	64	4,074	54,967
Percentage	0.4%	0.3%	2.1%	0.5%	0.2%	1.5%	0.6%	2.0%	1.1%
Asian	7	2	1	7	2	0	19	1,333	141,968
Percentage	0.4%	0.1%	0.1%	0.2%	0.1%	0.0%	0.2%	0.7%	2.9%
Hispanic or Latino	6	0	0	25	4	9	44	1,597	143,382
Percentage	0.3%	0.0%	0.0%	0.7%	0.2%	1.9%	0.5%	0.8%	2.9%
Other	14	10	1	58	6	4	93	3,206	150,531
Percentage	0.8%	0.6%	0.1%	7.9%	0.3%	0.8%	1.2%	1.6%	3.1%
Foreign born	26	13	15	36	26	0	116	3,897	260,463
Percentage	1.4%	0.8%	1.6%	1.0%	1.2%	0.0%	1.1%	1.9%	5.3%

Source: U.S. Bureau of the Census, Census 2000 Demographic Profile Highlights as reported in RS72, PolyMet 2006, modified for inclusion of the city of Ely, Minnesota. Data unavailable for the city of Soudan, Minnesota.

Table 4.10-4 includes the household/family size of the East Range cities, St. Louis County, and the state for 2000. The average household and family size of the cities are smaller than that of the county and the state, while the percentage of married adults over the age of 15 is higher. This can be attributed to the higher percentage of persons 65 and older in the East Range communities than in the state (Table 4.10-2). Married persons in this age range are less likely to have children living in the home, lowering the average household size.

Table 4.10-4 Household/Family Size of Selected East Range Cities in St. Louis County, MN, in 2000

	Aurora	Babbitt	Biwabik	Ely	Hoyt Lakes	Tower	All Cities	St. Louis County	State of MN
Average household size	2.19	2.27	2.09	2.05	2.27	2.06	2.16	2.32	2.52
Average family size	2.79	2.67	2.69	2.72	2.71	2.69	2.71	2.9	3.09
Married males (15 years and over)	467	468	207	695	569	101	2,507	44,387	1,089,778
Percentage	63.2%	69.5%	55.1%	42.6%	66.2%	54.0%	58.4%	55.6%	57.7%
Married females (15 years and over)	450	481	189	713	597	104	2,534	43,645	1,082,898
Percentage	56.5%	67.6%	45.2%	45.2%	66.2%	52.8%	55.6%	51.5%	55.0%

Source: U.S. Bureau of the Census, Census 2000 Demographic Profile Highlights as reported in RS72, PolyMet 2006, modified for inclusion of the city of Ely, Minnesota. Data unavailable for the city of Soudan, Minnesota.

Education levels in the East Range communities were lower than that of St. Louis County and the state in 2000 (Table 4.10-5). Individuals over 25 years of age who achieved a high school diploma in the communities are approximately 2% less than that of the county and the state.

Those with bachelor's degrees or above in the East Range communities are 24% lower than the county and 39% lower than the state.

Table 4.10-5 Education Characteristics of Residents of Selected East Range Cities in St. Louis County, MN (Population 25 years and older), in 2000

	Aurora	Babbitt	Biwabik	Ely	Hoyt Lakes	Tower	All Cities	St. Louis County	State of MN
High school graduate or higher	1,084	1,024	595	2,107	1,354	283	6,447	115,861	2,783,000
Percentage	80.8%	83.0%	87.5%	86.0%	88.2%	88.4%	85.3%	87.2%	87.9%
Bachelor's degree or higher	247	98	68	540	279	36	1,268	29,040	868,082
Percentage	18.4%	7.9%	10.0%	22.0%	18.2%	11.3%	16.8%	21.9%	27.4%

Source: U.S. Bureau of the Census, Census 2000 Demographic Profile Highlights as reported in RS72, PolyMet 2006, modified for inclusion of the city of Ely, Minnesota. Data unavailable for the city of Soudan, Minnesota.

4.10.1.2 Income

Table 4.10-6 presents income characteristics for the selected East Range communities, St. Louis County, and the state. The median income of the East Range communities is 21% lower than that of the county and 34% lower than that of the state. In addition, the East Range communities have 49% more families below the poverty level than the state, and the number of persons in the labor force in the region is lower than that of the county and state. The U.S. Bureau of Economic Analysis reports the average earnings per job in St. Louis County for 2004 as $38,364.

Table 4.10-6 Income Characteristics of Families and Residents of Selected East Range Cities in St. Louis County, MN (Population 25 years and older), in 2000

	Aurora	Babbitt	Biwabik	Ely	Hoyt Lakes	Tower	All Cities	St. Louis County	State of MN
Median family income in 1999	$43,095	$37,137	$37,386	$36,047	$45,603	$37,500	$37,443	$47,134	$56,874
Families below poverty level	44	19	31	88	42	5	229	3,731	64,181
Percentage	8.5%	3.6%	11.7%	9.5%	6.6%	3.7%	7.6%	7.2%	5.1%
In labor force (16 years and older)	833	662	388	1,806	1,003	242	4,934	101,258	2,691,709
Percentage	55.0%	48.6%	50.1%	57.1%	57.8%	64.0%	55.3%	62.7%	71.2%

Source: U.S. Bureau of the Census, Census 2000 Demographic Profile Highlights as reported in RS72, PolyMet 2006, modified for inclusion of the city of Ely, Minnesota. Data unavailable for the city of Soudan, Minnesota.

4.10.1.3 Employment

Employment trends for St. Louis County show a decline in mining since 1980 and an increase in the service sector (Tables 4.10-7 and 4.10-8). Data from 1980 and 1990 are reported by Standard Industrial Classification codes (SIC), while 2000 and 2004 data are reported by the new sectors of the North American Industrial Classification System (NAICS) codes. The major sectors of employment for St. Louis County for 1980 and 1990 are provided by SIC code in Table 4.10-7 and for 2000 and 2004 by NAICS code in Table 4.10-8. In 2004, the top three employment sectors were health care and social assistance, retail trade, and accommodation and food services. Mining employment fell from the seventh-ranked sector in 2000 to the twelfth-ranked sector in the county in 2004, with an average employment of 2,752.

In 2005 unemployment in St. Louis County was 4.9%, compared with 4.0% for the state (U.S. Census Bureau Map Stats, 2005).

Table 4.10-7 St. Louis County, Employment by Major SIC Industry in 1980 and 1990

SIC Title	1980		1990	
	Average Employment	**Percent**	**Average Employment**	**Percent**
Agriculture	223	0.3%	318	0.4%
Mining	**10,973**	**15%**	**5,326**	**7%**
Construction	3,939	5%	3,465	4%
Manufacturing	7,462	10%	6,868	9%
Transportation, Com., and Elec.	3,448	5%	4,733	6%
Finance, Insurance, and Real Estate	1,364	2%	2,820	4%
Services	22,525	30%	30,472	38%
Public Administration	5,838	8%	5,968	7%
Trade, Total	**19,332**	**26%**	**19,680**	**25%**
Total, all industries[1]	**75,104**		**79,650**	

Source: RS72, PolyMet 2006
[1] Due to rounding, the percentages reported may not add up to 100 percent.

Industry classifications for the East Range communities are summarized in Table 4.10-9, which suggest that education, health, and social services make up the largest percentage of each locale’s employment. In four of the six towns, agriculture, forestry, fishing and hunting, and mining make up the second highest percentage of employment as classified by NAICS. To provide an additional frame of reference, occupational categories are provided for each of the towns per the Standard Occupational Classification System (SOC). Farming, fishing, and forestry occupations make up extremely small percentages of the total occupations for each town, suggesting that mining is a prevalent constituent of the NAICS agriculture, forestry, fishing and hunting and mining industry classification within the communities.

Certain industries, particularly mining and utilities, are more concentrated in St. Louis County than in the state generally. Sector concentration can be measured by the location quotient, which is the ratio between the local economy and the economy of a reference unit. For this analysis, the location quotient was calculated using St. Louis County as the local economy and the state as the reference unit. As illustrated by Table 4.10-10, the location quotient for the mining industry is 14.9, meaning that in St. Louis County mining employment is over fourteen times that of the state.

Table 4.10-8 St. Louis County, Employment by Major NAICS Industry in 2000 and 2004

NAICS Title	2000		2004	
	Average Employment	**Percent**	**Average Employment[1]**	**Percent[1]**
Health Care and Social Assistance	17,916	19%	20,566	22%
Retail Trade	13,046	14%	12,183	13%
Accommodation and Food Services	8,781	9%	8,907	10%
Educational Services	7,735	8%	7,737	8%
Public Administration	5,783	6%	5,919	6%
Manufacturing	6,389	7%	5,504	6%
Construction	4,127	4%	3,926	4%
Finance and Insurance	3,040	3%	3,733	4%
Transportation and Warehousing	3,948	4%	3,313	4%
Administrative Waste Services	2,780	3%	3,242	3%
Other Services	3,293	3%	3,191	3%
Mining	**4,570**	**5%**	**2,752**	**3%**
Professional and Technical Services	2,776	3%	2,585	3%
Information	2,871	3%	2,356	3%
Wholesale Trade	2,755	3%	2,072	2%
Arts, Entertainment, and Recreation	2,251	2%	983	1%
Utilities	999	1%	942	1%
Real Estate and Rental and Leasing	963	1%	912	1%
Management of Companies and Entpr.	955	1%	662	1%
Agriculture, Forestry, Fishing & Hunting	248	0.3%	249	0.3%
Total, all industries[1]	95,157		92,668	

Source: RS72, PolyMet 2006

1 Due to rounding, the percentages reported may not add up to 100 percent.

Table 4.10-9 Employment Characteristics of Selected East Range Cities in St. Louis County, 2000

		Aurora	**Babbitt**	**Biwabik**	**Ely**	**Hoyt Lakes**	**Tower**	**All Cities**	**St. Louis County**	**State of Minnesota**
Occupation (SOC Title)	Management, professional, and related occupations	29%	19%	24.90%	30%	21.90%	16.20%	25.57%	30.50%	35.80%
	Service occupations	20.50%	18.20%	24.10%	21.40%	18.60%	23.40%	20.56%	18.20%	13.70%
	Sales and office occupations	15.90%	25.70%	16.20%	23.80%	20.40%	27.70%	21.66%	26.20%	26.50%
	Farming, fishing, and forestry occupations		0.30%		0.40%			0.20%	0.50%	0.70%
	Construction, extraction, and maintenance occupations	14.80%	12.70%	19.60%	14.60%	18%	16.60%	15.55%	11.90%	8.40%
	Production, transportation, and material moving occupations	19.70%	24.10%	15.10%	9.80%	21.10%	16.20%	16.45%	12.80%	14.90%
Industry (NAICS Title)	Agriculture, forestry, fishing and hunting, and mining	19.10%	16.90%	16.80%	10.30%	19.70%	7.20%	14.92%	5.70%	2.60%
	Construction	3.70%	2.90%	7%	6.70%	4.70%	8.90%	5.43%	5.90%	5.90%
	Manufacturing	7.10%	14.80%	9.50%	5%	15.40%	10.60%	9.43%	7.80%	16.30%
	Wholesale trade	2.10%	2.30%	1.70%	1.30%	0.80%	1.30%	1.47%	3.10%	3.60%
	Retail trade	11.20%	13%	10.40%	13.60%	10.50%	14%	12.25%	13.00%	11.90%
	Transportation and warehousing, and utilities	4.60%	5%	3.60%	2%	4.70%	6.40%	3.74%	6.50%	5.10%
	Information	1%	1.10%	1.70%	3.20%	1.50%		1.93%	2.80%	2.50%
	Finance, insurance, real estate, and rental and leasing	4.10%	4.70%	2.20%	5.80%	2.40%	3.80%	4.29%	4.60%	7.20%
	Professional, scientific, management, administrative, and waste management services	0.90%	2.90%	4.20%	6.50%	5.10%	1.30%	4.35%	5.20%	8.80%
	Educational, health and social services	25.90%	17.90%	18.80%	25.90%	20.30%	13.20%	22.47%	25.70%	20.90%
	Arts, entertainment, recreation, accommodation and food services	11.60%	7.80%	13.20%	12.50%	9.60%	22.10%	11.68%	10.10%	7.20%
	Other services (except public administration)	6.40%	5.90%	7%	4.10%	3.30%	7.20%	4.97%	5.00%	4.60%
	Public administration	2.40%	4.70%	3.90%	3.20%	1.90%	3.80%	3.08%	4.60%	3.40%

Source: U.S. Census Data, 2000. Data unavailable for the city of Soudan, Minnesota.

Table 4.10-10 St. Louis County Industries Employment Compared to the State of Minnesota in 2004

	State	County	Location Quotient
Total, All Industries	**2,577,178**	**92,668**	
Mining	5,182	2,780	14.9
Utilities	13,195	951	2.0
Health Care and Social Assistance	358,214	20,772	1.6
Public Administration	115,739	5,978	1.4
Accommodation and Food Services	203,091	8,996	1.2
Retail Trade	297,772	12,305	1.1
Educational Services	196,587	7,814	1.1
Other Services	85,026	3,223	1.1
Information	63,786	2,380	1.0
Transportation and Warehousing	98,921	3,346	0.9
Construction	132,521	3,965	0.8
Finance and Insurance	136,280	3,770	0.8
Administrative and Waste Services	120,537	3,274	0.8
Real Estate and Rental and Leasing	37,874	921	0.7
Professional and Technical Services	117,780	2,611	0.6
Arts, Entertainment, and Recreation	46,635	993	0.6
Wholesale Trade	127,476	2,093	0.5
Manufacturing	341,024	5,559	0.5
Agriculture, Forestry, Fishing & Hunting	16,380	251	0.4
Management of Companies and Enterprises	63,161	669	0.3

Source: RS72, PolyMet 2006

4.10.1.4 Public Finance

Sales and use tax revenues from St. Louis County by all industries and the mining industry are summarized in Table 4.10-11. This table outlines information compiled by the Minnesota Department of Revenue and illustrates the relative sales and use tax contribution from the mining industry in the state.

The mining and processing of base and precious metals in the state are not currently subject to production tax. However, this activity is subject to ad valorem tax, net proceeds tax, occupation tax, sales and use tax (6.5% sales and use on all purchases that do not qualify for an exemption), severed mineral interest (if applicable), and withholding tax on royalty payments (if applicable). Ad valorem taxes are established by the county, local communities, and school districts according to Minnesota state law. The Project would be subject to this tax. Occupation tax is equal to 2.45% of the taxable amount. The starting taxable amount for the occupation tax is the mine value as determined by the Minnesota Department of Revenue. Revenue generated through the occupation tax is credited to the general fund, where 10% supports the University of Minnesota, 40% supports public elementary and secondary schools, and 50% remains in the state's general fund.

Table 4.10-11 Select St. Louis County Sales and Use Tax Statistics

	Total Tax (Sales and Use)(in $1,000)	
Year	**All Industries**	**Mining**
1986*	Not Reported	Not Reported
1996	$97,492	$5,584
2000	$114,011	$4,155
2003	$146,182	$4,508
2004	$155,227	$4,356
2005	$163,022	$5,544

Source: Minnesota Department of Revenue: *Minnesota Sales and Use Tax Statistics, County by Industry Annual*. Total taxes for 1986 were not reported. Data prior to 1986 was not available. Mining data reported for 1986 as "metal mining", for 1996 and 2000 as the combination of "metal mining" and "mining, nonmetallic". Data reported for 2003 through 2005 as "mining – all other" and "mining – support activity".

4.10.1.5 Housing

Table 4.10-12 illustrates the housing characteristics of the East Range communities, St. Louis County, and the state. Though the population of these communities has declined (Table 4.10-1), the East Range communities have a lower percentage of available housing than the County. This percentage is supported by the demographic trends of aging population and lower household size. The elevated percentages of owner-occupied housing units versus renter-occupied units over the county and state are also indicative of these trends. In addition to available housing, representatives of individual cities in the East Range have suggested that there is capacity for housing expansion (RS72, PolyMet 2006).

Table 4.10-12 Housing Characteristics of Selected East Range Cities

	Aurora	Babbitt	Biwabik	Ely	Hoyt Lakes	Tower	All Cities	St. Louis County	State of Minnesota
Total Housing Units	**893**	**801**	**492**	**1,912**	**995**	**295**	**5,388**	**95,800**	**2,065,946**
Occupied housing units	812	735	454	1,694	916	233	4,844	82,619	1,895,127
Percentage	90.9%	91.8%	92.3%	88.6%	92.1%	79.0%	89.9%	86.2%	91.7%
Owner-occupied	654	656	376	1,209	840	171	3,906	61,683	1,412,865
Percentage	80.5%	89.3%	82.8%	71.4%	91.7%	73.4%	80.6%	74.7%	74.6%
Renter-occupied	158	79	78	485	76	62	938	20,936	482,262
Percentage	19.5%	10.7%	17.2%	28.6%	8.3%	26.6%	19.4%	25.3%	25.4%
Vacant housing units	81	66	38	218	79	62	544	13,181	170,819
Percentage	9.1%	8.2%	7.7%	11.4%	7.9%	21.0%	10.1%	13.8%	8.3%
Median value[1]	$46,900	$44,200	$43,400	$56,900	$39,100	$55,800	$45,550	$75,000	$122,400

Source: U.S. Bureau of the Census, Census 2000 Demographic Profile Highlights as reported in RS72, PolyMet 2006, modified for inclusion of the city of Ely, Minnesota. Data unavailable for the city of Soudan, Minnesota.

[1] Single-family owner-occupied home

4.10.1.6 Public Services

Water and Sewer

Most of the infrastructure supporting the East Range communities was constructed to accommodate a larger population than currently resides in the area. All of the East Range communities have public water and wastewater systems, with varying degrees of available capacity. The WWTF in the City of Babbitt has a total capacity of 500,000 gallons per day (gpd) with an actual daily load of 200,000 to 300,000 gpd, according to the manager of the facility. According to representatives of the Hoyt Lakes WWTF, the design capacity of the facility was 1.2 million gpd, while the current maximum daily load of the facility was 670,000 gpd with average daily loads ranging between 250,000 and 300,000 gpd.

Police and Fire Protection

The East Range communities are served with continuous police protection either through their own department or via contract with St. Louis County.

The East Range communities all have volunteer fire departments. Officials from the City of Babbitt indicate that they have state-of-the-art fire-fighting equipment and that they currently provide emergency service to the Peter Mitchell Mine. The volunteer fire department for the

City of Ely includes over 30 volunteers and provides fire and rescue services for approximately 400 square miles of northeastern Minnesota.

Medical Services

There is available ambulance service to each of the East Range communities. The City of Aurora contracts with the City of Hoyt Lakes for this service.

The East Range communities are served by both medical clinic and hospital facilities. The nearest emergency center to the City of Hoyt Lakes is the White Community Hospital. This facility is located in Aurora and has 16 hospital beds. The nearest trauma facility to the City of Babbitt is the Ely Bloomenson Community Hospital located in Ely. The City of Babbitt officials indicate that response time for emergencies is generally five minutes, with a 15-minute trip to the emergency room. For services not provided by these facilities, residents travel to Ely, Virginia, or Duluth. The Virginia Regional Medical Center in Virginia, Minnesota has 83 hospital beds.

Schools and Libraries

The area school systems were originally constructed to accommodate a greater population than is currently living in the region, so there is capacity for growth. The City of Aurora has closed schools and combined them with adjacent communities. The City of Babbitt is using former education buildings to house municipal facilities. The City of Ely contains an elementary school, high school, and the Vermilion Community College. The selected East Range communities have available library services, though most libraries share building space with municipal or education facilities.

4.10.1.7 Commercial/Retail Centers

Commercial and retail activities occur in all of the East Range communities, but only to a limited extent, and the success of these operations has declined in recent years. Residents obtain basic goods and services in their communities and in the Project area, and travel to Duluth or Virginia to purchase items that cannot be acquired locally.

4.10.1.8 Recreational Facilities/Gathering Places

The Superior National Forest, including the BWCAW and Voyageurs National Park, are important recreation areas in the region. The Superior National Forest includes approximately 3 million acres and provides recreation opportunities for camping, boating, fishing, hiking, viewing scenery, off-highway vehicle (OHV) riding, wilderness related recreation, snowmobiling, and cross country skiing. Located 20 miles to the north of the East Range communities, the million–plus-acre BWCAW is protected as part of the National Wilderness Preservation System. The National Wilderness Preservation System prohibits the use of motorized vehicles with the exception of limited motor craft use on certain designated lakes. Voyageurs National Park is located approximately 50 miles north of the East Range communities.

Each of the East Range communities has access to at least one large and several smaller parks for recreational use. These parks, as well as area beaches, teen centers, gyms, and athletic arenas serve as both recreational facilities and gathering places for the local communities.

Tourism provides a significant percentage of the economies of some of the East Range communities, especially Biwabik and Tower. According to the 2000 census, about 22% of employment in the City of Tower was attributed to the NAICS category of “arts, entertainment, recreation, accommodation and food services” while 7% was attributed to the category of “agriculture, forestry, fishing and hunting, and mining.” The Iron Range region affords various outdoor tourism activities including cross-country skiing, hiking, biking, water sports, OHV/ ATV paths, snowmobiling, fishing, hunting, and camping.

Computer Access Facilities

Computers are available for use through educational facilities, libraries, and municipal facilities. The communities also have access to private internet service providers.

4.10.1.9 Community Structure

East Range communities use one of two types of government structure, as described below:

- Plan A City – City council including an elected mayor and four to six elected council members. A clerk and treasurer are appointed; neither serve on the city council. The cities of Babbitt, Hoyt Lakes, and Aurora have this form of government.

- Home Rule Charter City – Design own government through the adoption of a charter. The cities of Biwabik, Tower, and Ely have this form of government.

Participation in Voluntary Associations

City administrators and clerks of the East Range Cities provided the following partial list of organizations in which residents in the area may participate. This list is not exhaustive and may not include additional small organizations and business groups.

- Rotary Club;
- Civic Association;
- Veterans of Foreign Wars (VFW);
- Lions Club;
- Knights of Columbus;
- American Legion;
- Lions – Leo Club;

- Church groups;
- Chamber of Commerce;
- East Range Readiness Committee;
- East Range Women of Today;
- Athletic clubs;
- Garden clubs; and
- Seasonal/community events committees.

4.10.2 Impact Criteria

Socioeconomic aspects assessed to evaluate potential beneficial and adverse effects of the proposed Project on the local region include the following:

- Changes in local population, employment, or earnings associated with Project operations.
- Changes in demand for temporary or permanent housing during Project construction, operation, and Closure periods.
- Changes in long-term demands on public services and infrastructure that consume capacities in these systems, either triggering the need for capital expansion or resulting in a discernable reduction in the level of service provided.
- Changes in public sector revenues or expenditures, or the underlying fiscal conditions of local governments.
- Displacement or other use of property that affects residences or businesses.
- Changes induced in the social or business community that can cause important changes in organizational structures, local government, or traditional lifestyles of the community.
- Disproportionate effects on minority or low-income populations, including human health or environmental effects.

4.10.3 Socioeconomic Consequences

This section describes the potential effects of the Project on environmental justice, population, housing, income and employment, public finance, transportation, and public services (which includes water and sewer, fire protection, medical services, schools, and libraries), commerce/retail centers, recreation, and community structure.

The economic multiplier effect for St. Louis County was estimated using the IMPLAN model completed by the University of Minnesota Duluth (UMD) Labovitz School of Business and Economics Bureau. Economic baseline conditions are based on the economic activity reported in the most recent tax year available in St. Louis County for IMPLAN data (2002) and the 2000 census. Direct, indirect, and induced effects are included in the overall economic impact, which was converted from 2004 to 2008 data. The UMD model defined effects in the following way:

- Direct effects - initial new spending in the study area (St. Louis County) resulting from the Project.
- Indirect effects - additional inter-industry spending from the direct impacts.
- Induced effects - impact of additional household expenditure resulting from the direct and indirect impacts.

Because the nature and magnitude of construction and operation activities are different, the effects of these activities on the communities will differ. For instance, it is assumed that a greater percentage of local labor would be used during the operations phase than during construction. These differences are reflected in the IMPLAN calculated multiplier for the two phases of the Project.

The position of the tribal cooperating agencies is that this section as a whole fails to acknowledge or account for any negative social impacts associated with the loss of natural features that will occur as a result of the Project. It also fails to adequately assess the economic and social impacts to local communities at and post-closure, or as a result of a temporary shutdown. The tribal cooperating agencies note that a recent report by Dr. Thomas Powers entitled “The Economic Role of Metal Mining in Minnesota: Past, Present, and Future,” addresses some of the impacts that are inadequately addressed in the present draft and should be used in developing this section for the DEIS.

4.10.3.1 Proposed Action

Environmental Justice

The Project was evaluated for effects relating to the social, cultural, and economic well-being and health of minorities and low-income groups through a review of socioeconomic and demographic data compiled from the 2000 U.S. Census. Such effects are termed environmental justice issues, and none were identified for the Project. Minority populations in the affected communities do not comprise over 50 percent. In addition, in 2007 (U.S. Census) the Native American population was 2.1% of the total population of St. Louis County, Minnesota. A portion of this population lives on the Bois Forte Reservation (Vermillion sector) on Lake Vermillion. The same census reported 1.2% of the population was Native American across the state of Minnesota. Therefore the Proposed Action would not have disproportionately high or adverse effects on minority populations. While there are an elevated percentage of families below the poverty level in the East Range communities as compared with the state, the Project would create an economic benefit to the community and would not appear to have disproportionately high or adverse effects on low income populations.

As discussed in section 4.8.3.1, the Project area overlaps the 1854 Ceded Territory, where certain tribal communities retain rights to hunt, fish, and gather on public lands. Although 2.1% of the population in St. Louis County is Native American, few members of these tribal communities live in the immediate vicinity of the Project. Further discussion of tribal use of Project area resources is provided in Section 4.8. It is the position of the tribal cooperating agencies that any impacts to natural resources will disproportionately affect tribes due to their subsistence consumption of wild rice, fish, and other wildlife within the 1854 Ceded Territory. Executive Order 12898 specifically identifies issues to be addressed regarding Native American Populations.

Population

Construction Period

Construction activities are estimated to create an average of 347 full-time equivalent (FTE) direct construction jobs over an 18-month period. The projected peak labor force for the construction activities is 800 individuals. Typical construction involves fluctuating work flows, as specialized crews may be employed for short duration tasks. Any population increases during construction would be temporary (18 months or less). It is anticipated that the majority of the labor force would be from Minnesota.

Due to proximity to population centers such as Duluth, it is estimated that 60% of construction labor would commute on a daily or weekly basis. It is estimated that approximately 15% would seek more permanent residence and the remaining jobs would be filled by local residents. Given the short duration of the construction, it is assumed that non-local workers would not relocate their families. In-migrating construction workers are estimated at approximately 50 to 100 individuals. This represents less than a 2% increase to the 2004 population of the East Range communities.

Operating Period

Current operating period labor force projections are estimated at 448 FTE employees. Due to the estimated 20-year operating life of the facility, it is estimated that approximately 55% of labor for operations would be non-local and would relocate to the East Range; 20% would commute daily or weekly from centers such as Duluth; and the remaining labor would be local. In-migrating operations workers are estimated at approximately 247 individuals. In order to estimate the number of individuals relocating to the area to fill direct jobs, of these in-migrating workers, 25% are assumed to be single or married without families present, and 10% of the married households are assumed to be two-worker families. As a conservative estimate, married households are assumed to be equivalent to the Minnesota average of 3.09 persons per household. This suggests that an additional 351 family members would relocate to the East Range for a total direct population influx of 598 individuals.

IMPLAN modeling suggests that approximately 553 indirect and induced jobs would be created by the Project. In order to estimate the number of individuals relocating to the area to fill indirect and induced jobs, it is assumed that 70% of the indirect labor force would be second persons in a direct labor household or current residents of the East Range. Of the remaining 30% percent, it is estimated that 10% would commute daily or weekly from other population centers, and 20% would be non-local and seek to relocate to the East Range. Relocating operations workers are estimated at approximately 111 individuals. Of these individuals, 40% are assumed to be single or married without families present, and half of the married households are assumed to be two-worker families. Utilizing an average family size of 3.09 persons suggests that an additional 88 family members will relocate to the East Range, for a total indirect and induced population influx of 199 individuals. The total estimated population influx from direct, indirect, and induced employment would be 797 people.

Closure Period

After Closure, it is estimated that a reduced number of employees and contractors would remain employed for a few years to perform post-mining activities such as demolition and reclamation. These activities would likely be followed by several years of operations and maintenance of reclamation activities. Unless new industry is developed in the East Range area prior to completion of these activities, it is assumed that 95 percent of working-age people formerly employed by the Project would need to secure alternative local employment or would leave the area after this time. Approximately five percent of working-age people formerly employed by the Project would remain to help with long-term closure activities.

Housing

Construction Period

It is anticipated that demand for temporary housing during the construction period would increase. The majority of the labor force would likely either commute from nearby city centers or would already be part of the East Range community. It is estimated that on average between 100 and 200 individuals would seek temporary accommodations. The cities of Hoyt Lakes and Biwabik both have available temporary accommodations in the form of hotels and lodges. The hotel in Hoyt Lakes has 40 rooms, while Biwabik has at least 129 units. The adjacent communities of Virginia and Eveleth each have several hotels. Availability of hotels in the East Range communities and surrounding areas should be sufficient to meet demand given the total number of available rooms and current vacancy rates.

Operating Period

Demand for permanent housing is likely to increase during the operating period. Based upon population estimates previously presented, there would be approximately 247 in-migrating workers, all but 10%[1] of whom would seek independent housing. As previously discussed, the total population influx for direct, indirect, and induced employment effects is estimated at 797. This translates into an estimated increase in households of 358; the actual number may be lower than this due to two-worker in-migrating households. In addition to existing housing vacancies, East Range cities' staff and officials indicate that there is sufficient land to accommodate such growth. New home construction would increase demand for construction labor; this demand may exceed the local area's construction capacity and as such it would be necessary to bring labor in from outlying metropolitan areas (e.g., Duluth).

Closure Period

During Closure, it is likely that the demand for housing would drop as workers migrate from the area, leaving a portion of available housing vacant. New housing built to originally accommodate the employment generated by the Project would have high vacancy rates as well. After some time, the baseline vacancy rate for existing properties should return.

Income and Employment

Construction Period

As noted previously, the construction labor force is estimated at approximately 347 FTE positions, peaking at 800 individuals for a short period of time. Local labor is estimated to fill approximately 25% of the direct Project jobs. IMPLAN modeling conducted for the Project suggests that approximately 233 indirect and induced jobs would be created during the construction phase, for a total of 580 FTE jobs generated.

Total labor costs for the construction activities (local and non-local) over the estimated 18 month period are estimated to be $52 million in 2008 dollars. In addition to labor expenditures, an estimated $171 million (2008 dollars) is projected to be spent for capital equipment (local and non-local).

Operating Period

The projected labor force for the steady state operating period is estimated at 448 FTE. Table 4.10-13 illustrates the employment levels by trade. IMPLAN modeling conducted for the Project suggests approximately 553 FTE indirect and induced jobs would be created, for a total of 1,003 FTE jobs generated.

Table 4.10-13 Anticipated Steady State Operation Employment Levels

Area	Total Number

[1] Assumed 10% of workers will commute weekly from larger centers and stay in hotels / motels, rather than seek independent housing

Management	13
Mine Operations – Contract supervision, operators, maintenance	149
Mine technical – Geology, grade control, planning	18
Railroad operations	25
Plant operations	199
Sample preparation and analytical laboratory	19
Finance, purchasing, marketing, environmental, HR	25
Total	**448**

Based upon data provided by PolyMet, an estimated $130 million would be spent per year of operation on wages, consumables, power, maintenance, and contract services. IMPLAN modeling estimates an additional $58.5 million would be spent in the region for a total of $188.5 million.

Closure Period

As mentioned previously, it is assumed that during Closure and reclamation a reduced number of jobs and materials would be required; the remainder of the 448 jobs would be terminated, and additional expenditures related to mining activity would cease.

Public Finance

The Project would be subject to the Minnesota net proceeds tax, which is a 2% tax on net proceeds. The net proceeds are calculated as the gross proceeds, less allowable deductions. Net proceeds taxes are distributed as follows:

- 5% to the city or town where the minerals are mined or extracted;
- 10% to the Municipal Aid Account (distributed to qualifying cities and townships);
- 10% to the school district where mining or extraction occurred;
- 20% to the Regular School Fund (split between 15 school districts in the Taconite Relief Area);
- 20% to the county where mining or extraction occurred;
- 20% to Taconite Property Tax Relief, using St. Louis County as a fiscal agent (distributed to qualifying owner-occupied homes and farms in the taconite relief area);
- 5% to Iron Range Resources (IRR);
- 5% to the Douglas J. Johnson Economic Protection Trust Fund; and
- 5% to the Taconite Environmental Protection Fund.

Mining and processing organizations are subject to a 6.5% tax on all purchases that do not qualify for the industrial production exemption.

Project tax impacts are based upon IMPLAN model estimates as described for the various Project phases as well as available information for the state's tax system as described in Section 4.10.1.4. The IMPLAN model assumes typical business operation and excludes tax structures such as net proceeds. Tax impacts from direct and induced effects included in the model are personal income taxes, indirect business taxes, and other taxes paid by the affected sector.

Construction Period

IMPLAN modeling estimates the federal government would receive approximately $5.4 million and the state and local government would receive $2.5 million in taxes for the construction of the Project. Sales and use taxes paid on items purchased for new mining and processing facilities in the state qualify for refund.

Operating Period

The majority of economic benefits to the local community through taxes would be realized during the operating period. IMPLAN modeling estimates that after an initial operation ramp up, during a typical year of operation the federal government would receive $17.3 million and the state and local governments would receive $14.5 million in taxes from the operation of the Project, excluding net proceeds tax. PolyMet estimates that total taxes throughout the operating period would vary from $22 to $47 million per year.

The 2% net proceeds tax collected during the operations phase would be distributed as described in Section 4.10.1.4. Tax dollars collected would benefit communities throughout the East Range in addition to the city and school district where the mining occurs.

Minnesota mining and processing organizations are subject to a 6.5% tax on all purchases that do not qualify for the industrial production exemption. The majority of items used or consumed for mining and processing (e.g., chemicals, fuels, lubricants, explosives), however, are subject to this exemption.

Closure Period

It is assumed that Post-Closure of the facility is complete, the public finance through taxes paid would return to baseline values.

Transportation

The Project has two access points: the Main Gate at the end of County Road (CR) 666 and the North Gate on MN 135. Many of the building materials and some labor for Project construction and operation are expected to be transported from Minneapolis/St. Paul. These goods would be transported along Interstate 35, MN 33, US 53, MN 37, MN 135, CR 110, and CR 666 to the Main Gate. Heavy loads would bypass Hoyt Lakes (CR 110 and CR 666) and use the North

Gate on MN 135. Some materials will be transferred via Lake Superior and through the ports of Duluth and Superior. These goods will likely be transported along US 53, MN 37, MN 135 or CR 4, MN 135, and the rest of the route to the Main Gate or North Gate described above. Refer to Figure 4.10-2 showing mapped routes. The East Range communities may be affected by increased travel times over baseline times due to the increased amount of traffic on the roadways; however, projected traffic values are less than traffic associated with former LTVSMC operations and the Project would use the same road infrastructure. Since there are no significant impacts anticipated with traffic, a traffic study has not been performed. With the closure of the mine, it is anticipated that traffic would revert to current levels.

Product from the mine and some raw materials used on site would be shipped via rail. A common carrier (Canadian National) rail spur serves the Project area. A PolyMet plant switch engine would move rail cars to and from their destination within the Project, and a private railroad connects the Plant Site to the Mine Site.

Public Services

City officials in the East Range indicated that they anticipate limited problems accommodating the influx of people that construction and operation of the Project may bring. For instance, representatives of the cities of Hoyt Lakes and Babbitt indicated nearly 50% capacity is available in their wastewater treatment facilities.

Emergency and medical services are currently equipped to handle similar area operations and East Range communities have mutual aid agreements in place to cooperatively respond to major emergencies. The addition of police, fire, and ambulance staff may be required to service an expanded population.

Renovations of existing school buildings and additional teachers may be needed to accommodate additional school-age children in the area.

With Closure, it is anticipated that demands on public service would decrease to current or slightly elevated levels because of a potential decrease in population. Some individuals may choose to remain in the area, maintaining a slightly elevated demand.

Commerce/Retail Centers

The Project would not displace any existing residences or businesses. On the contrary, commercial and retail businesses are expected to expand to meet increased market demand. This translates into the increased size of existing businesses and addition of new commercial and retail enterprises.

Post-Closure and reclamation activities are expected to generate 20 to 50 jobs for many years, so local business would continue to be used; however, subsequent complete closure would likely result in a reduction in retail spending to baseline levels.

Recreation

The area directly impacted by the Project is part of the Superior National Forest. While access to the Mine Site is currently limited due to the lack of public roads, the Project would further reduce access to the site for hiking, fishing, and hunting. Limited hunting activities occur in this area and the proposed Project area is not heavily used for tourism or recreation. During both construction and operations phases, the Project would generate some noise and light which may impact the recreational experience. Boating impacts associated with water level changes in both the Embarrass and Partridge Rivers should be minor; some impacts may be experienced by recreational users of Whitewater Reservoir due to water level reductions. Additional discussion of wildlife, fish, and vegetation impacts are provided in their respective sections of this DEIS.

Community Structure

The construction and operation of the Project is unlikely to significantly affect community structure. A potential 797-person population increase may prompt the addition of a few additional city staff, but participation in community groups and functions is expected to remain similar to the baseline period.

4.10.3.2 No Action Alternative

Under the No Action Alternative, current trends of declining employment in the mining industry, population decline, underutilized housing, and aging population in St. Louis County and the East Range communities would likely continue. There is evidence, however, that there may be non-ferrous mines currently in exploration phases of development that could become operational. These activities coupled with historically increasing trends in non-mining sectors may help offset these negative developments.

4.10.3.3 Mine Site and Tailings Basin Alternatives

The Mine Site and Tailings Basin Alternatives would have no discernible differences in socioeconomic impacts on the local community as compared to the Proposed Action.

4.10.3.4 Potential Mitigation Measures

This analysis did not identify any adverse socioeconomic effects from the Project, therefore, no mitigation measures are proposed.

4.10.4 Cumulative Impacts

An assessment of both economic and social cumulative effects evaluated the combined impacts of past, present, and future projects on the East Range and St. Louis County (Table 4.10-14). Cumulative economic impacts were initially assessed through IMPLAN modeling of the baseline economic activity, average annual employment projections (year by year), and estimated construction costs (year by year) for the past and future actions identified in the Final SDD (Tables 4.10-15 and 4.10-16). These quantitative results were then evaluated in the context of additional past, present, and reasonably foreseeable future projects identified subsequent to the Final SDD to describe both economic and social effects.

Table 4.10-14 Summary of Economic and Social Cumulative Effects

Project[1]	Temporal Scale	Potential Cumulative Effect
Projects Identified in Final SDD[2]		
Shutdown of LTVSMC mine	Past	In 2001, LTVSMC, a subsidiary of the LTV Corporation, closed operations due to blast furnaces experiencing lower levels of productivity and high costs as a result of poor taconite pellet quality. Approximately 1,400 people were employed by the company. The shutdown of the facility decreased employment needs in the area, thereby influencing the economic condition of the region.
Proposed NorthMet Project	Future	Cumulative impacts for these projects were quantified using the IMPLAN model for Years 1 through 5. Table 4.10-15 illustrates estimated impacts from the construction of each project. Maximum employment effects are estimated at 1,874 jobs in Year 2; employment is considered the primary driver for social impacts to the community. Table 4.10-16 illustrates estimated impacts from the operation of each project. Maximum direct employment effects are estimated at 1,641 jobs in Year 5.
Proposed Mesabi Nugget Plant Phase I	Future	
Proposed NOνA Off-Axis Detector	Future	
Proposed expansions of existing taconite plants	Future	
Projects Identified Subsequent to the Final SDD		
Establishment of the Erie Mining Company (aka LTVSMC) (1950s)	Past	The Erie Mining Company peaked in 1970 employing over 3,000. The LTV Corporation acquired full ownership in 1986 and modernized the operations, thereby increasing efficiency and production. The establishment of this company and its evolution in the area helped launch Hoyt Lakes, a community based on mining, thereby affecting economic and social conditions of the region.
Proposed Cliffs Erie Railroad Pellet Transfer Facility	Future	This facility would store and transfer taconite iron pellets at Hoyt Lakes from the Hibbing and United Taconite mines before being shipped to docks at Taconite Harbor. This facility would contribute to cumulative economic benefits to the local community through employment and increased tax base.
Proposed Mesaba Energy power generation (coal gasification station)	Future	The Mesaba Energy Project proposes a 606 megawatt (MW) integrated gasification combined-cycle (IGCC) power plant in Taconite, Minnesota. This project would create over 1,000 construction jobs during the four-year construction phase and over 100 jobs during plant operation. Approximately 290 additional indirect jobs are expected during plant operation. The plant would also expand the tax base in Itasca County and provide a significant source of property tax revenue. Itasca County is immediately west of St. Louis County and its economic impacts would provide beneficial cumulative effects to the region. This project was initially looking at Hoyt Lakes for a potential site in addition to Taconite. When IMPLAN modeled cumulative effects, the preferred site was in Hoyt Lakes. Since then the preferred site has become Taconite with Hoyt Lakes as an alternate. Because of this change, the modeled cumulative impacts are higher than expected for the modeled projects.
Proposed Minnesota Steel DRI/ steel plant	Future	Minnesota Steel is developing a $1.6 billion project in Nashwauk, Minnesota that fully integrates mining through steelmaking. This project will employ 2,000 skilled workers for two years during construction and 700 employees during operation. Approximately 2,100 indirect and induced jobs should be created because of the facility's construction and operation.

Project[1]	Temporal Scale	Potential Cumulative Effect
Proposed Minnesota Steel taconite mine and tailings basin	Future	Minnesota Steel also proposes to reactivate the former Butler Taconite open mine pit approximately three miles southwest of Nashwauk. Ore from the mine would be hauled to the ore processing facility and tailings would be transported via pipeline to the existing Butler Taconite tailings basin two miles southeast of the mine. This project would employ approximately 700 full-time employees. Because both this project and Minnesota's Steel's new steel project are located near the St. Louis County border and would have such a significant economic impact on its local community, regional effects are expected that would cumulatively impact the NorthMet project.
Proposed Mesabi Nugget Phase II (mining operation)	Future	Mesabi Nugget Mining L.L.C. proposes to reactivate the LTVSMC Area 2WX and 6 mines and install a new crusher and concentrator with magnetic separation and flotation (Phase II Project) on the former LTVSMC property north of Hoyt Lakes. The project would produce iron oxide concentrate at the existing nugget plant on the former LTVSMC property. The project would employ approximately 250 skilled workers during construction and 124 during operation. This project would have an economic benefit on the local community and synergistic economic impacts with the effects of the NorthMet project through increased employment and tax base.
Proposed US Steel Keewatin taconite mine and plant expansion	Future	U.S. Steel proposes to reactivate an idled production line and expand the mine pit at its Keetac taconite mine and processing facility north of the Keewatin on the St. Louis County border. This project would increase Keetac's iron pellet production output by 3.6 million tons per year (total of 9.6 million tons per year). This project would employ approximately 500 skilled workers during construction and 70 workers during facility operation. This project would have a strong economic benefit on the local community and synergistic economic impacts with the effects of the NorthMet project through increased employment and tax base.

1 The economic impact modeling (IMPLAN) was conducted prior to February 2006. Projects that were proposed and in the public domain at the time of modelling are included in the economic modeling.

2 Projects identified in the Final SDD as contributing to socioeconomic conditions. For additional information on these projects, refer to the RS72, PolyMet 2006. Because the cumulative effects were modeled in IMPLAN, this initial analysis was limited to economic impacts only and did not take into account cumulative social impacts, such as housing, community services, and family effects.

Table 4.10-15 Total Impacts from Construction, by Project, by Measure, by Year (2008 Dollars)

Year	Project Phase	Project[2]	Value Added	Employment	Output
Year 1	Construction	Mesabi Nugget	$16,010,014	299	$29,714,385
		Expansion Plants	$49,530,982	926	$91,928,877
		Total	**$65,540,996**	**1,225**	**$121,643,262**
Year 2	Construction	**NorthMet**	**$40,242,870**	**752**	**$74,690,351**
		Mesabi Nugget	$16,010,014	299	$29,714,385
		NO*v*A	$20,012,520	374	$37,142,981
		Expansion Plants	$24,015,022	449	$44,571,578
		Total	**$100,280,426**	**1,874**	**$186,119,294**
Year 3	Construction	NO*v*A	$20,012,520	374	$37,142,981
Year 4	Installation	NO*v*A	$6,766,708	128	$12,242,354
Year 5	Installation	NO*v*A	$6,766,708	128	$12,242,354

Source: RS72, PolyMet 2006, modified using the U.S. Department of Labor Bureau of Labor Statistics Consumer Pricing Index Inflation Calculator (http://www.bls.gov/cpi/#overview) to adjust 2004 dollars to 2008 dollars.

2 The economic impact modeling (IMPLAN) was conducted prior to February 2006. Projects that were proposed and in the public domain at the time of modelling are included in the economic modeling.

Table 4.10-16 Total Impacts from Operations, by Project, by Measure, by Year (2008 Dollars)

Year	Project Phase	Project[3]	Value Added	Employment	Output
Year 1	Operation	Mesabi Nugget	$7,096,833	83	$21,559,937
		Expansion Plants	$15,921,736	177	$41,829,027
		Total	**$23,018,569**	**260**	**$63,388,964**
Year 2	Operation	**NorthMet**	**$106,588,271**	**529**	**$183,818,215**
		Mesabi Nugget	$42,580,994	158	$129,359,620
		Expansion Plants (1)	$15,921,736	177	$41,829,027
		Expansion Plants (2)	$37,150,713	236	$97,601,060
		Total	**$202,241,714**	**1,100**	**$452,607,922**
Year 3	Operation	**NorthMet**	**$160,274,310**	**1,058**	**$276,403,198**
		Mesabi Nugget	$42,580,994	158	$129,359,620
		Expansion Plants (1)	$15,921,736	177	$41,829,027
		Expansion Plants (2)	$37,150,713	236	$97,601,060
		Total	**$255,927,753**	**1,629**	**$545,192,906**
Year 4	Operation	**NorthMet**	**$160,274,310**	**1,058**	**$276,403,198**
		Mesabi Nugget	$42,580,994	158	$129,359,620
		Expansion Plants (1)	$15,921,736	177	$41,829,027
		Expansion Plants (2)	$37,150,713	236	$97,601,060
		Total	**$255,927,753**	**1,629**	**$545,192,906**
Year 5	Operation	**NorthMet**	**$160,274,310**	**1,058**	**$276,403,198**
		Mesabi Nugget	$42,580,994	158	$129,359,620
		Expansion Plants (1)	$15,921,736	177	$41,829,027
		Expansion Plants (2)	$37,150,713	236	$97,601,060
		NOvA	$1,094,915	12	$1,942,732
		Total	**$257,022,668**	**1,641**	**$547,135,638**

Source: RS72, PolyMet 2006, modified using the U.S. Department of Labor Bureau of Labor Statistics Consumer Pricing Index Inflation Calculator (http://www.bls.gov/cpi/#overview) to adjust 2004 dollars to 2008 dollars

Conclusions

The degree of potential cumulative social and economic impacts from construction and operation of the above-mentioned projects depends on the timing of the various projects. The beneficial effects include increased employment opportunities, a larger tax base, and increased county revenue from property taxes.

However, potential increases in construction and other related employment, as well as population, would increase pressure on housing, schools, and hospitals, and other community services and infrastructure. Employment and population changes during a single construction

[3] The economic impact modeling (IMPLAN) was conducted prior to February 2006. Projects that were proposed and in the public domain at the time of modelling are included in the economic modeling.

event typically follow a bell curve, with the peak of the curve coinciding with the peak of construction activities. However, when multiple projects occur within the same time period, the magnitude of the peak could be significantly increased over a relatively short duration, causing more disruptive impacts and increased stresses on existing infrastructure.

Potential social impacts from construction activities are typically temporary and localized. As with the demand on public services, if multiple construction projects occur within the same time period there may be a more intense period of social disruption due to rapid increases in population. In the case of the operations described above, it is less likely that construction workers with families would relocate (or that the workers would relocated their families to the region). This demography suggests an increased risk of a significant change to population and social dynamics with the likely influx of single, transient males.

However, it is more likely that heavy construction activity associated with the projects described above would be staggered, and that the disruption period may be less intense over a longer duration, allowing for infrastructure and resources to expand to accommodate growth. With staggered construction activities there is also a greater opportunity for incoming workers to provide their services to multiple projects over a longer period of time. This would reduce the total number of new workers needed for the projects described above. It also increases the likelihood that construction workers would relocate their families and become active participants in the community.

The operations phase typically provides a more stable and sustainable work force than the construction phase. Impacts from the operation of a project are typically longer term, also allowing the community to respond to expand infrastructure and services over time. Operations employees are more likely to relocate their families to neighboring communities for the life of the project and become integral members of the community. While the influx of employees would place pressure on housing, schools, hospitals, and other infrastructure, the East Range communities have historically had higher levels of employment than currently exists today, suggesting that these communities already have some capacity to accommodate increased activity without increasing pressure on public services. In addition, any capacity building during the construction phase would serve to reduce pressure posed during operations.

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4.11 VISUAL RESOURCES

4.11.1 Existing Conditions

The Project lies within, and adjacent to, the Superior National Forest in northeastern Minnesota. The Superior National Forest provides over three million acres of rich and varied resources, including over 445,000 acres of surface waterways for recreational use, timber for the forest products industry, and historical mining and logging operations (USFS 2007). The visual character of the Project area varies between upland forests and bog wetlands to developed industrial areas. There are several mines near the Project. The Plant Site is fully contained within the operating area of the former LTVSMC taconite processing facility.

4.11.1.1 Visual Character of the Project Area

Mine Site

The Mine Site is located along the south flank of the Mesabi Iron Range, immediately south of the Giants Range formation (Figure 4.11-1). The Iron Range supports numerous active mining operations, including the Peter Mitchell taconite mine located north of the Mine Site. The site is relatively flat, with elevations between 1,570 feet and 1,600 feet msl. The Giants Range formation is the dominant landscape feature and rises steeply to an average elevation of approximately 1,700 feet msl along the ridgeline and declines approximately 150 to 200 feet on its northern flank. The BWCAW lies approximately 20 miles north of the Giants Range. The 100 Mile Swamp, Partridge River, and the Peter Mitchell Mine lie to the north between the Mine Site and the Giants Range formation. The Mine Site is surrounded by wetlands and mixed deciduous and coniferous upland forests to the east, south, and west. The average canopy height in the upland forest is 30 to 60 feet with occasional white pine and white spruce in excess of 70 feet. In the wetland areas, the coniferous canopy is approximately 30 to 40 feet while the deciduous growth is less than 20 feet tall. The Partridge River makes a horseshoe bend and is immediately north, east, and south of the Mine Site.

The nearest potential visual receptors are located approximately six miles to the east along Lake County Road 2 within the incorporated limits of the City of Babbitt. There are no major trails within the Superior National Forest adjacent to the Mine Site that would expose recreational users to the mine. Additional residences are rural homes approximately seven miles to the south near the unincorporated village of Skibo. The Babbitt city center is located approximately six miles north of the Mine Site. To the immediate west of the Mine Site are uninhabited forests, wetlands, and open land. The City of Hoyt Lakes is approximately nine miles to the southwest of the Mine Site. It is the Tribal cooperating agencies' position that the use of a few visual receptors to assess PolyMet related visual impacts is not adequate. Using this method means that the conclusions presented in this chapter apply only to those visual receptors and do not apply to any other publicly accessible area in the vicinity of the proposed project. Tribal cooperating agencies have requested that a more complete Visual Impact Assessment (VIA) be developed for inclusion in this PDEIS (GLIFWC Comment letter of June 30, 2008 and GLIFWC comment

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letter of February 6, 2009). Methods for a complete VIA were developed and used for other mine proposals as part of the Army Corps federal EIS process (Crandon Mine EIS Preliminary Draft Technical Memorandum: Visual Resources Section of Draft Chapter 3, November 2002). Despite these comments and Corps precedent, a complete VIA has not been included in this iteration of the PDEIS. A complete VIA would allow the public to review the impacts of project features to all publicly accessible lands in the vicinity of the project which include large sections of the Superior National Forest immediately adjacent to the mine site (See figure 4.9-1). A VIA of all public access lands is important information for assessing cultural impacts to tribes who have retained the right to hunt, fish and gather on national forest lands.

Plant Site

The Plant Site is located at the former LTVSMC taconite processing facility. Topography at the Plant Site rises from approximately 1,550 feet msl near the railroad at the south end of the plant to approximately 1,780 feet msl at the north end adjacent to the Tailings Basin. The inactive LTVSMC industrial processing buildings dominate the visual landscape at the Plant Site including crushing, grinding, concentrating, and maintenance and pellet storage/rail loading facilities. The LTVSMC Tailings Basin is located to the north of the buildings with mine pits and waste rock stockpile sites to the south and east, and a railroad to the west. Second Creek and its headwater wetland also border the site immediately to the south. The nearest potential visual receptors are residences approximately 3.5 miles north of the Plant Site on County Road 358 and County Road 615. These rural residences are outside the incorporated limits of Babbitt and Hoyt Lakes. The City of Hoyt Lakes is the next closest visual receptor, and is approximately five miles south of the Plant Site.

The proposed Tailings Basin is located at the former LTVSMC Tailings Basin on the northern portion of the Plant Site. The Tailings Basin ranges in elevation from approximately 1,650 feet msl bordering the Plant Site to approximately 1,730 feet msl along its northern border. The basin is surrounded by wetlands and low, forested (mixed coniferous and deciduous) uplands to the north, east, and west.

4.11.1.2 Management Class

The Management Classification System (MCS) was developed by the USACE to provide general guidelines as to the degree and nature of visual change acceptable in a landscape (USACE 1988). Based on the assessment of features described in Sections 4.11.1.1, the Mine Site falls into the “Modification Management Class” of areas not noted for their distinct qualities and often considered to be of average quality. The Plant Site is in the “Rehabilitation Class,” or areas noted for their minimal visual quality due to historic use as a mining material processing center. In the planning and design of projects in the Rehabilitation Class, the USACE has determined that “project activity may attract attention and dominate the existing visual resource. However, the project should exhibit good design and visual compatibility with its surroundings” (USACE 1988).

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4.11.2 Impact Criteria

The primary issues related to visual resources, and therefore the potential for impacts, would include:

- The number of sensitive viewpoints affected by the Project;
- Significant increases in the extent or scale of visible mining disturbances; and
- The ultimate appearance of the Project at full reclamation versus current and interim stages of active mining.

The Tribal cooperating agencies' position is that the Army Corps has not completed consultation with potentially affected tribes. Therefore, this document does not estimate the degree of disturbance to tribal members who may be involved in traditional natural resource harvest harvests on national forest lands.

4.11.3 Environmental Consequences

4.11.3.1 Proposed Action

At the Mine Site, the waste rock stockpiles would range from approximately 1,730 feet msl (Category 4 waste rock stockpile) to 1,840 feet msl (Category 1 and 2 waste rock stockpile) with a maximum stockpile elevation of 1,920 feet msl (RS49, Golder 2007) or approximately 130 feet to 240 feet above ground surface with a maximum of 320 feet. The ridgeline rises sharply to the north of the Mine Site before dropping off, so receptors to the north, including the BWCAW, would not see the stockpiles or the safety lights from atop the stockpiles.

The upland forest communities surrounding the Mine Site to the east, south, and west would shield ground-level views of the Mine Site in those areas. These forest stands are a mix of coniferous and deciduous forests and would provide year-round screening. Potential users on elevated terrain to the east, north, or west of the Mine Site would have a limited view of the mine and stockpiles. The Project would increase the scale of disturbance in the region; however, mining activity is a long-established aspect of the Iron Range landscape and the addition of the proposed mining facilities would not introduce visual elements to surrounding viewpoints that are in stark contrast to the regional visual character. Tribal cooperating agencies disagree with this conclusion. This document does not present enough information to make this claim.

The Mine Site would be in operation 24 hours per day; therefore, nighttime safety lighting of the stockpiles would potentially contribute to a localized "glow" effect in the night sky. Similar to the daytime impacts, the Giants Range ridgeline and Peter Mitchell Mine site would act as a barrier and potentially shield night lighting for residences to the north. Light sources at the Mine Site would be similar to light levels at other mining projects across the Iron Range. PolyMet does not propose specific mitigation measures with respect to light impacts.

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No significant changes are anticipated to the visual character of the Plant Site during Project operations. The Project would use the existing infrastructure, including the Tailings Basin, for processing operations; therefore, the Project would be in keeping with the existing, modified, industrial landscape, and consistent with the USACE's management objectives for the "rehabilitation" landscape management class.

The Tailings Basin is potentially visible to rural residences on County Road 358, located approximately one mile to the north. However, the basin has been previously used for storing tailings. The Project would raise the elevation of Cells 1E to about the same elevation as the existing Cell 2W. The hydromet cells would raise the elevation on the southern portion of Cell 2W by about 40 feet. The continued use of the Tailings Basin would increase the silhouette of the low mound on the southern horizon as the Tailings Basin and hydromet elevations would increase approximately 40 feet to 50 feet. However, this would be consistent with the current visual landscape and not have significant visual impacts due to the pre-existing mining characteristics of the surrounding area.

The Project would not increase the number of affected sensitive viewpoints or significantly increase the extent or scale of visible disturbance. Following the completion of the mining activities, the PolyMet reclamation plan would remove all buildings and facilities at the Mine and Plant sites and revegetate disturbed areas with a proposed vegetation mix.

4.11.3.2 No Action Alternative

Under the No Action Alternative, the Project would not be developed, the Mine Site and associated lighting, and the hydrometallurgical process buildings would not be constructed, and the former LTVSMC processing facility would be demolished in accordance with the LTVSMC closure plan. The reclamation activities would have the potential for a short-term disruption of the visual landscape due to the demolition and revegetation activities. Long-term visual effects would be beneficial as the LTVSMC processing plant would be revegetated with appropriate species.

4.11.3.3 Mine Site Alternative

Under the Mine Site Alternative, the most reactive waste rock (all Category 3 and 4 and some Category 2 waste rock) would be disposed subaqueously in the East Pit. The waste rock would be temporarily stockpiled at the Mine Site until the East Pit was available for disposal. As additional Category 1 waste rock is produced, it would be placed within the footprints of the former Category 2 and 3 stockpiles. The Category 4 waste rock stockpile would be eliminated completely after backfilling of the waste rock in the East Pit.

Similar to the Proposed Action, the ridgeline north of the Mine Site would obscure the stockpiles (including lighting) from visual receptors north of the ridgeline and the surrounding upland forest communities would shield ground-level views of the Mine Site to the east, south, and west. This alternative would result in a slight increase in the Category 1 stockpile height; however, relative to the Proposed Action this alternative would be less intrusive from surrounding viewpoints as the temporary stockpiles would be removed as the East Pit becomes available for storage.

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The impacts of this alternative relative to the Plant Site would be the same as the Proposed Action.

4.11.3.4 Tailings Basin Alternative

Under the Tailings Basin Alternative, vertical wells would be constructed on existing benches of the northern embankment of LTVSMC Cells 2E and 2W to capture and pump Tailings Basin seepage. In addition, increased rock buttress material would be placed along the northern embankment of Cell 2E to increase geotechnical stability. Buttress construction material would consist of screened overburden material and waste rock from existing stockpiles from nearby taconite mine sources.

The impacts of this alternative relative to the Mine Site would be the same as the Proposed Action.

4.11.3.5 Other Mitigation Measures

Section 3.2.2 describes potential mitigation measures for impacts from the Project, one of which has the potential to affect visual resources.

- Lighting - the Proposed Action would operate 24 hours a day and would contribute to a localized "glow" in the night sky. We recommend shielding light sources to direct operating lights downward to reduce light pollution.

4.11.4 Cumulative Impacts

The Project, as proposed, would be visually secluded from the surrounding area by the Mesabi Iron Range and surrounding vegetation. In addition, implementation of the above referenced mitigation measure (i.e., shielded lighting) would minimize impacts to the night sky. Therefore, there would be no long-term impacts from the Project relative to Visual Resources and no cumulative effects analysis would be warranted. The Tribal cooperating agencies' position is that a cumulative impact of visual impacts analysis is needed. A thorough VIA following past Army Corps practices has not been conducted for this project and tribal consultation regarding cultural impacts have not been completed. Therefore, this conclusion is premature. Finally, the Tribal cooperating agency position is that the introduction of non-native, invasive species as a revegetation measure may have long-term visibility impacts to the site.

4.13 GEOTECHNICAL STABILITY

While not a specific natural or cultural resource like other sections of this DEIS, geotechnical stability was preliminarily reviewed from a safety perspective, to determine if proposed large-scale waste material storage facilities could fail, and thus cause further direct or indirect impacts. Geotechnical stability will be further analyzed during permitting when final facility designs will be available.

Three proposed facility types were analyzed for this DEIS:

- Mine Site - - Waste Rock Stockpiles;
- Plant Site - - Flotation Tailings Basin; and
- Plant Site - - Hydrometallurgical Residue Facility.

4.13.1 Existing Conditions

4.13.1.1 Mine Site

The proposed Mine Site is a greenfield site currently impacted only by exploration drilling and logging activities. There are no mining facilities on site.

4.13.1.2 Plant Site

At the Plant Site, the existing brownfield LTVSMC flotation tailings basin is inactive and reclaimed. Geotechnical investigations of this tailings basin (Sitka 1995 & 1997) indicates a significant portion of the peat and clay soils under the dam have the potential to develop instability under certain loading conditions. In addition, there are layers of loose saturated slimes (fine silty tailings) within the LTV stored tailings material that extend from the central portion of Cell 2E northward and connect with the perimeter embankment, that are subject to liquefaction under certain conditions and therefore may create instability of the perimeter dam.

4.13.2 Impact Criteria

For preliminary designs of the proposed facilities that were analyzed, the MnDNR used qualitative and quantitative impact criteria to assess the geotechnical stability of each. This included liner integrity and side slope stability for the Waste Rock Stockpiles, embankment stability for the Tailings Basin, and liner integrity and embankment stability for the Hydrometallurgical Residue Facility.

4.13.3 Environmental Consequences

4.13.3.1 Proposed Action

Mine Site

Estimates of liner systems integrity as proposed in the preliminary waste rock stockpile designs (RS 49, Golder 2007) are reasonable, although the vertical infiltration (seepage) rate for the Overburden Category 1 and 2 Stockpile may be higher than predicted. Uncertainty in liner leakage infiltration rates were reviewed in section 4.1 Water Resources of this DEIS.

Proposed heights and slope angles in the preliminary waste rock stockpile designs are within typical mine engineering practice, however a slope stability assessment has not been completed. Further design and analysis will occur during permitting to ensure that the proposed construction meets acceptable design standards.

Tribal cooperating agencies strongly disagree with this approach. The Tribal cooperating agencies' position is that this approach is not consistent with the federal EIS process. The purpose of this document is to provide information for all reasonably foreseeable impacts. The lack of a stability analysis for the stockpiles is a serious data gap given the serious environmental consequences of a structural failure of a stockpile.

Plant Site

Review of the proposed NorthMet Tailings Basin preliminary design (Barr 2009, FTMP) geotechnical stability analysis indicates the perimeter embankments would be stable for unsaturated conditions, but have a low margin of safety for stability for saturated or static liquefaction conditions. Previous studies (Sitka 1995) have showed that slimes close to the dam face and clay beneath the peat in the foundation are the primary reasons for the low factors of safety. This is a special concern for Cell 2E, the area where the NorthMet tailings would be deposited, as it contains the thickest and most extensive peat in the foundation and has the weak slimes close to the dam face. This low factor of safety is a reason for reviewing and selecting mitigation measures described below.

The structural stability of the tailings basin has been a serious concern since the Polymet project was first proposed. This concern has led to the development of at least 3 different tailings basin designs that have been presented in various draft documents. Contractors reviewing these designs have expressed serious concerns with both the short-term and the long-term stability of the facility. Tribal cooperators take the position that given the history of design problems, it is irresponsible to postpone a serious analysis of the structural integrity of the latest tailings basin design until the permitting stage. A complete stability analysis must be included in the DEIS to comply with NEPA and so that the public can review a complete set of possible environmental impacts associated with this project.

Review of proposed Hydrometallurgical Residue Facility preliminary designs (RS 28T, Barr 2007) indicates it would have reasonable liner integrity and stability of embankments, however it is unknown if the slimes layer exists under the facility. Further design and analysis will occur during permitting to ensure that construction meets acceptable design standards.

The Tribal cooperating agencies' position is that this approach is not consistent with the federal EIS process. The hydrometallurgical residue facility would contain the most hazardous waste materials produced by this project that, if released to the environment, would cause serious and long lasting contamination. The unknowns listed in the previous paragraph are a serious data gap and the tribal cooperating agency position is that the analysis should be conducted and included in the DEIS to comply with NEPA and so that the public can review a complete set of possible environmental impacts associated with this project.

4.13.3.2 No Action Alternative

Mine Site

No mine facilities exist so no geotechnical stability environmental consequences occur under this alternative.

Plant Site

Although the existing LTVSMC tailings facility continues to drain down (which tends to increase geotechnical stability), there is a risk that static liquefaction (fluidizing of the saturated slimes by strain or deformation) could occur and may cause a flow failure along the impoundment perimeter if an event or stress condition triggers the liquefaction (Sitka 1997). Monitoring and inspection would continue under the LTVSMC site closure plan and the MnDNR dam safety regulations. The Tribal cooperating agencies' position is that the existing facility has stability concerns ***before*** any Polymet tailings have been deposited on top of it. This simple fact illustrates the need for a complete structural stability analysis to be performed and included in the DEIS.

4.13.3.3 Mine Site Alternative

Under this alternative, the permanent and temporary waste rock stockpiles would have no significant changes to stockpile liner systems or stockpile heights and slope angles. There is insufficient data available to determine whether specific mitigation methods would be required to maintain the appropriate slope stability of the waste dumps. However, no change in liner integrity or stockpile stability would be anticipated. Further design and analysis will occur during permitting to ensure that construction meets acceptable design standards.

Tribal cooperating agencies strongly disagree with this approach. The Tribal cooperating agencies' position is that this approach is not consistent with the federal EIS process. The EIS must identify alternatives and mitigation methods that address potential problems with the project. Sufficient data must be collected so that a complete structural integrity analysis can be performed and included in the DEIS.

4.13.3.4 Tailings Basin Alternative

Increased rock buttressing designs prepared for the northern outer embankment side slope of the existing LTVSMC tailings embankment would increase the geotechnical stability of the NorthMet Tailings Basin to within an acceptable margin of safety. Further investigations, design and analysis will occur during permitting to ensure that construction meets acceptable design standards.

The Tribal cooperating agencies' position is that this approach is that the analysis must be conducted prior to permitting and included in the DEIS.

4.13.3.5 Mitigation Measures

Mine Site

If during permitting, at which time a greater level of design detail will be available, the final designs and analyses suggest risks associated with waste rock stockpile liner system integrity, mitigation measures (such as modifying the liner materials, installation methods, seepage collection systems, etc.) would be analyzed.

If during permitting, at which time a greater level of design detail will be available, stockpile slope stability concerns are identified, mitigation measures (such as reduced heights, bench widths to reduce side slope angles, etc.) would be analyzed, and any increased impact on wetlands be assessed.

Tribal cooperating agencies strongly disagree with this approach. The Tribal cooperating agencies' position is that the purpose of an EIS is to identify mitigation measures that address potential problems in the project. The analysis described in the previous paragraph must be conducted prior to permitting and included in the DEIS.

Tailings Basin

The Tailings Basin Alternative incorporates many mitigation measures identified to improve the Proposed Action design. While many other mitigation measures were considered but determined to be less effective, they are available for reconsidering during permitting. In addition, a Dam Break analysis and risk assessment is recommended during permitting. Should the Tailings Basin Alternative be the design evaluated in permitting, and the predicted stability is determined to be insufficient through further analysis, additional mitigation measures such as increasing the rock buttress, dewatering of LTVSMC tailings slimes layer (e.g. using sand drains), etc. would be evaluated.

The Tribal cooperating agencies' position is that given the lack of confidence in the structural integrity of the tailings basin, the dam break analysis and risk assessment must be conducted prior to permitting and the results included in the DEIS so that the public can be fully informed about the risks associated with this project.

4.13.4 Cumulative Effects

No cumulative effects were identified for Geotechnical Stability.

4.14 CUMULATIVE EFFECTS

The CEQ defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR § 1508.7). In 1997, the CEQ published Considering Cumulative Effects under the National Environmental Policy Act as a comprehensive guidance document for cumulative analyses. The methodologies recommended in this guidance document were used by the EPA in their Final Protocol to Assess Expanded Cumulative Effects on Native Americans (2007) and were recommended by the MEQB as providing "the best source of guidance on cumulative impacts" (MEQB 1998). Therefore, the 1997 CEQ guidance document was used in this EIS to assess the potential cumulative impacts of the proposed NorthMet Project in combination with other past, present, and reasonably foreseeable future actions in the greater project vicinity[1].

It is the position of Tribal cooperating agencies that the CEQ guidelines on cumulative effects were only one of the sources used to develop the Protocol to Assess Expanded Cumulative Effects on Native Americans. This protocol was submitted to the lead EIS agencies with the expectation that the additional information detailed in the protocol would be used to assess cumulative impacts on the potentially affected tribes. The Tribal cooperating agency position is that while the protocol is mentioned in this section, none of the expanded data collection or analysis that the protocol recommends was done. Therefore it is the tribal cooperating agency position that the cumulative impact section is incomplete and does not properly assess cumulative effects of the proposed project on natural and cultural resources.

This section is intended to summarize the resource-specific cumulative effects analyses (refer to Sections 4.1 to 4.13) and provide an overall, synergistic analysis of the system-level cumulative effects resulting from the combined influence of the resource-specific effects to the regional airshed, watershed, and land cover surrounding the Project. In addition, this section also discusses the influence of these synergistic effects on uniquely-affected communities in the region.

The Tribal cooperating agencies' position is that there are several important topics that have not been included in this document.

- Climate Change implications of the proposed project. The project would disturb extensive areas of peat (Section 4.2) Peat is known to be an important carbon sink. Wetlands in general are recognized as important carbon sinks and areas where wildlife will seek refuge as the climate warms.
- Cumulative impacts to wild rice. Wild rice is a valuable tribal resource that has been declining throughout the 1854 ceded territory. Mine effluent is often associated with levels of sulfate that has impacted wild rice and hydrologic changes from pit dewatering and seepage from tailings basins can also impact wild rice, which is dependent upon a relatively stable hydrologic regime. The cumulative impacts to wild rice have not been assessed.

1 The greater project vicinity varies dependent upon the resource under discussion (e.g., water resources, air quality, uniquely-affected communities, etc). The specific geographic scope for each resource is further discussed within the appropriate subsection of this analysis.

- Cumulative impacts to plant and animal species that are not listed as threatened or endangered. The focus of the EIS on listed species is understandable but other species that are important to tribal and non-tribal members would likely be impacted by mining projects. Moose, for example, are likely to be impacted through disturbance along the few wildlife corridors remaining along the Mesabi range and through wetland impacts of this project. At a time when moose populations in Minnesota are declining, this analysis is particularly important and should be done as part of this EIS.
- The Cumulative effects of noise and vibration. These issues have not been analyzed although they were raised by the public during scoping.
- The Cumulative risk analysis of transportation of hazardous materials. This issue has not been analyzed.
- The cumulative effects on fish and macroinvertebrates. This discussion is limited to sulfate and mercury. Cumulative effects of habitat degradation on the fisheries of the region have not been discussed.

4.14.1 Methodology for Cumulative Effects Assessment

The 1997 CEQ guidelines recommend analyzing cumulative effects according to a tiered approach among specific resources, interconnected systems, and human communities. This hierarchical approach allows for a quantitative, resource-specific analysis as well as a synergistic, additive discussion of the system-level influence of regional actions. Under the resource-specific lens, the resources considered were identified during the scoping process as those having the potential for cumulative effects by the Proposed Action or Alternatives. If the Proposed Action or Alternatives did not result in direct or secondary impacts on a resource, then that resource was eliminated from the cumulative impact evaluation (CEQ 1997). Cumulative effects generally do not occur within predetermined political or administrative boundaries, and as such, the analysis should encompass a geophysical boundary appropriate to that resource or system. The Final Scoping Document (October 25, 2005) identified 12 resource-specific areas of concern related to cumulative effects. Table 4.13-1 provides a summary of the resource-specific concerns identified during scoping, and the spatial and temporal scales considered in this cumulative effects analysis. For those resource areas not identified in this section, no cumulative effects were identified.

The Tribal cooperating agency position is that even though cumulative effects to groundwater, vegetation (other than threatened and endangered species), visual and noise effects, hazardous materials, and cultural resources weren't considered during the initial scoping period, they were identified later in the process and therefore should have been made a part of the cumulative impacts analysis and incorporated into the DEIS.

Table 4.14-1 Resource-Specific Scope of Cumulative Effect Subject Areas

Subject Area	Spatial Scale	Temporal Scale
Hoyt Lakes Area Projects and Air Concentration in Class II Areas	NorthMet site boundary with a 10-km buffer	Existing conditions (inclusive of historic influences) through the life of the mine, including closure.
Class I Areas PM_{10} Increment	Arrowhead Region (Koochiching) Airshed	Current emissions baseline and potential outlook through 2020.
Ecosystem Acidification Resulting from Deposition of Air Pollutants	Itasca, St. Louis, Lake, and Cook Counties	Current SO_2 and NO_x emissions and sulfate and nitrate deposition baseline (inclusive of historic trends) and potential outlook through 2020.
Mercury Deposition and Bioaccumulation in Fish	Itasca, St. Louis, Lake, and Cook Counties (used emissions data from state and US)	Current emissions and deposition baseline (inclusive of historic trends) and potential outlook through 2020.
Visibility Impairment	Iron Range	Existing conditions (inclusive of historic influences) through the life of the mine, including closure.
Loss of Threatened and Endangered Plant Species	State of Minnesota	Current or historic projects with "taking" permits from MnDNR and future projects through the life of the mine, including closure.
Loss of Wetlands	Partridge River Watershed. It is the Tribal cooperating agencies position that this scale is too small to accurately assess cumulative impacts to wetlands.	Historic conditions from the 1930s to current. Future conditions through the life of the mine, including closure. It is the Tribal cooperating agencies position that cumulative effects should be assessed for however long mine impacts would occur. In the case of wetlands, this could be for hundreds of years.
Loss or Fragmentation of Wildlife Habitat	Arrowhead Region for habitat; Mesabi Iron Range plus 15-mile buffer for wildlife travel corridors	Historical trends over the last ~100 years, and future through the life of the mine, including closure. It is the Tribal cooperating agencies position that some mine features (e.g. pit lake) would become permanent features of the landscape. Therefore post closure impacts should also be included in the analysis.
Streamflow and Lake Level Changes	Upper Partridge River (including Colby Lake) and Upper Embarrass River	2004 conditions (inclusive of historic influences) through operation and post closure (independent scenarios)
Water Quality Changes	Upper Partridge River (including Colby Lake) and Upper Embarrass River	2004 conditions (inclusive of historic influences) through operation and post closure (independent scenarios)
Economic Impacts	St. Louis County and the East Range (municipalities of Aurora, Babbitt, Biwabik, Ely, Hoyt Lakes, Soudan, Tower, and the surrounding areas)	1980 (or closest available data) through closure of reasonably foreseeable projects (as defined in the Scoping Decision Document)
Social Impacts	East Range (municipalities of Aurora, Babbitt, Biwabik, Ely, Hoyt Lakes, Soudan, Tower, and the surrounding areas)	2002 conditions (inclusive of historic influences) through closure of reasonably foreseeable projects (as defined in the Scoping Decision Document)

4.14.1.1 Resource-Specific Scale

At the resource-specific scale, cumulative effects on individual resources (e.g., air quality in Class I areas or surface water quality) are analyzed to determine if the proposed Project, in combination with other actions, would adversely affect specific resources. Table 4.14-2 summarizes the findings of the resource-specific cumulative effects analyses. For a detailed analysis of each subject area, refer to the individual resource analyses (Sections 4.1 through 4.13).

It is the Tribal cooperating agencies position that the DEIS fails to adequately analyze cumulative impacts to either the Partridge or Embarrass Rivers. Cumulative impact analysis is hobbled by lack of baseline data. In Colby Lake, the community water supply for the city of Hoyt Lakes, aluminum, iron, copper, and mercury concentrations already exceed Minnesota Water Quality Standards (“WQS”). The existing large number of water-quality exceedances and the suite of constituents, particularly trace metals, exceeding WQS shows the site has not been remediated from previous mining activities. Additionally, amphibole or asbestos-like mineral fibers, known to cause digestive tract cancers in high concentrations, have been identified as existing pollutants in the Hoyt Lakes community water supply and their presence should be identified in the DEIS. Related cumulative-impacts issues such as groundwater drawdown or mounding due to multiple mine projects, water quality in aquifers impacted by previous and existing other mine projects, and surface waters such as the Partridge and Embarrass Rivers and Second Creek that are impacted by multiple mines need further analysis.

Table 4.14-2 Findings of the Resource-Specific Cumulative Effects Analysis

Cumulative Effect Subject Area	Section in DEIS	Cumulative Effects Summary
Hoyt Lakes Area Projects and Air Concentration in Class II Areas	Air Quality (Section 4.6)	The Project area is in attainment for all NAAQS. The Project and past, current, and future actions, while increasing emissions, would cumulatively comply with the Federal and state increment limits. Therefore there would be no significant cumulative effect on Class II areas. It is the Tribal cooperating agencies position is that the cumulative analysis did not account for all of the PolyMet emissions from the tailings basin, nor did it factor in emissions from the Keetac Expansion Project so that attainment for $PM_{2.5}$ might be in question due to the 24 hr standard almost being met without those sources modeled.

Cumulative Effect Subject Area	Section in DEIS	Cumulative Effects Summary
Class I Areas PM_{10} Increment	Air Quality (Section 4.6)	The Project area is in attainment for all NAAQS. The Cumulative Class I PM_{10} Increment Analysis determined that there would be no significant impacts associated with the Project and other past, current, and future actions (see Air Quality, Section 4.6.4). Cumulatively, there would be an increase in PM_{10} emissions; however, these emissions would not exceed the PSD increment l It is the Tribal cooperating agencies position that this statement can be called into question. The Class I visibility analysis performed for the project indicates that visibility impacts greater than 5 of 10 percent could occur at some point within the BWCWA on a small number of days each year. Furthermore, the Tribal cooperating agencies position is in disagreement with the assessment that there is no significant impact. That analysis did not take into effect the full particulate emissions from the tailings basin. That analysis also did not factor in any emissions from the Keetac Expansion Project, which plans to increase production by 61% by reopening another furnace line nor is there any mention of the Essar Steel Expansion project that is planned. The present analysis showed that there was very little increment left without accounting for these sources and that as such it would have a significant impact by exceeding the increment limit.
Ecosystem Acidification Resulting from Deposition of Air Pollutants	Air Quality (Section 4.6)	The Project and past, current, and future actions would increase deposition of SO_2 and NO_2; however, the deposition rate would be below Federal and state threshold values. In combination with the overall reduction in sulfate and nitrate-producing emissions since 2000, there would be a net decrease in emissions and therefore no adverse cumulative impact.
Mercury Deposition and Bioaccumulation in Fish	Air Quality (Section 4.6)	The Project and future actions would add new mercury emitting sources; however, the implementation of mercury reducing legislation will cause a reduction in existing mercury emissions in the region. This reduction will serve to off-set the new mercury sources and result in a net decrease in mercury emissions. Therefore, there would be no cumulative impact to fish from mercury deposition and bioaccumulation. Tribal cooperating agencies strongly disagree with this conclusion. Section 4.1 describes the potential for increased mercury methylation associated with this project on the St. Louis River Watershed. The conclusion presented is speculative at best and is not based on quantitative methods. This cumulative impact analysis is inadequate.
Visibility Impairment	Air Quality (Section 4.6)	The Project and future actions would add new emissions sources in the region; however, these emissions would be offset by the emissions reductions at past and current projects. There would be an overall net reduction in visibility degrading emissions; therefore, the Project and past, current, and future actions would have no cumulative impact on visibility. It is the Tribal cooperating agencies' position that the aesthetic component of visibility has not been assessed. Furthermore, consultation with the affected Tribes has not been completed. Therefore this conclusion is premature. While overall emissions may be decreasing, regional haze models do not show visibility improving enough to meet the standards set forward in the Regional Haze Rule. It is the Tribal cooperating agencies' position that mitigation strategies for NOx emissions should be aggressively pursued by the MPC and the FLM's and the implications for cumulative impacts described in the DEIS.
Loss of Threatened and Endangered Plant Species	Vegetation (Section 4.3)	Future cumulative impacts to ETSC plant species from the Project and other past, current, and future actions range from 2% to 21% of the known populations of these species. The ETSC plant species known to occur in the Project area exhibit preferences for disturbed sites and therefore will likely not experience adverse cumulative effects for the Project and past, current, and future projects.

Cumulative Effect Subject Area	Section in DEIS	Cumulative Effects Summary
Loss of Wetlands	Wetlands (Section 4.2)	The Project would result in the loss of 1,197 acres of primarily high quality wetland habitat; however, over 97% of the existing wetlands in the Partridge River watershed would remain in the foreseeable future. Wetland mitigation would occur on-site; however, would primarily be outside of the watershed (and Ceded Territory) leading to a net loss of wetland function within the watershed and Ceded Territory. Tribal cooperators strongly disagree with the estimates of wetland loss and the potential impacts of that loss; see discussion in Section 4.2 for further detail. A cumulative impact assessment should be conducted after the flaws in the wetland section have been addressed.
Loss or Fragmentation of Wildlife Habitat	Wildlife (Section 4.4)	Largest impact is due to forestry. Habitat will be increased for species requiring older forests and forests with a significant conifer component, and decreased for species that utilize young forests and non-forested habitats. Mining adds to the impact on a temporary basis (prior to closure).
Wildlife Travel Corridors	Wildlife (Section 4.4)	Impacts from new and future projects are anticipated to 10 of the 18 wildlife travel corridors; the proposed project is anticipated to have minimal effects on Corridor 12 (17). This impact would continue for the duration of operations (approximately 20 years); however, no high impact mining features would occur such that impacts to the corridor would be permanent. Tribal cooperating agencies disagree. Regarding the cumulative impacts of mining on wildlife corridors, section 4.4.5.3 states "These impacts should be considered significant" Tribal cooperating agencies are concerned that the analysis in the resource section has not been carried forward to the cumulative impacts section.
Streamflow and Lake Level Changes	Water Resources (Section 4.1)	**Partridge River:** No effect on streamflow or water levels in Colby Lake under high flow conditions. Lake levels could be affected under low flow conditions, depending on the timing of other mine dewatering activities. Tribal cooperating agencies strongly disagree. As detailed in section 4.1, the available data and anaylsis is insufficient to make this claim. This cumulative impact analysis is incomplete.
		Embarrass River: No effect.
Water Quality Changes	Water Resources (Section 4.1)	**Partridge River:** Sulfate would have no significant effect on mercury methylation risks and no effect on wild rice. Potentially contributing to a cumulative effect for mercury concentrations in fish tissue in Colby Lake due to the uncertainty regarding the West Pit overflow. It is the Tribal cooperating agencies position that the tailings basin alternative would lead to water quality impacts to the Partridge River. In combination with proposed discharges by Mesabi Nugget Phase II, and the operations of Laskin Energy, these impacts could be perpetual.
		Embarrass River: It is unknown if the wild rice standard will apply; therefore, the cumulative effects of sulfate are not evaluated at this time. As previously discussed, tribal cooperating agencies strongly disagree with this assertion. It is the Tribal cooperating agencies' position that the wild rice standard applies and they expect the state to require the project to meet it. The Proposed Action could increase mercury methylation, and therefore have a cumulative effect on downstream lakes already on the 303(d) list. The Tailings Basin Alternative would not contribute to a mercury-related effect. It is the Tribal cooperating agencies position that the cumulative effects on the Embarrass River could be perpetual.
Economic Impacts	Socioeconomics (Section 4.10)	The Project and past, present, and future development along the Iron Range would increase regional employment and spending, thereby having a beneficial impact on the regional economy
Social Impacts	Socioeconomics (Section 4.10)/ Cultural Resources (Section 4.7)	Potential for cumulative effects to indigenous land use practices. See discussion below for additive/synergistic assessment of cumulative effects to uniquely-affected communities.

4.14.1.2 System Scale

At the system level, relationships among resource-specific cumulative affect subject areas were analyzed to determine if the impacts to system components would combine for synergistic/additive effects on regional natural systems. In this DEIS, three natural systems, regional airshed, watershed, and ecoregion, were analyzed for additive and synergistic cumulative effects.

Regional Airshed

The Arrowhead Region airshed includes the seven counties in northeastern Minnesota including St. Louis County and the proposed Project area. The Arrowhead Region extends across the Mesabi Range mining areas where past and present mining activities have contributed to increased air and fugitive dust emissions from construction, extraction, and processing operations and increased vehicular traffic in support of the commercial operations. The Arrowhead Region is currently in attainment for all NAAQS and the proposed project would not violate these standards or contribute to a regional nonattainment situation or violate state air quality regulations. It is the Tribal cooperating agencies' position is that the cumulative analysis did not account for all of the PolyMet emissions from the tailings basin, nor did it factor in emissions from the Keetac Expansion Project. The attainment for $PM_{2.5}$ is questionable because the 24 hr standard is almost met without those sources included in the modeling. A detailed discussion of these standards can be found in Section 4.6. The Clean Air Act standards regulate project-specific emissions; and these project-specific regulations presumptively act to protect and preserve regional air quality. As described in Table 4.14-2, the Project and other past, current, and future actions would have no significant cumulative effects on the regional airshed. Tribal cooperating agencies disagree with this statement. The Tribal cooperating agencies' position is that the Class 1 PM_{10} increment analysis did not take into account the full particulate emissions from the tailings basin. That analysis also did not factor in any emissions from the Keetac Expansion Project, which plans to increase production by 61% by reopening another furnace line nor is there any mention of the Essar Steel Expansion project that is planned. The present analysis showed that there was very little increment left without accounting for these sources and that as such it would have a significant impact by exceeding the increment limit. Relative to mercury deposition and ecosystem acidification, the region is expected to experience a cumulative decline in the mercury, sulfates, and other acidifying compounds in the future due to new regulation, voluntary reductions, and technological improvements. Therefore, while the proposed Project would result in additional air emissions, the additive influence of actions in the region would not contribute to a significant cumulative effect on regional air quality. Tribal cooperating agencies are not aware of any quantitative analysis that would support this claim. A cumulative impact analysis should provide citations to analysis or research that supports the conclusions presented. Data from the Central Regional Air Planning Association (CenRAP) indicate that visibility in Minnesota Class I areas is not expected to improve as much as is required by the Regional Haze Rule, even with expected reductions. Aggressive mitigation of NOx emissions is expected by the MPCA and the FLM's during the permitting process. The Tribal cooperating agencies should be included in these discussions to the extent possible.

Watershed

Tribal cooperating agencies are concerned that the discussion in the following paragraph does not constitute a cumulative impact analysis. It is merely a re-statement of the impact assessment of the proposed project. The question is not whether the proposed project would affect other watersheds but whether all existing and proposed projects in the watershed would combine to affect the St. Louis River watershed. An adequate cumulative impact analysis would have quantitatively assessed the impacts of the multiple projects in the Embarrass and Partridge River watersheds. Data are available for the existing and predicted water quality impacts of Mesabi Nugget Phase I and II, the existing water quality discharges of Laskin Energy, and the legacy water quality for pit lakes for the other projects in the watershed. Predicted air quality emissions from Mesabi Nugget Phase II have also been developed. None of these data appear to have been used in the cumulative impact analysis. The tribal cooperating agency position is that a complete cumulative impact analysis should be conducted.

The St. Louis River watershed includes the Partridge and Embarrass Rivers in St. Louis County, drains the southern of the Mesabi Ridgeline, and flows south out of the Mesabi Range (Figure 4.14-2). The St. Louis River Watershed is one of several watersheds that drain the Mesabi Range, where past and present mining activities have discharged to local waterbodies; however, because the proposed Project area is solely within the St. Louis River watershed and would have no direct or indirect influence on other regional watersheds it would not contribute to any cumulative effect to those other watersheds. Similar to airsheds, the Clean Water Act regulates project-level discharges as a presumptive protection measure for regional water quality. The Project will meet the surface water quality standards for all parameters under all flow conditions for all mine years in the Partridge and Embarrass rivers. Tribal cooperating agencies disagree. The potential cumulative effects of the Project to the St. Louis River watershed are currently being evaluated. Sulfate, mercury, and specific conductance are already being exceeded in both the Partridge and Embarrass Rivers. Aluminum is being exceeded in the portions of the Embarrass River below the old LTV tailings basin and area Pit 5NW, as stated in the Water Resources section. Colby Lake (the Hoyt Lakes community water supply) already has several constituents including aluminum, iron, copper, and mercury in concentrations that exceed Minnesota Water Quality Standards. The existing large number of water-quality exceedances and the suite of constituents, particularly trace metals, exceeding WQS shows the site has not been remediated from previous mining activities. Therefore, this Project will have a cumulative effect on the waters in Colby Lake, the Partridge River and the St. Louis River.

While the Project would increase ambient concentrations of several parameters, primarily metals (e.g., antimony, arsenic, copper, nickel, and zinc), these concentrations would remain relatively low and would not combine with other activities to significantly degrade water quality within the St. Louis River watershed. It is the Tribal cooperating agencies position that water quality within the St. Louis River has already been degraded by past and present mining activities as documented by staff from Fond du Lac and the 1854 Treaty Authority. Additional discharges of sulfate, mercury and other trace metals will have a cumulative effect on water quality in the St. Louis River. An Antidegradation Analysis for the Lake Superior Basin must be conducted for several contaminants in addition to mercury. The results of this analysis should be included in the DEIS.

The Project and other ongoing and future mining activities would have the potential to cumulatively increase the mercury levels in fish tissue within the Partridge River under the

Proposed Action and Mine Site Alternative; however, there is uncertainty surrounding the Project attainment of the Great Lakes Initiative mercury standard and it is recommended for further study prior to the Final EIS. The Proposed Action would also potentially increase mercury methylation rates within the Embarrass River and cumulative affect 303(d) listed waterbodies downstream. The influence of the Project on methylation rates in the Embarrass River would be less under the Tailings Basin Alternative, and the potential for cumulative effects under this alternative would be reduced. It is the Tribal cooperating agencies position that the previous paragraph is simply a restatement of the potential impacts of the project and not a cumulative impact analysis.

The potential cumulative influences of the Project and current and future mining activities within the St. Louis River watershed are limited to mercury and sulfate concerns in the upper reaches of the watershed, as described above. The extent of influence of these effects in the lower St. Louis River watershed (below the confluence of the Embarrass and Partridge rivers) is under evaluation for inclusion in the DEIS. It is the Tribal cooperating agencies position that no analysis has been conducted to support this claim.

Ecoregion

The proposed Mine Site is located within the Superior National Forest and both the Plant and Mine sites are surrounded by federal, state, and local public lands (Figure 4.9-1). These areas provide large tracts of natural vegetative cover, including wild rice, and habitat for endemic aquatic and terrestrial wildlife species such as moose throughout northeastern Minnesota. The development of past and current mining operations throughout the Mesabi Range has led to a historic reduction in natural vegetative cover and habitat fragmentation throughout the region and the future mining activities (including the Project) would contribute to further declines in habitat during the life of their respective projects. However, Northeastern Minnesota currently retains large regional tracts of undisturbed habitat, such as wetlands, where despite the impacts of this and other Projects within the Partridge River watershed, more than 97 percent of historic wetlands still remain. Long-term reclamation plans following cessation of operations include the use of non-native, invasive species; however, the use of a native seed mix (provided it meets the reclamation goals and requirements) would mitigate the long-term forest community such that it would mimic historic, natural conditions. There would be a short-term decline in habitat availability at the Mine and Plant sites.

As discussed in Sections 4.3 and 4.4, the Project would impact some ETSC plant species, wetlands, and wildlife corridors used by large mammals (including moose). The ETSC affected species are disturbance tolerant and impacts would not be significant. Use of one of the identified wildlife travel corridors would be impaired throughout the life of the mine. Some habitat fragmentation would occur, although the impact would be largely mitigated at mine closure and overall are not expected to be significant over the long-term. It is the Tribal cooperating agencies position that the Ecoregion section is simply a restatement of the potential impacts of the project and not a cumulative impact analysis.

4.14.1.3 Uniquely-affected Communities

In the case of human communities, the CEQ guidelines recommend analysis along sociocultural boundaries, or human communities that would be uniquely affected, rather than arbitrary political or administrative units. The uniquely affected communities in this Project area the Native American tribes within the 1854 Ceded Territory in northeastern Minnesota. These tribes have culturally-unique ties to the natural landscape that would potentially be uniquely impacted by the proposed project and therefore has the potential for cumulative effects to the tribes with cultural ties to the natural landscape. These impacts can manifest themselves in many ways, such as the loss of significant cultural landscapes, the loss of ancestral and/or sacred sites, and deterioration in the health or availability of animal and plant populations culturally associated with traditional diets, hunting practices, or spiritual practices.

These communities have used lands with the Ceded Territory for traditional culture purposes including wild rice harvesting and moose hunting. Wild rice communities are found within the Embarrass, Partridge and St. Louis Rivers; however, the Plant Site, Mine Site, and Transportation Corridors do not support wild rice communities. Moose do occur in the vicinity of the Project; however, their populations are relatively low in this area compared to other portions of the 1854 Ceded Territory. The MN wildlife advisory committee studying the decline of the moose population in northeastern Minnesota has recommended preserving wetlands as sanctuaries for moose from heat stress. The committee also recommended allowing a very limited moose hunting season, and to end the moose hunting season immediately if low hunter success indicates the population ahs dropped to critical levels. The Project is proposing the largest direct wetland fill ever permitted in this region. The wetland mitigation that is being proposed would be outside of the St. Louis River watershed and 1854 ceded territory. Two major wildlife corridors that moose currently use will be impacted by the Project. The Project will have cumulative effects on the moose herd and Tribal harvest in the 1854 ceded territories. Consultation between the USACE and Native American tribes to identify an indirect APE for the Project is ongoing.

The Project, as currently proposed, would result in a permanent loss of tribal access to public lands for traditional uses, although it should be noted that access to the Mine Site area via the Dunka Road is currently restricted and would continue to be restricted in the absence of the Project. Tribal cooperating agencies disagree with this characterization. Use of the road is restricted but access to the area through other Forest Service roads is open to the public. It is unclear to what extent these specific Project lands have been used by tribal members in the recent past, and these lands do not support wild rice or large moose populations, which are common tribal uses of public lands, nevertheless, the loss of public access represents an adverse effect to the tribes. Tribal cooperating agencies disagree with the assertion that the land does not support wild rice or large moose populations. Wild rice grows in the Partridge River and a substantial moose population has been identified in the mine site area by aerial and ground surveys. Therefore cumulative effects to both wild rice and moose must be considered. For the Mine Site, the USFS and PolyMet have been working together to complete a land exchange to resolve the current split estate between Federal surface overlying private mineral rights. The USFS has identified approximately 6,700 acres of National Forest land to exchange to PolyMet for yet to be determined non-federal land. However, it is currently unknown if this non-federal land would occur within the 1854 Ceded Territory and be available to the affected tribes, thereby reducing the effect of the Project on tribal access to lands within the 1854 Ceded Territory.

5.0 COMPARISON OF ALTERNATIVES

Minnesota law requires that an EIS include a discussion of alternatives (*Minnesota Statutes* section 116D.04 and section 116D.045; and *Minnesota Rules* part 4410.0200 through part 4410.7500) and alternatives that incorporate reasonable mitigation measures as identified during the scoping process and public comment periods (*Minnesota Rules* part 4410.2300, item G). Section 3.2.2.2 of this DEIS describes the alternatives and reasonable mitigation and monitoring measures considered during the scoping process. This chapter compares the identified reasonable alternatives and potential mitigation measures.

5.1 ALTERNATIVES CONSIDERED IN THE DEIS

Four alternatives were carried forward for analysis in the DEIS: the Proposed Action, the Mine Site Alternative, the Tailings Basin Alternative, and the No Action Alternative. The three action alternatives are differentiated by their treatment of the Category 2, 3, and 4 waste rock and tailings. Under the Proposed Action, the Category 2, 3, and 4 waste rock stockpiles would be revegetated as part of the Mine Site reclamation and remain permanent surface features. The Mine Site Alternative would temporarily store the Category 2, 3, and 4 waste rock at the surface; however, most of the Category 2 and all Category 3 and 4 waste rock would ultimately be disposed as backfill in the mine pits and submerged. The Category 2 and 3 waste rock stockpiles would be replaced with less-reactive Category 1 waste rock and the Category 4 waste rock stockpile would be permanently eliminated. The Tailings Basin Alternative would install vertical wells and test a permeable reactive barrier (PRB) along the northern toe of the Tailings Basin to treat seepage, construct a partial dry cap over the tailings basin to decrease surface water infiltration, and raise the height of the rock buttress along the northern slope of the Tailings Basin to increase geotechnical stability. The No Action Alternative would result in closure of a portion of the Plant Site as per the existing Cliffs Erie closure plan; however, no mining activities would occur. Table 5.1-1 compares the anticipated impacts of the Proposed Action with the Mine Site, Tailings Basin, and No Action Alternatives. Mitigation measures that address some or all of the anticipated impacts are described in Section 5.2 below.

It is the position of the Tribal cooperating agencies that the Proposed Action has a number of serious flaws that must be addressed, both from the perspective of the substantive environmental impacts of the Proposed Action and from the perspective of presenting an adequate assessment of the potential impacts that the Project may cause. These include the likelihood of structural failure at the tailings facility, the lack of structural integrity information for the proposed stockpiles, and the need for perpetual water treatment to avoid contamination to surface and groundwater resources.

It is the position of the Tribal cooperating agencies that the tailings basin alternative is also seriously flawed due to the lack of accounting for the interaction between basin seepage and the existing tailings and the long-term water quality treatment that would be needed to prevent significant environmental impacts. As indicated in section 4.1, the Permeable Reactive Barrier (PRB) that is proposed to be pilot tested during operations would require periodic recharging/replacement that would last for as long as water treatment is needed. The length of time that water treatment would be needed for tailings basin effluent has not been defined in this document but is likely to last centuries. In addition, it is likely that the proposed discharge of untreated tailings basin water to the Partridge River that is part of this alternative would further exacerbate water quality violations already occurring.

It is the position of the Tribal cooperating agencies that the environmental impacts associated with the mine site alternative have not been adequately defined. It is not possible to completely evaluate the environmental impacts of this alternative to surface water, groundwater, or wetlands due to the lack of baseline water quantity and quality information, the lack of knowledge on groundwater flow and the lack of understanding of the interconnections of groundwater and the extensive wetland complexes in the area. What data is available for the mine site, suggests that water treatment would be needed for an unspecified period of time (likely centuries) in order to avoid contamination to the Partridge River. It is the position of the Tribal cooperating agencies that these serious data and knowledge gaps must be addressed prior to the release of the DEIS.

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Table 5.1-1 Comparison of the Proposed Action, Mine Site Alternative, Tailings Basin Alternative, and No Action Alternative

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Water Resources				
Groundwater levels at the Mine Site	Drawdown expected during mine operations and filling of West Pit (~65 years), but minimal impact to surrounding wetlands expected. As stated in sections 4.1 and 4.2, Tribal cooperating agencies strongly disagree with this conclusion.	Drawdown expected during mine operations and filling of West Pit (~65 years), but minimal impact to surrounding wetlands expected. As stated in sections 4.1 and 4.2, Tribal cooperating agencies strongly disagree with this conclusion.	Not applicable	No effect
Groundwater quality at the Mine Site	Manganese, nickel, and possibly antimony concentrations would exceed either USEPA primary MCLs or MDH Health Risk Limits in groundwater, potentially for long term. Sulfate concentrations would exceed USEPA secondary MCLs.	Antimony concentrations may exceed USEPA primary MCL and MDH Health Risk Limits.	Not applicable	No effect
Flows in the Upper Partridge River	Minimal reduction in annual 7-day low flow (~0.1 cfs). No significant effect on river morphology or 100-year floodplain. As stated in section 4.1, Tribal cooperating agencies believe this conclusion is unsupported.	Minimal reduction in annual 7-day low flow (~0.1 cfs). No significant effect on river morphology or 100-year floodplain. As stated in section 4.1, Tribal cooperating agencies believe this conclusion is unsupported.	Not applicable	No effect

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Water quality in the Upper Partridge River	All parameters would meet surface water quality standards under all flow conditions for all mine years. West Pit overflow in Closure is predicted to initially exceed standards, but should be able to be treated if necessary and water quality is expected to improve over time. Tribal cooperating agencies' position is that this is misleading. Pit water quality would exceed surface water standards for the foreseeable future.	All parameters would meet surface water quality standards under all flow conditions for all mine years. West Pit overflow in Closure predicted to initially exceed standards, but water quality is expected to improve over time. Tribal cooperating agencies' position is that this is misleading. Pit water quality would exceed surface water standards for the foreseeable future.	Not applicable	No effect
Water levels in Colby Lake	Negligible increase in average water level drawdown and improvement in maximum annual fluctuation and % days below critical lake elevation.	Negligible increase in average water level drawdown and improvement in maximum annual fluctuation and % days below critical lake elevation.	Reduced water withdrawals (Maximum Recycle Option only) should maintain higher water levels in Colby Lake and reduce water level fluctuations in Whitewater Reservoir, while the No Recycle Option would have negligible effect on average water level drawdown in either reservoir.	No effect
Water quality in Colby Lake	Predicted to meet all water quality standards for all flow conditions for all mine years.	Predicted to meet all water quality standards under all flow conditions for all mine years.	Not applicable	No effect
Flows in the Lower Partridge River	Reduce flows by as much 10.5 cfs (9%) and increase the frequency of low flows.	Reduce flows by as much 13 cfs (12%) relative to a mean annual flow of approximately 111 cfs at the Aurora gaging station on the Partridge River.	Average flow reduced by between 3.5 cfs (Max Recycle Option) and 5.4 cfs (No Recycle Option), but should have negligible effect on river morphology.	No effect

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Water Quality in Lower Partridge River	All parameters should meet surface water quality standards under all flow conditions for all mine years.	All parameters should meet surface water quality standards under all flow conditions for all mine years.	Discharge of between 1.1 cfs (Maximum Recycle Option) and 5.2 cfs (No Recycle Option) of seepage pumped from vertical wells to the Partridge River would meet all surface water quality standards under all flow conditions for all mine years, although it would significantly increase the sulfate loadings. Tribal cooperating agencies disagree. The wild rice sulfate standard would be exceeded.	No effect.
Groundwater levels downgradient of the Tailings Basin	Groundwater seepage would exceed aquifer flux capacity resulting in significant seepage upwelling and wetland impacts.	Not applicable	Pumping by vertical wells would reduce the amount of unrecovered NorthMet seepage by approximately 95% during operations and 150% during Closure (until pumping is allowed to cease) relative to existing conditions.	Groundwater seepage would exceed aquifer flux capacity resulting in continued seepage upwelling and wetland impacts

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Groundwater quality downgradient of the Tailings Basin	Seepage from the Tailings Basin would generally meet groundwater evaluation criteria with the possible exception of aluminum and manganese. These two parameters are USEPA secondary MCL standards for managing aesthetics considerations and not to protect human health, and both of which are naturally found in elevated concentrations in the Project area. Tribal cooperating agencies disagree. Existing contamination is not included in the groundwater quality analysis, therefore, impacts are not fully characterized.	Not applicable	Seepage from the Tailings Basin would meet USEPA primary MCLs and MDH Health Risk Limits.	Anticipate slight improvement in groundwater quality as Areas of Concern are investigated and remediated as appropriate.
Flows in the Embarrass River	Net 6% increase in average flow during operations and net decrease of 1% during Closure would have negligible effect on Embarrass River.	Not applicable	Average flow reduced by 1.7 cfs (during operations) and 2.1 cfs (during Closure), but should have negligible effect on river morphology.	Slight reduction in base flow as a result of gradually reduced seepage rate from Tailings Basin.
Water quality in the Embarrass River	Generally all parameters would meet surface water quality standards during all flow conditions for all mine years. Elevated sulfate concentrations (146 mg/L at PM-13), however, could exceed “wild rice waters” standard if applicable. Tribal cooperating agencies strongly maintain that the wild rice standard applies.	Not applicable	All parameters would meet all surface water quality standards in the Embarrass River under all flow conditions for all mine years. Tribal cooperating agencies disagree. Existing contamination is not included in the groundwater quality analysis, therefore, impacts are not fully characterized.	Potential slight improvement in water quality as Areas of Concern are investigated and remediated as appropriate

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Mercury in Water	Relatively high sulfate concentrations in seepage from Tailings Basin would be released to wetlands north of the Tailings Basin and lakes downstream on Embarrass River that represent "high risk situations" for mercury methylation. There is some uncertainty as to whether the West Pit overflow would meet the Lake Superior mercury standard.	There is some uncertainty as to whether the West Pit overflow would meet the Lake Superior mercury standard.	Significant reduction in mercury methylation risk by reducing NorthMet sulfate loadings from Cells 1E/2E by over 70% relative to existing conditions. Tribal cooperating agencies disagree. A reduction in mercury methylation risk in the Embarrass River would be accompanied by an increase in mercury methylation risk in the Partridge River.	Relatively high sulfate concentrations in seepage from Tailings Basin would continue to be released to wetlands north of the Tailings Basin and lakes downstream on Embarrass River, both of which represent "high risk situations" for mercury methylation.
Wetlands				
Direct Impacts	Direct impact to 850 acres to forested, scrub/shrub, and open water wetlands.	Similar to the Proposed Action. Elimination of some permanent surface stockpiles would slightly reduce impacts at the Mine Site during Closure and Post-Closure.	Similar to the Proposed Action; however, additional direct impacts (approximately 5.2 acres) due to water discharge pipeline.	No effect. Historically-disturbed wetlands at the Plant Site would revert to natural hydrology quicker than under the action alternatives.
Indirect Impacts	Indirect impact to 638 acres of due to wildlife fragmentation and hydrologic effects. Tribal cooperating agencies disagree. As described in section 4.2, indirect impacts are likely to be greater.	Similar to the Proposed Action. Leachate and runoff water quality would improve due to subaqueous disposal of reactive waste rock. Tribal cooperating agencies disagree. As described in section 4.2, indirect impacts are likely to be greater.	No effect.	No effect. The tribal cooperating agencies' disagree. The existing tailings basin effluent would continue to affect existing wetlands to the north.
Vegetation				
Cover Types	Loss of native vegetation cover until completion of the reclamation actions (e.g., the life of the mine plus up to 40 years depending on cover type).	Similar to the Proposed Action; however, the elimination of some permanent surface stockpiles would reduce the loss of vegetation communities at the Mine Site during Closure and Post Closure.	Permanent loss of forested areas along expanded right-of-way for water discharge pipeline.	Increased native species cover at the Plant Site following partial Closure. Loss of vegetation cover due to ongoing logging efforts.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Non-Native Invasive Species	Revegitation would introduce invasive, non-native species.	Same as the Proposed Action	Potential emigration of invasive species through natural means.	Potential emigration of invasive species through natural means.
ETSC Species	Direct impacts to six of the nine ETSC populations at the Mine Site including loss of populations. Indirect impacts to all ETSC species due to changes in hydrology and other surface conditions	Same as the Proposed Action.	No effect	Direct impacts due to logging influence on habitat types. Indirect impacts due to natural succession influence on habitat types.
Wildlife				
Wildlife Habitat	Loss of natural wildlife habitat until completion of the reclamation actions (e.g., the life of the mine plus up to 40 years depending on habitat type). The tribal cooperating agencies' position is that impact characterization is incomplete.	Similar to the Proposed Action; however, the elimination of some permanent surface stockpiles due to subaqueous disposal would reduce the loss of natural habitat at the Mine Site at Closure.	No significant effect.	Limited beneficial effect following partial Closure of the Plant Site. No effect at the Mine Site. The tribal cooperating agencies' position is that no analysis is provided to justify this claim.
ETSC Species	Potential to impact Canada Lynx (federally threatened species) and Grey Wolf at the Mine Site. The tribal cooperating agencies' position is that impact characterization is incomplete.	Same as the Proposed Action.	No significant effect.	Limited beneficial effect following partial Closure of the Plant Site. No effect at the Mine Site. The tribal cooperating agencies' position is that no analysis is provided to justify this claim.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Fish and Macroinvertebrates				
Water Quality	Embarrass River would exceed aluminum standard downstream of groundwater discharges affected by the NorthMet Plant Site and exacerbate existing aluminum stress in the Partridge River. The Tribal cooperating agencies' position is that sulfate and mercury methylation impacts would increase.	Same as the Proposed Action.	All parameters would meet all surface water quality standards in the Partridge River. Tribal cooperating agencies disagree. Increased mercury methylation is likely due to the discharge of high sulfate tailings water.	No effect. The tribal cooperating agencies' disagree. The existing tailings basin effluent would continue to affect existing wetlands and the Embarrass River.
Physical Habitat	No significant effect.	No significant effect.	No significant effect.	No effect.
Mercury and Bioaccumulation	Potential increase in the availability of methylmercury to fish. The tribal cooperating agencies' reiterate the PCA's position that increased sulfate in the tailings basin seepage interacting with the wetland complexes would constitute a high risk mercury methylation scenario. The extent of this impact has not been characterized.	Same as the Proposed Action	Reduce methyl mercury formation in wetlands north of the Tailings Basin and lakes along the Embarrass River. Tribal cooperating agencies disagree. The reduction in methylmercury in the Embarrass River would be accompanied by an increase in the Partridge River.	No effect. The tribal cooperating agencies' disagree. The existing tailings basin effluent would continue to affect existing wetlands and the Embarrass River. The potential for mercury methylation would continue.
Air Quality				
	No significant effect.	No significant effect.	No significant effect.	No effect.
Noise				
	No significant effect. Tribal cooperating agencies disagree. The analysis and available data do not support this conclusion.	No significant effect. Tribal cooperating agencies disagree. The analysis and available data do not support this conclusion.	No significant effect. Tribal cooperating agencies disagree. The analysis and available data do not support this conclusion.	No effect.
Cultural Resources				

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Historic/ Archaeological Resources	No significant effect. Potential effect on the Concentration Plant, an NRHP eligible property. Tribal cooperating agencies disagree. The analysis and available data do not support this conclusion.	No significant effect. Tribal cooperating agencies disagree. The analysis and available data do not support this conclusion.	Same as the Proposed Action.	No effect.
Tribal Use	If the land exchange is within the 1854 Ceded Territory and of similar size and ecological value, then there would be a limited impact to tribal uses. The Tribal cooperating agency position is that the PDEIS does not contain any data or analysis that would support this conclusion.	Same as the Proposed Action.	Same as the Proposed Action.	No effect. The Tribal cooperating agency position is that the PDEIS does not contain any data or analysis that would support this conclusion. Increased access to natural resources may occur.
Compatibility with Plans and Land Use Regulations				
	The reclamation plan proposes use of non-native, invasive species for replanting. Loss of access to Mine Site lands during life of the Mine would be offset by areas gained through land exchange. The Tribal cooperating agency position is that the PDEIS does not contain any data or analysis that would support this conclusion. No violation of the state and local land management plans would occur.	Same as the Proposed Action.	Same as the Proposed Action.	No effect.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Socioeconomics				
	Beneficial effect: Local increase in employment, taxes, and spending. The local infrastructure can support the anticipated influx of workers; therefore, there would be no significant effect on community infrastructure. Tribal cooperating agencies' position is that this section fails to address negative impacts, and the conclusions are therefore unsupported.	Same as the Proposed Action.	Same as the Proposed Action.	No effect. Tribal cooperating agencies disagree. The ongoing cost of cleanup of legacy contamination should be addressed.
Visual Resources				
	No significant effect. The Tribal cooperating agency position is that the PDEIS does not contain sufficient data or analysis that would support this conclusion.	No significant effect. The Tribal cooperating agency position is that the PDEIS does not contain sufficient data or analysis that would support this conclusion.	No significant effect. The Tribal cooperating agency position is that the PDEIS does not contain sufficient data or analysis that would support this conclusion.	Limited beneficial effect following partial Closure of the Plant Site. No effect at the Mine Site. The Tribal cooperating agency position is that the PDEIS does not contain sufficient data or analysis that would support this conclusion.
Hazardous Materials				
	No significant effect.	No significant effect.	No significant effect.	No effect.
Geotechnical Stability				
	Tailings Basin embankment stability would have low margin of safety.	Same as the Proposed Action.	Potential increased stability of the Tailings Basin embankment due to increased buttress design. No effect at Mine Site.	Slight risk of slumping at the north toe of the Tailings Basin. No effect at the Mine Site.

5.2 MITIGATION AND MONITORING MEASURES

5.2.1 Mitigation Measures

During the EIS scoping process, additional mitigation measures were identified for consideration to minimize the potential impacts from the Project. The mitigation measures were analyzed, revised or eliminated, and additional mitigation measures were identified during the development of the DEIS to develop the agency-recommended mitigation and monitoring measures for the Project. A summary of these recommended mitigation and monitoring measures are presented in the Table 5.2-1 below. The table identifies whether the mitigation measure is applicable to the Proposed Action (PA), Mine Site Alternative (MSA), Tailings Basin Alternative (TBA), or all three (All). Refer to Section 3.2.2 and the resource-specific sections in Chapter 4 of the DEIS for a detailed description and the potential benefits of the measures. Note that many of these measures are suggested for consideration in permitting, as appropriate.

5.2.2 Monitoring Measures

PolyMet developed a proposed monitoring program for Project operations and closure (RS52, Barr 2007), which includes water quality and flows, wetlands, and dam safety. In this DEIS we have identified some critical factors for monitoring. PolyMet's proposed monitoring program will be refined if the Project moves forward to permitting, including our recommended measures. As indicated in section 3.1.7, the Tribal cooperating agency position is that closure information is inadequate and incomplete.

It is the position of tribal cooperating agencies that the Permeable Reactive Barrier (PRB) is a necessary component of the tailings basin alternative, and should be included as part of that alternative instead of being listed in Table 5.2-1. In addition, pretreatment of tailings basin water captured by the perimeter well system prior to discharge into the Partridge River should be added as a potential mitigation measure. Finally the replacement of outdated rail cars that are likely to spill ore dust along the rail line should be added to the mitigation measure table.

Table 5.2-1 Summary of Mitigation Measures

Resource	Mitigation Measures	Applicability	Section in Text
4.1 - Water Resources	Increase the stockpile overliner cover to 24 to 26 inch-thick	PA, MSA	4.1.3.5
	Chemical modification of reactive waste rock stockpiles	PA, MSA	4.1.3.5
	Maximize the elevation of the Category 1 and 2 stockpile	PA, MSA	4.1.3.5
	Revised overburden management for sulfate, mercury and other heavy metals, if sampling indicated significant leaching concerns	PA, MSA	4.1.3.5
	Treat drainage from the Overburden Storage and Laydown Area as process water at the WWTF.	PA, MSA	4.1.3.5
	Treatment of West Pit overflows after Year 45 (various methods)	PA, MSA	4.1.3.5
	Stormwater management at the Plant Site	PA, TBA	4.1.3.5
	Use of alternative embankment material at the Tailings Basin	PA, TBA	4.1.3.5
	Retain the seepage barrier to Second Creek after Closure	PA, TBA	4.1.3.5
	Permeable Reactive Barrier	PA, TBA	4.1.3.5
4.2 - Wetlands	Maximize the elevation of the Category 1 and 2 stockpile	PA, MSA	4.2.4.2
	A wetland monitoring plan to characterize indirect effects on wetlands and provide for potential mitigation, including additional compensatory mitigation, as needed. The Tribal cooperating agency position is that the wetland monitoring plan should be developed and included in the DEIS.	All	4.2.4.3
4.3 - Vegetation	Use a native species seed mix to stabilize disturbed areas during site reclamation	All	4.3.3.5
	Fencing/Flagging ETSC plant species along Dunka Road	PA, MSA	4.3.3.5
	Maximize the elevation of the Category 1 and 2 stockpile	PA, MSA	4.3.3.5
4.4 – Wildlife	Vehicular prevention and avoidance techniques including speed limits and driver instructions for Dunka Road users	PA, MSA	4.4.3.5
	Use a native species seed mix to stabilize disturbed areas during site reclamation	All	4.4.3.5
	Limit access to the Mine Site during reclamation through signage, barriers, berms to facilitate habitat restoration and wildlife use. Tribal cooperating agencies disagree. Barriers and berms could add to impacts on wildlife.	PA, MSA	4.4.3.5
	Maximize the elevation of the Category 1 and 2 stockpile	PA, MSA	4.4.3.5
4.5 - Fish and Benthic Macroinvertebrates	Develop a mercury monitoring plan for the Mine Site. The Tribal cooperating agency position is that the wetland monitoring plan should be developed and included in the DEIS.	PA, MSA	4.1.3.5
4.6 - Air Quality	Replace older locomotives with units that meet USEPA Tier III requirements	PA, MSA	4.6.3.5
	Use premium efficiency motors in the Power Plant	PA, TBA	4.6.3.5
	Use electric rather than diesel-powered drilling and excavation equipment	PA, MSA	4.6.3.5

Resource	Mitigation Measures	Applicability	Section in Text
	Water and other dust suppressant applications during construction and operation	All	4.6.3.5
	Minimize drop distances during loading and stockpiling	All	4.6.3.5
	Dry baghouse controls at the crushing plant	PA, TBA	4.6.3.5
4.7 - Noise	Adjust drill hole density and add delay weights to mitigate vibrations	PA	4.7.3.5
	Maintain air overpressure levels through delay weight reductions	PA	4.7.3.5
	Avoid unfavorable atmospheric conditions during blasting	PA	4.7.3.5
	Schedule blasting at a consistent time daily	PA	4.7.3.5
4.8 - Cultural Resources	Land exchange should be within the 1854 Ceded Territory and be of similar size and ecological value to the Project lands.	PA, MSA	4.8.3.5
	Develop recordation plan for the Concentrator Building and portions of the Mine/Plant track	All	4.8.3.5
4.9 - Compatibility with Plans and Land Use Regulations	Use a native species seed mix during reclamation	All	4.9.3.5
4.10 - Socioeconomics	No mitigation measures identified		4.10.3.5
4.11 - Visual Resources	Shield light sources to direct operating lights downward	PA, MSA	4.11.3.5
4.12 - Hazardous Materials	No mitigation measures identified.	All	4.12.3.5
4.13 – Geotechnical Stability	No specific mitigation measures identified at this time. Additional mitigation to be considered during permitting, as necessary. Tribal cooperating agency position is that more analysis on geotechnical mitigation measures is needed given the serious concerns regarding tailings basin and stockpile structural integrity.	All	4.13.3.5

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